2015 Yonsei-Nagoya University

Research Exchange Meetings in Health Sciences & Nursing

2015. 11. 5. – 11. 7.

YONSEI,
where we make *history*

Yonsei University Wonju Campus

Wonju, Republic of Korea

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Preface

As the Dean of College of Health Sciences, it is my utmost pleasure to host 2015 Yonsei-Nagoya University Research Exchange Meeting in Health Sciences (November 5-7th, 2015) at the Yonsei University Wonju Campus. On behalf of the Yonsei University Wonju Campus, I would like to extend my heartfelt welcome to the delegates from Nagoya University who travelled long distances to take part in this research exchange meeting. I am very excited to welcome you to our community here at Yonsei

I believe that this meeting will be a unique forum to exchange ideas, to discuss not only the results of their research work but also matters of mutual interest and concerns, and to share experiences among professors and students between the two universities.

This is the 6th meeting jointly held by the two institutions, since the 1st meeting was held in Nagoya University in 2010. The history of this meeting is still young and beginning stage of our joint efforts. We've just taken a first step toward building a greater cooperation. I am very excited to see what we will be able to produce and accomplish through this joint meeting.

I also hope that your visit to our campus will provide you with a great opportunity to get to know Korea and the Korean people as well as experience Korean culture in a fragrant fall atmosphere. I once again welcome all of you who are visiting Yonsei University Wonju Campus and I believe that your visit to our campus ensure for our bilateral cooperation and partnership between the two institutions to closely work together in the years to come.

Thank you.

Jong Bae Kim, DVM, PhD
Dean
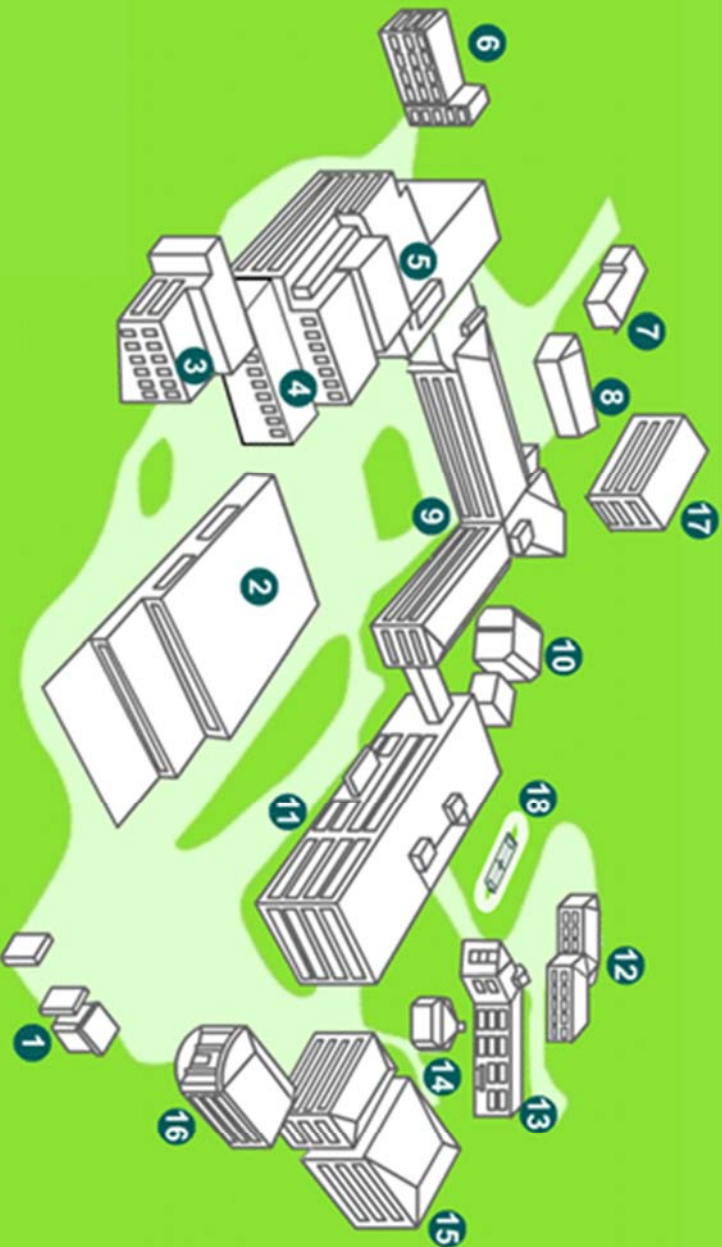College of Health Sciences, Yonsei University

Professor
Department of Biomedical Laboratory Science, Yonsei University

Itinerary

Date	Time	Schedule	Others
2015. 11. 5. **(Thursday)**	- 11:35	Flight from Nagoya to Incheon	11 professors and 17 students KE752
	11:50 - 13:00	Lunch in Korean restaurant	Near Incheon airport
	13:00 - 15:00	Move to Namisum in Chuncheon	
	15:00 - 16:00	Namisum tour	
	16:00 – 17:40	Move to Inter-Burgo hotel	
	17:40 - 18:00	Check in, Inter-Burgo hotel	Professors
	18:00 - 21:00	Welcome ceremony and banquet	Inter-Burgo hotel
	21:00 -	Move to dormitory and check in	students
2015. 11. 6. **(Friday)**	8:00 - 9:30	Breakfast	Professors: Inter-Burgo hotel Students: school cafeteria
	9:30 - 10:00	Move to conference site	Yonsei University, Wonju Campus
	10:00- 11:00	Opening ceremony	Baekwoon Hall 120
	11:00 - 12:00	Departmental presentations	Arranged by each department
	12:00 - 14:00	Lunch	Committee meeting (Baekwoon 4th floor, iBMW)
	14:00 - 17:00	Departmental presentations	Arranged by each department
	17:00 - 19:00	Dinner	Arranged by each department
	19:00 -	Move to Inter-Burgo hotel	Professors
2015. 11. 7. **(Saturday)**	8:00 - 9:00	Breakfast and check-out	Students: Dormitory 2 students
	09:00-09:30	Move to Inter-Burgo hotel	
	09:30-09:45	Inter-Burgo hotel checkout	Professors: Inter-Burgo hotel 10 professor
	9:40 - 09:50	Move to hanji theme park	
	10:00 - 11:00	Hanji theme park tour	
	11:00 – 11:30	Move to pig culture center	
	11:30 - 13:30	Lunch and tour	Pig culture center
	13:30 - 16:00	Move to Incheon international airport	
		Departure for Nagoya	10 professors, 2 students KE751

1. Main Gate
2. Husang-Gwan
3. **Regionsl Emergency Medical Center, Gastroenterology Center**
4. Health Promotion Center, Cancer Center
5. Judy Memorial hall (Clinic, Ward)
6. Dormitory(Nurse)
7. Vocational Rehabilitation Center, Dormitory(Doctor)
8. **Worship room,** Labor Union
9. Moon Chang Mo Memorial hall
10. Laboratory of Experimental Animal
11. Euihak-Gwan(Main **Building**)
12. Woneui -1-Haksa(Student Dormitory)
13. Woneui -2-Haksa(Student Dormitory)
14. Ilsan Historical Materials Pavilion
15. Jili-Gwan(Medical Library)
16. Luke Auditorium
17. Funeral Hall
18. Playground

연세대학교 원주캠퍼스
YONSEI UNIVERSITY WONJU CAMPUS

1. 정문 Main Gate
2. 대학교회 University Church
3. 대학본부 Headquarters of Administration
4. 정의관 Jeongui Hall
5. 청송관 Cheongsong Hall
6. 창조관 Changjo Hall
7. 백운관 Baekun Hall
8. 미래관 Mirae Hall
9. 중앙도서관 Main Library
10. 학생회관 Student Union

11. 연세프라자 Yonsei Plaza
12. 연세스포츠센터 Yonsei Sports Center
13. 종합운동장 Athletic Field
14. 테니스장 Tennis Court
15. 노천극장 Amphitheater
16. 대학박물관 University Museum
17. 학군단 1071 Reserve Officers' Training Corps

18. 매지 1학사 Maeji 1 Haksa (Dormitory)
19. 매지 2학사 Maeji 2 Haksa (Dormitory)
20. 매지 3학사 Maeji 3 Haksa (Dormitory)
21. 청연학사 Cheongyeon Haksa (Dormitory)
22. 세연 1학사 Seyon 1 Haksa (Dormitory)
23. 세연 2학사 Seyon 2 Haksa (Dormitory)
24. 세연 3학사 Seyon 3 Haksa (Dormitory)
25. 현운재 Hyonunjae (Guest House)

26. 첨단의료기계테크노타워 Medical Industry Techno Tower
27. 첨단의료기기벤처센터 Medical Industry Venture Center
28. 환경녹색기술센터 Eco Environmental Technology Center
29. 장애인창업보육센터 Business Incubator Center for the Disabled
30. 창업보육센터 Business Incubator Center
31. 무궁화동산 The Rose of Sharon Park

- 7-

Organizing committee

김종배	(Jong Bae Kim)	Dean, College of Health Science	Department of Biomedical Laboratory Science
김희중	(Hee Joung Kim)	Professor	Department of Radiological Technology
최지혜	(Ji Hea Choi)	Assistant Professor	Department of Nursing
민철희	(Chul Hee Min)	Assistant Professor	Department of Radiological Technology
전보영	(Bo Young Jeon)	Associate Professor	Department of Biomedical Laboratory Science
전혜선	(Hey-Seon Jeon)	Professor	Department of Physical Therapy
박지혁	(Ji Hyuk Park)	Assistant Professor	Department of Occupational Therapy

Sponsors

College of Health Sciences Yonsei University
Institute of Health Science Yonsei University
Yonsei University Wonju Campus

Abstracts

NURSING

2015 Yonsei-Nagoya University Joint Symposium on Department of Nursing

Date: 2015.11.06.(Fri)

Moderator: Prof. Jihea CHOI

Session I

11:20~11:40	Welcome & Introduction of YUWCM Dept. of Nursing	Prof. SoMi PARK
11:40~12:00	Introduction of Nagoya University Dept. of Nursing	Prof. Midori ASANO
12:00~14:00	Lunch Break	

Session II

14:00~14:15	Recognition of the family and child in allergy nursing practice for shared decision-making in Japan	Prof. Midori ASANO
14:15~14:30	Effects of simulation-based training for basic life support using video-assisted debriefing on non-technical skills and technical skills of nursing students	Jin Hwa KOH
14:30~14:45	Relation between patients' information sharing and job satisfaction among home visiting nurses	Akiyo TSUJI
14:45~15:00	Nursing clinical judgement for schizophrenic inpatients to prevent the early readmission : The case of one nurse	Shigeyoshi MAKI
15:00~15:15	Coffee Break	

Session III

15:15~15:30	Husbands' experiences on their partners' postpartum depression in Japan: A qualitative study	Prof. Hiroe YAMAMOTO
15:30~15:45	The factors to affect the during of exclusive breast feeding of the infant mothers	Yong Ju JUNG
15:45~16:00	Current status and issues of research on the burden of family care-givers of elderly with dementia	Tsubasa AOYAMA
16:00~16:15	Effects of self-directed feedback practice using smartphone videos on basic nursing skills, confidence in performance and learning satisfaction	Seul Gi LEE
16:15~16:45	Discussion	Prof. Hee Young SONG
16:45~17:00	Closing Mark	Prof. SoMi PARK

Recognition of the Family and Child in Allergy Nursing Practice for Shared Decision-Making in Japan

Midori Asano[1], Tomoko Yamada[2], Makoto Ishii[1][2], Chikae Yamaguchi [1][3]

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2) Department of Nursing, College of Life and Health Sciences, Chubu University, Kasugai, Japan
3) School of Nursing, Nagoya City University, Nagoya, Japan

Purpose and Background

In this presentation, I would like to talk about shared decision-making (SDM) between the child and family dyad, in which the child has an allergy, and health care providers, especially nurses in outpatient settings in Japan.

The background of the situation of allergic diseases in children in Japan as follows, the most prevalent is allergic rhinitis, which occurs in 9.2% of school-aged children. Asthma and atopic dermatitis is over 5%. On the other hand, food allergy and anaphylaxis are under 3%, although recently both diseases are increasing year on year. Another side of prevalence, there are the difference in prevalence of the allergic diseases between children and parents generations. Each disease is three to five times greater in the child's generation than in the parents' generation.

Shared decision making (SDM) has been defined as: 'an approach where clinicians and patients share the best available evidence when faced with the task of making decisions, and where patients are supported to consider options, to achieve informed preferences''(Glyn Elwyn et. al., 2012). Furthermore, Sufficient explanation and guaranteed choice by health care providers enhance the patient's and family's adherence to medical treatment (Charles et.,al,1997). Therefore, nursing practice based on SDM is essential for the patient and family's consent to medical treatment.

The purpose of this study was to clarify the recognition and expectations of the nurses' role in the practice of mutual partnership between the health care providers and child-family dyad, in which the child has an allergic disease, such as asthma, atopic dermatitis, and food allergy, in the outpatient setting.

Methods

Semi-structured interviews were conducted with six families who have a child with an allergic disease, such as asthma, atopic dermatitis, or a food allergy. Categories were extracted using qualitative descriptive analysis. Most parents were around 30 to 40 years old. The average age of children was 9.7 years old.

The interview questions were as follows:

Q1: How do nurses usually interact with the child and family in the clinic?

Q2: With what kind of interaction with the nurses do you feel comfortable?

Q3: What do you think is the role of a pediatric allergy nurse？

This study was part of the project *"Exploring the characteristic of pediatric allergy nursing practice based on shared decision-making."* This study was performed with the approval of Nagoya University ethics committee (2013-0194).

Results

Table.1 shows the results of the first question. Seven categories were extracted from the interview data. Unfortunately, children with allergic diseases and their families mentioned that it was quite rare that nurses were concerned with them directly in the outpatient setting.

Q1 Interaction of nurses and child & family in the clinic
- Medical treatment is needed, such as injection, inhalation...
- Ask the child's condition or symptoms
- Explanation concerning the medication
- Communication which indicates the interest to the patient, such as concerning parenting, light conversation ...
- Concerning on the procedure, such as paperwork
- Education of skin care for child
- No chance to talk with nurses

Nurses were mainly concerned with the child and family when the child needed medical treatment or a medical examination, such as an injection,

inhalation, blood test, or oral food challenge (OFC) in the allergy outpatient setting. On the other hand, children and mothers felt happy that they had effective education about care skills like a skin care of child more easily and successful and also they felt comfortable talking about their family daily life with nurses, because they thought that nurses concerned about their child and daily life of family who have child with chronic condition.

The result of third question, specialty of the pediatric allergic nursing (expectation of nurses by the family), as follows; *Explanation of medical treatment, examination and practice, because they hesitated to ask the doctor about small matters, Explanation of a medical examination from a long-term perspective, communication that indicates an interest in the patient, such as their daily life, school life, friends, and family; and Respect for the child's point of view and communicating with them.* On the other hand, some children and family *did not expect anything.*

Discussion

Shared decision-making between service users and health care providers is increasingly being suggested as a key component of good health care. As the first step, nurses have to talk with the child and family more in various situations in the outpatient setting/clinic in Japan.

Edbrooke-Childs et al. (2015) mentioned that the child-reported experience of SDM was only associated with higher levels of child-reported improvement when their parents also reported higher levels of SDM. Therefore, it is very important that child and parents both usually talk about the issue of family daily life with nurses.

In our former study, the pharmacists perceived that nurses play a wide range of roles that are difficult to visualize and verbalize. They hoped to enhance communication between families and health care providers, and had expectations toward nurses to appeal to their expertise by sharing information they obtained regarding patients (Asano et al., 2014).

In our country the training system of the pediatric allergy educator (PAE) was established in 2009. This system was constructed trying to facilitate the adherence of child and family in which the child has allergic diseases. The PAE is a qualification that covers all allergic diseases in childhood that is certified by *the Japan Pediatric Society of Intractable Asthma and Allergic Diseases (JSPIAAD).* The PAE's ultimate

responsibility is to educate and encourage patients and their families, and to facilitate the development of appropriate patient self-care competence. Initially, PAE training was intended for nurses, but the candidates of the PAE have been expanded to include pharmacists and dieticians since 2013. Although we could not find clear evidences of the nursing practice which contribute to create shared decision making between the child and family dyad with allergic disease and health care providers in out-patient settings in this study,   we belief nurses are required to provide information regarding the child and family's real daily life to other professionals.

Conclusions

First, children with an allergic disease and their families mentioned that it was quite rare that nurses talked to them about their daily life directly and casually in the outpatient setting. They recognized that nurses were concerned about them, when the child needed medical treatment or a medical examination, such as an injection, inhalation, blood test, or OFC in the allergy outpatient clinic. Mothers felt comfortable and want to talk with nurses, not only the condition of their child, but also small worries about family daily life.Unfortunately, we could not find clear evidence of nursing practice and/or an approach that contributes to create SDM by the child with an allergy and their family in this research. Then, in the near future, we have to make specialized nursing practice for SDM in pediatric allergy settings clearly.

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Effects of Simulation-based Training for Basic Life Support using Video-assisted Debriefing on Non-technical Skills and Technical Skills of Nursing Students

Jin Hwa Koh[1]   Hea Kung Hur[2]   SoMi Park[2] Gi Yon Kim[2]

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[2] Professor, Department of Nursing Wonju College of Medicine, Yonsei University

Introduction

Cardiac arrest resulted unexpected death due to sudden circulatory arrest[1]. Situation that you need to perform CPR in clinical was demanded the non-technical skills and technical skills and team should be appropriate harmony in CPR because they perform different activities as a team who several structures rather than one person at the same time[2]. Simulations are useful to improve the non-technical skills and technical skills. Especially, it helps to determine the difference between the team members to using video-assisted debriefing in performing simulations[3].

Therefore, the purpose of this study was to investigate the effects of simulation-based training for basic life support using video-assisted debriefing on non-technical skills and technical skills in order to apply CPR accurately and effectively in a situation of cardiac arrest.

Methods

Study design: The control group pre-test, post-test non-synchronized experimental study was conducted from March 6 to June 22, 2015.

Participants: A total of 36 students in the Department of Nursing of Y. University located in W. City, and a total of 12 teams, six teams in an experimental group and six teams in a control group, with one team of three persons who were randomly assigned according to their CPR knowledge score.

Measurements: The tool for non-technical skills of the emergency medical team developed by Cooper et al. (2010) was used as a tool measuring non-technical skills, which was composed of a total of 11 questions, while the checklist of basic life support performance developed by Jung, Ji-su (2013) was used as a tool measuring technical skills, which was composed of 26 questions.

Data analysis: Data were analyzed using Cronbach's α, Intraclass Correlation Coefficient (ICC), χ2-test, Fisher's exact probability test, t-test, Mann-Whitney U test and Willcoxon signed rank test with IBM SPSS 20.0.

Results

Of the 36 participants, 85.7% were women and the mean age was 22.86 years old.
1) Non technical skills
In simulation-based training for basic life support, the experimental group had significantly higher score in non-technical skills than the control group (Z=-2.65, *p*<.01)
2) Technical skills
In simulation-based training for basic life support, the experimental group had significantly higher score in technical skills than the control group (Z=-2.04, *p*<.01)
.

Conclusions

The hypotheses were supported in simulation-based basic life support training, and debriefing using video was effective for improving both non technical skills and technical skills. In other words, in a situation of cardiac arrest, non technical skills are an important factor that can lead CPR successfully, so video-assisted debriefing can be used as an efficient teaching-learning strategy in the simulation-based training for basic life support for nursing students or nurses.

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Relation between patients' information sharing and job satisfaction among home visiting nurses

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Introduction

Home visiting nurses are expected to increase the quantity and provide high quality care because of progress in aging society. However, home visiting nurses' turnover rate is higher than hospital nurses' turnover rate (home visiting nurses' turnover rate=15.0%, hospital nurses' turnover rate=12.6%) [1]. Job tenure and job satisfaction were the strongest predictors of nurse retention [2]. Eight independent subscales were validated: Relationship with Patients, Relationship with Peers, Professional Pride, Relationship with Physician, Relationship with Organization, Autonomy and Control, Stress & Workload, and Salary & Benefits [3]. Relation between retention and job satisfaction of visiting nurses was conducted to prove the credibility and validity of the job satisfaction measurement indices in Japan [4]. In the study, the four components of job satisfaction in home visiting nurses were defined as "specialty of home-visit nursing care", "management", "difficulty in nurturing relationship between users, their family and doctors", and "preference for home-visit nursing care". In addition, the study indicates that the importance of environmental planning for satisfying visiting nurses' household and occupational responsibilities together, as well as keeping their personal health.

First purpose of this study was to reveal how to share patients' information among home visiting nurses and some factors which influence on sharing the information. Second purpose was to clarify the relation between sharing the information and job satisfaction of home visiting nurses. It is expected to enhance quality of home visiting nurses and reduce turnover rate of home visiting nurses.

Methods

Sample: A cross-sectional study with nonymous self-administered questionnaire was carried out in 2015 in one district of Japan; Aichi. Home healthcare agencies were selected based on the database announced by the national association for home-visit nursing care. Of 101 directors of agencies which I contacted by telephone, 67 agencies assented to participate in this study. Then 495 questionnaires were mailed to the 67 agencies for this study.

This research was approved by the Ethics Committee of the school of Health Sciences, Nagoya University.

Materials: Demographic variables included sex, age, spouse and child. Organizational variables included agency size, the existence of clerks, being on call at night and charge system. Job-related variables included kinds of license, years of nursing experience, years of home visiting nursing experience, experience of working at a hospital, years of working at current agency, employment status, pay system, the number of visiting per week, role of a care manager, role of a director, the number of days working on weekend per month, the number of days being on call at night per month, joining workshop in the last three month and eating lunch with colleagues in the last three month. Health condition and Sleep quality was asked. Communication related variables include a friendly adviser in an agency, talking to a director friendly and communicating tools. Patients' information

share related variables included 4 items ("Do you feel anxiety because you cannot grasp patient's information when you visit patient's home?" "Are you confused about talking with patient or the family members because you cannot grasp patient's information when you visit patient's home?" "Are you confused about talking with other medical staff because you cannot grasp patient's information when you visit patient's home?" "Can you visit patient's home with grasping patient's information sufficiently?"). These items are rated on a 4 point scale. Patient's information sharing opportunities related variables included each using or participating frequency. These items are rated on a 4 point scale. Job satisfaction measurement indices followed the questions used in the research paper of Nakano (2008), "The relation between retention and job satisfaction of visiting nurses". Job satisfaction measurement indices included 4 items. These items are rated on a 4 point scale.

Data analysis: All the data were analyzed by using IBM SPSS Statistics (version 22.0 for Windows). Descriptive analyses were performed on all variables, using Chi-square test and the like. Particularly "uneasy feelings due to insufficient sharing of patients' information" were analyzed.

Results

Sample

The number of respondents was 280 of 495 home visiting nurses. Among them, 277 respondents completed the questionnaires (valid response rate: 56%). The number of male was 7(2.5%) and the number of female was 268(96.8%). The largest number of generation was from 40 to 44 years old (22.0%). 54.2% of the respondents were full-time employees. 53.1% of the respondents were monthly-pay system, 13.7% of them were hourly-pay system and 32.5% of them were fixed by the number of home visiting. 40.8% of respondents were less than 4 years that they have been working as home visiting nurses.

Relationship between characteristics and information Sharing

Table1 shows characteristics associated with uneasiness due to insufficient sharing of patients' information. Nurses who had longer experiences as nurses or as home visiting nurses had less uneasiness due to insufficient sharing of patient information. The uneasiness was also less found in those who had roles of care managers or duties of being on call at night, joined workshops, had a friendly adviser in an agency and talked to a director friendly. People who worked as directors, were in good health condition and used some communication tools tended to have less uneasiness.

Table2 shows sharing measures associated with uneasiness due to insufficient sharing of patient information. The uneasiness was less encountered in people who well communicated by telephone and attended some conferences. People who well talked with colleagues tended to have less uneasiness.

Relationship between job satisfaction and information Sharing

Table3 shows an association between job satisfaction and the uneasiness due to insufficient sharing of patient information. People without uneasy feeling about insufficient sharing of patient information were likely to be satisfied with their job.

Discussion

The results have suggested that longer experiences as nurses or home visiting nurses help share patient information. Nurses who had roles of care managers or duties of being on call at night could often share the information because they probably needed to understand the information fully. The present study also indicated that better information sharing could be linked with good communicating with colleagues such as having a friendly adviser in an agency, talking to a director friendly, calling, attending a conference and talking with colleagues. These results imply that promoting better information sharing, nurses can visit patients' home without anxiety, which may lead to improving their job satisfaction.

Conclusions

The results suggest that it is important to build relationship with colleagues or to promote friendly communication, which can contribute to better information sharing. Sharing patient information might be effective in enhancing quality of home visiting nurses and possibly reducing turnover rate of home visiting nurses.

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Table 1, Characteristics according to anxiety

	anxiety	yes		no		P	trendP
		n	%	n	%		
age	≦29	3	4.5%	7	3.3%	0.602	0.219
	30-39	16	23.9%	43	20.6%		
	40-49	29	43.3%	81	38.8%		
	50≦	19	28.4%	78	37.3%		
years of nursing experience	≦9	12	18.5%	25	12.1%	0.080	**0.029**
	10-19	31	47.7%	80	38.6%		
	20≦	22	33.8%	102	49.3%		
years of home visiting nursing experience	≦9	54	81.8%	130	62.2%	0.013	**0.006**
	10-19	10	15.2%	66	31.6%		
	20≦	2	3.0%	13	6.2%		
experience of working at a hospital	yes	65	98.5%	207	98.6%	0.959	
	no	1	1.5%	3	1.4%		
agency size (the number of nurses)	<5	7	10.4%	25	11.9%	0.938	0.734
	5-9	24	35.8%	76	36.2%		
	10≦	36	53.7%	109	51.9%		
the existence of clerks	yes	58	86.6%	175	84.1%	0.630	
	no	9	13.4%	33	15.9%		
being on call at night	yes	63	94.0%	201	95.7%	0.570	
	no	4	6.0%	9	4.3%		
charge system	yes	53	79.1%	181	86.6%	0.137	
	no	14	20.9%	28	13.4%		
employment status	full-time	34	50.7%	116	55.2%	0.521	
	part-time	33	49.3%	94	44.8%		
pay system	monthly-pay	35	52.2%	112	53.8%	0.516	0.863
	hourly-pay	12	17.9%	26	12.5%		
	fixed by the number of home visiting	20	29.9%	70	33.7%		
role of a care manager	yes	1	1.5%	26	12.4%	**0.009**	
	no	66	98.5%	184	87.6%		
role of a director	yes	5	7.6%	35	16.7%	**0.067**	
	no	61	92.4%	175	83.3%		
the number of visiting (/week)	≦19	42	62.7%	133	63.3%	0.177	0.553
	20-29	24	35.8%	62	29.5%		
	30≦	1	1.5%	15	7.1%		
the number of days working on weekend (/month)	0	23	34.3%	64	30.5%	0.355	0.845
	1-2	28	41.8%	108	51.4%		
	3≦	16	23.9%	38	18.1%		
the number of days being on call at night (/month)	0	37	55.2%	76	36.2%	0.022	**0.017**
	1-4	15	22.4%	69	32.9%		
	5≦	15	22.4%	65	31.0%		
health condition	best	8	11.9%	48	22.9%	0.135	**0.066**
	good	41	61.2%	118	56.2%		
	bad	18	26.9%	44	21.0%		
sleeping quality	good	56	83.6%	185	88.1%	0.339	
	bad	11	16.4%	25	11.9%		
joining workshop	yes	42	62.7%	162	77.9%	**0.013**	
	no	25	37.3%	46	22.1%		
eating lunch with colleagues	yes	43	64.2%	145	69.7%	0.397	
	no	24	35.8%	63	30.3%		
having a friendly adviser in an agency	yes	56	83.6%	196	93.8%	**0.010**	
	no	11	16.4%	13	6.2%		
talking to a director friendly	yes	45	72.6%	161	89.0%	**0.002**	
	no	17	27.4%	20	11.0%		
communicating tools	yes	32	47.8%	128	61.0%	**0.057**	
	no	35	52.2%	82	39.0%		

Table 2, Methods of sharing according to anxiety

	anxciety	yes		no		P
		n	%	n	%	
nursing records	yes	66	100.0%	196	93.8%	**0.038**
	no	0	0.0%	13	6.2%	
talking with colleagues	yes	64	95.5%	208	99.0%	**0.059**
	no	3	4.5%	2	1.0%	
e-mail	yes	36	53.7%	135	64.3%	0.122
	no	31	46.3%	75	35.7%	
calling	yes	31	46.3%	129	61.4%	**0.029**
	no	36	53.7%	81	38.6%	
summary of nursing report	yes	60	89.6%	189	90.0%	0.916
	no	7	10.4%	21	10.0%	
electronic chart	yes	24	36.4%	70	33.3%	0.650
	no	42	63.6%	140	66.7%	
hand over	yes	43	65.2%	147	70.7%	0.397
	no	23	34.8%	61	29.3%	
conference	yes	50	74.6%	183	87.6%	**0.011**
	no	17	25.4%	26	12.4%	

Table 3, Job satisfaction according to anxiety

	anxciety	yes		no		P
		n	%	n	%	
satisfaction	yes	46	68.7%	183	87.6%	**<0.01**
	no	21	31.3%	26	12.4%	
like this work	yes	58	86.6%	203	97.6%	**<0.01**
	no	9	13.4%	5	2.4%	
suited for this work	yes	43	64.2%	175	85.0%	**<0.01**
	no	24	35.8%	31	15.0%	
worthwhile	yes	53	79.1%	196	93.8%	**<0.01**
	no	14	20.9%	13	6.2%	

NUSING CLINICAL JUDGMENT FOR SCHIZOPHRENIC INPATIENTS TO PREVENT THE EARLY READMISSION : THE CASE OF ONE NURSE

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Introduction

Mental health system have been shifted from the facility centered to the community centered. Japanese government promotes community centered care in mental health. However, even after some patients are discharged once from the psychiatric hospital, they are readmitted repeatedly. They have not been able to settle in the community. The risk the patients would no longer live in the community has been pointed out [1]. In the previous studies, they focused on the clinical judgment made by the community mental health nurses. They were carried out in Sweden [2], Australia [3], UK [4], and USA [5.] However there are few studies about clinical judgment made by the hospital mental health nurses.

The purpose of this study is to investigate the nursing clinical judgment which the hospital mental health nurses make for schizophrenic inpatients to prevent the early readmission.

Subject

The participant was the nurse who;
· worked in Japanese public psychiatric hospital.
· worked more than five years.
· was recommended to be proficient or expert by the hospital nursing manager.
· had much knowledge, many skills and experiences.

Methods

This is a qualitative study with the semi-structured interview. The semi-structured interview, lasting 60 minutes, was carried out in relaxed and private environment. The interview was recorded.

In the interview, the participant was asked to remember the schizophrenic patient who;
· was readmitted within three months.
· was nursed in the hospital by the participant.
· was discharged from the hospital.
· continued community life more than three months.

The participant was questioned: "How did you grasp of the patient?" and "How did you make a judgment on nursing intervention?"

The patient information and the nurse's demographic data were written on paper.

Data analysis

A qualitative approach using Saiki's grounded theory was chosen. A two-stage coding process was applied, starting with a substantive coding (open and descriptive codes) followed with the theoretical coding (increasingly higher-level conceptual categories that encompassed the descriptive codes and the relationships between them).

Ethical considerations

The informed consent was obtained from the nurse, and this study was approved by the Ethics Committee of Nagoya University Graduate school of Medicine.

Results

Nurse

Male, 50s, ordinary employee. His psychiatric experience was 30 years. He had the experiences of psychiatric nursing in the community.

Patient

Male, 40s. He lived with his mother and younger brother. His stress coping methods were to drink juice and to eat ice cream. 10 years ago, he was readmitted. After discharge, he continued living in community for 5 years He attended to the day hospital and received home-visiting nursing after discharge.

The clinical judgment process

The process of the nursing clinical judgment was composed of three phases: predicting the patient's lifestyle after discharge, letting the patient have good habits he can keep in the community, requesting for cooperation of the family and the home-visiting nurses.

Predicting the patient's lifestyle after discharge

When the patient was readmitted, the nurse grasped of the characteristics of the patient and grasped of the lifestyle before the readmission. The nurse thought the reason why the patient was readmitted. And the nurse compared the patient's lifestyle between before and after the readmission. The nurse predicted the patient's lifestyle after discharge and judged what the nurse could do in the hospital.

Letting the patient have good habits which he can keep in the community

The nurse let the patient have good habits which the patient could keep in the community (e.g. the nurse urged the patient to check the table of lifestyle every day.). Then the nurse focused on the compulsive aspects of the patient. In other word, the nurse did the intervention for changing the patient's weakness to the strength.

A short time later, the nurse did intervention for letting the patient keep the habits (e.g. the nurse praised the patient when the patient check the table every day).

The nurse encouraged the patient to change behavior gradually because he had the opinion that rapid changes in the patient's lifestyle would worsen the patient's condition.

Requesting for cooperation of the family and the home-visiting nurses

The nurse grasped of the things the family had done unconsciously (e.g. the family gave stresses unconsciously to the patient by scolding). Then the nurse explained the characteristics of the illness and let the patient and the family perceive the unconscious. The nurse requested that the family let the patient keep the lifestyle also after discharge. By this, the patient had been able to keep the same lifestyle. So the patient had lived in the community with the family without the problem.

Similarly, the nurse requested for cooperation of the home-visiting nurses who would provide the services after discharge.

The nurse requested that the home-visiting nurses continued the intervention made in the hospital.

Discussion

    After grasping of the lifestyle of the patient, the nurse predicted the patient's lifestyle after discharge. The nurse let the patient have good habits which the patient could keep in the community. This intervention was to encourage the patient to change behavior gradually. By nurse's requesting for cooperation of the family and the home-visiting nurses, the patient could keep the same lifestyle also after discharge.

    Relapse of schizophrenia and worsening of the symptoms are pointed out to be caused subsequent to the stressful life events [6]. Keeping the same lifestyle would reduce the patient's stresses caused by the changes of lifestyle after discharge. It is important for nurses to predict the patient's lifestyle after discharge early. By doing so, the nurse could let the patient have good habits which the patient could keep in the community.

Conclusions

    The nursing clinical judgment for schizophrenic inpatients to prevent the early readmission was;
- to predict the patient's lifestyle after discharge.
- to let the patient have good habits which he could keep in the community.
- to encourage the patient to keep the lifestyle also after discharge.

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Husbands' experiences on their partners' postpartum depression in Japan : A qualitative study

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Introduction

Pregnancy and childbirth involve many biological, psychological and social changes that require adjustment and adaptation for both parents. Postpartum depression is a serious mental health problem affecting about 13% of women in the first three months after delivery [1].Risk factors for postpartum depression include antenatal depression, recent life stressors, previous traumatic birth, obstetric and infant complications and a perceived or actual lack of practical and emotional support. Postpartum depression has a negative influence on child health and development. While the concern on maternal postpartum depression has been increasing over the past two decades, much less is known about the impact of postpartum depression among husbands. As many as 24% to 50% of men whose partners have postpartum depression may also experience depression [2].

The purpose of this study was to identify husbands' experiences on their partners' postpartum depression in Japan for supporting family with new born babies.

Methods

This study was conducted from November 2012 to February 2013.Semi-structures interviews were conducted among three men whose partners had experienced postpartum depression and resided in Tokyo and Aichi prefecture. The interviews explored how husbands were aware of and perceived their partner's depression. The interviews were audio-recorded and transcribed verbatim. Data were analyzed using qualitative descriptive approach.

The informed consent was obtained from all participants. This study was approved by the Ethics Committee of the Nagoya University Graduate School of Medicine, Nagoya University, Nagoya, Japan.

Findings

The age of participants were between 35 and 61years old .Their children's age were between 1 and 12 years old. The participants felt that their partner's experience of postpartum depression had significantly affected their life. All participants were conscious of disease about postpartum depression. Nevertheless, they were not aware of physical symptoms of their partners' postpartum depression (e.g. insomnia, appetite disturbances). Their awareness of partners' postpartum depression was consisted of three categories. Initially, they were aware of "difficulty of their partners' emotional control" and "feeling of strangeness" . Then, they were aware of " their partners' verbal expression" .Their perception was consisted of four categories that were categorized as "little minor trouble for my wife", "helpless feeling", "out of ideas" and "hopeless".

Discussion

This study is the first approach to identify husbands' experiences on their partners' postpartum depression in Japan. This study revealed the husbands were hard to be aware of physical symptoms of their partners. Thus they might delay to find their partners' depression. The content of their perceptions showed that they faced a serious aspect. This finding was in line with previous study [3].The previous study reported that men whose partners suffered from postpartum depression were experienced fear, confusion, much concern for their partners, and felt unable to help them in overcoming postpartum depression.

Furthermore, this study also revealed that the husbands tend to struggle the difficult situation that leads family to crisis. Beestin L et al. reported that the husbands whose partners had experienced postpartum depression emphasized the inescapable, unexpected and isolating experiences [4]. Thus, medical professionals may pay more attention to husbands whose partners had experienced postpartum depression for providing appropriate care.

One of the limitations of the study was the relatively a small sample size. Further study may consider to increase samples for conforming this result.

Clinical Implications

This study revealed experiences of husbands on their partners' postpartum depression in Japan.

The result of present study could be committed to supporting the well-being of family with new born babies.

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The Factors to Affect the During
of Exclusive Breast Feeding of the Infant Mothers

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Introduction

This is the descriptive study to understand the factors to affect the duration of exclusive breast feeding in the mothers who have 6 to 12 month-old infants until 6 months after their deliveries. This study was conducted in the subjects of 136 mothers who had 6 to 12 month-old infants in Y university hospital, two pediatric clinics, and a public health center. The data collection period was from March 31 to April 30, 2015. We investigated the factors to affect the duration of exclusive breast feeding in the mothers including the characteristics of breast feeding such as past experience of breast feeding, training experience of breast feeding, first breast feeding duration, and successful breast feeding experience during hospitalization period; knowledge and attitude on the breast feeding and supports from their husbands and parents.

Methods

To measure the knowledge on the breast feeding, we utilized the measurement tool in 'breast feeding knowledge' by Lee (1997) which dealt with the topics of the advantages of mothers' milk to infants, the advantages of breast feeding to the mothers, and the solutions to overcome when they encountered the method and technical problems of breast feeding. Regarding the attitude of breast feeding, we applied the measurement tool in 'the attitude of breast feeding' by Jeong (1997) to check the cognitive, emotional and behavioral domains. For the supports from husbands and parents, we used the amended tools of 'husband supports,' and 'parents supports' from the original measurement tool by Sung (2003) which focused on the psychological, physical, and evaluative supports in the subjects of puerperium mothers, so as to check the supports from their husbands and parents on the exclusive breast feeding in the subjects of infant mothers. The statistical analysis of the collected data was conducted using PASW Win 20.0 statistics program for t-test, ANOVA, Scheffe post-hoc test, Kruskal Wallis test, Pearson's Correlation Coefficient, and multiple regression analysis. The main outcomes of this study are as follows:

Results

1)   The scores of each domain were 15.79 ($\pm$3.73) points on average out of 25 for the knowledge of mothers on the breast feeding 75.88 ($\pm$11.55) out of 100 for the attitude of breast feeding 36.35 ($\pm$6.70) out of 45 for husband supports 34.93 ($\pm$6.38)out of 45 for parents support and 4.14 ($\pm$2.09) months for the duration of exclusive breast feeding.

2)   The duration differences of exclusive breast feeding were significant by age (x^2=9.18, p=.027), occupation existence 6 months after the delivery (t=3.72, p<.001), past deliver experiences (t=-2.31, p=.022), delivery methods (t=2.11, p=.037), past breast feeding experiences (t=12.58 p=.011), training experience on the breast feeding (t=-2.21, p=.028), and successful breast feeding experience during the hospitalization period (t=-2.85, p=.005).

3)   Positive correlation was found statistically between the exclusive breast feeding duration of the infant mothers and the followings; knowledge on the breast feeding (r=.348, p<.001), attitude on breast feeding (r=.461, p<.001), husband supports (r=.211, p=.014), and parents supports (r=.194, p=.023).

4)   The factors to affect the duration of exclusive breast feeding in the infant mothers were knowledge on the breast feeding (β=.19) and attitude of breast feeding (β=.35). It demonstrated that the higher the knowledge scores on the breast feeding and the more positive attitude to the breast feeding, the more to affect the duration of breast feeding. These factors could explain 28.6% of the duration of exclusive breast feeding in the infant mothers (F=7.33, p<.001).

of Breast-Feeding.

Discussion

From these study results, we learned that the knowledge and attitude on the breast feeding significantly affected to the duration of exclusive breast feeding in the infant mothers. Therefore, the developmental needs of nursing intervention programs were found to enhance their knowledge and attitude for the exclusive breast feeding.

Conclusions

Based on this, this study played a role to provide with the basic data for further studies on the duration of exclusive breast feeding to find various variables as well as to suggest the institutional and educational supports from public health institutions, and moreover needs of national policy and publicity to educate the people on the advantages and importance of the exclusive breast feeding with the initiatives of the national and public health institutions.

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CURRENT STATUS AND ISSUES OF RESEARCH ON THE BURDEN OF FAMILIY CAREGIVERS OF ELDERLY WITH DEMENTIA

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Introduction

Currently, due to the aging society of Japan, the number of elderly people with dementia is steadily increasing. Since Japanese health policy encourages the elderly to stay at home, the role of the family will become more and more important in caring the home dwelling elderly with dementia. However, caring for people who keep declining their daily life activities and their decision-making capability may be stressful. In order to clarify direction of research studies to develop strategies to alleviate such stress, a literature review was conducted to determine the present status and problems of existing research studies on the burden of family caregivers who take care of the elderly with dementia.

Materials and Methods

The purpose of this was to organize the knowledge about the care burden of family caregivers caring for the elderly with dementia at home.

Subjects: The sample articles published from 2003 to 2014 were identified through the Ichushi-Web (Japan Medical Abstracts Society) and the CiNii databases using the following key words: "dementia elderly", "family", "burden" and "home".

Data analysis: Among the 40 searched articles (31 articles from Ichushu-Web and 9 articles from CiNii), a total of thirty research articles were used for analysis excluding duplicated search. The extracted articles were classified and organized by their study topics, published date, research methods, and study results.

Results

There were 20 quantitative studies, 4 qualitative studies, 2 mixed method studies, 1 literature review study, 1 case study, and 2 abstracts. None of the articles was published in 2003 and 2004, 12 were published from 2005 to 2009, 18 were published from 2010 to 2014.

Study topics were classified into the following 6 categories: "Family caregivers' burden and their perceptions"(9), " Caregivers' burden and family function" (3), " Behavioural and psychological symptoms of dementia (BPSD) and caregivers' burden"(7), "Medical institution related burden"(3), " Care service related burden"(3), "Evaluation of assessment tools and interventions to alleviate the burden "(7). Six articles focused on more than one topic

Table. Results of research studies on caregivers' burden

Categories	Results	Author (year)
Family caregivers' burden	Enhanced by day-to-day care Execrated by loneliness and anxiety	Takahashi.J et al. (2013)
	Reluctance for long-term care	Sugihara.Y et al. (2012)
and their perceptions	Negative effect on HRQOL	Fujiwara.K et al. (2010）
	Identified six domains of physical, mental, psychological, social burden	Kudou.S et al. (2009)
	Sense of limitation, negative emotion, and economic burden increase care needs	Matsumoto. K (2008）
	Lower education is related to economical, time, mental restrain; married caregivers feel social restrain; having alternate caregivers is related to unstable physical condition	Horie.M (2014)
	Family exchanges between caregivers suppress the care burden	Saeki.A (2006)*
	Dementia severity, BPSD, the number of the caregivers, the main caregiver of health, nursing time were related to the feeling of burden.	Saeki.A et al. (2008)*
	"Social activity restriction feeling" and "economic crunch feeling" possibly of increase "deny feelings"	Yu.H et al. (2007)
Caregivers' burden and family function	Lowest burden in "balanced" family	Fujiwara.K et al. (2011)
	Highest burden in "extreme" family Influenced by caregiver's personality and familial environment	Fujiwara.K et al. (2011)
	No relationship with family system	Saeki.A et al. (2008)*
	No relationship with family system	Saeki.A (2006)*
Behavioural and psychological symptoms of dementia (BPSD) and caregivers' burden	Associated with BPSD at home	Hashidate.Y et al. (2012)
	Significant correlation with agitation, depression, irritability	Kajiwara.K et al. (2012)
	Wandering care did not alleviate	Takizawa.Y et al. (2011)
	Related to fear for unpredictability, not understood by the elderly, irritability for not understandable, elderly's agitation and delusion	Sugiura.K et al. (2007)
	Caregivers tend to attribute BPSD to poor caregiving	Utsuki.T et al. (2008)
	Frequent wandering increased and positive self-evaluation decreased the burden	Utsuki.T et al. (2007)
	Caregivers of elderly with higher BPSD maintained a sense of purpose in life	Komatsu.S et al. (2011)
Medical	Utilization of resources was effective for family's decision-making	Tanaka.Y et al. (2013)

	Moving to the hospital, waiting time, and attendant caused the burden	Nakai.Y et al. (2012)
instituti on related burden	Family caregivers' burden was statistically involved in medical needs	Matsumoto. K et al. (2007)
Care service related burden	Continued use of day care reduced the burden through respite effect and lowering social constraints	Fujiwara.K et al. (2012)
	High needs for "short stay" while dissatisfied with user fees and frequency (or length of time)	Nakai.Y et al. (2012)
	Use of "short stay" did not reduce the care burden	Arakawa.A (2010)
Evaluat ion of assess ment tools and interve ntions to alleviat e the burden	Intervention to improve knowledge about dementia was ineffective in the long-term care burden	Yoshizawa. M et al. (2012)
	Tactile Care reduced "physical pain" in HRQOL but did not alleviate direct care burden nor psychological stress	Suzuki.M et al. (2012)
	Cognitive Behavioral Therapy and Social Skills Training were provided for the caregivers but not evaluated	Yuuki.C (2010)
	Original assessment tool discriminated severity of dementia but not related to care burden	Kamijou.K et al. (2008)
	Care burden was not reduced by family support intervention	Kamijou.K et al. (2010)
	Coping and social support were related to the burden implying intervention for coping skills to be effective	Watanabe. M et al. (2009)
	Stress coping behavior was related to the burden indicating needs of coping behavior intervention	Watanabe. M (2009)

*Duplicated listing

Discussion

Published research articles on the family caregivers' burden who take care of elderly with dementia have been increasing since 2005. It was studied not only in nursing but also in other fields such as rehabilitation sciences and social welfare studies. This trend may be attributed to the elevating societal awareness on the burden of the family caregivers who take care of home-dwelling elderly with dementia. More research studies are expected to be conducted in the future because of a national plan which is called "Orange plan" proposed by the Ministry of Health, Labour and Welfare in June 2012.

Results of the studies of "Family caregivers' burden and their perceptions" imply that family caregivers are confused with the changes of the dementia symptoms and having difficulty in admitting the changes while keep working for their care. These emotions may enhance the physical, mental and psychological exhaustion. Anxiety and loneliness of the caregivers are also implied.

Studies of "Caregivers' burden and family function" revealed that the majority of the families were "extreme type" or "intermediate type" in their family function while a few families were "balanced type". Families of "upsetting" and "extremely cohesive" types showed high tendency of aggregation implying their adaptability is diminished.

According to the studies of "BPSD and caregivers' burden", family caregivers perceive those behaviors such as agitation, depression, irritability, delusions, and loitering as "problems". Therefore, they feel distressed when the elderly exhibit BPSD, and their psychological stress is aggravated by the BPSD.

Findings of studies of "Care service related burden" indicate using the short-stay service do not always have a beneficial effect on the care burden, and other factors are thought to be involved. Those factors may be intricately intertwined.

Using medical service is also found to be the source of caregivers' burden according to the studies of "Medical institution related burden." Such burden was triggered by the experience of being unable to smoothly use medical institution. It is revealed that outpatient visits and hospitalizations can worsen the family caregivers' burden. Specifically, bringing the elderly to the hospital, waiting time, and attendance of hospitalization were such factors. There was a qualitative study of single case. However, it did not elucidate caregivers' burden because its scope was limited to discharge planning.

Due to the studies in the category of "Evaluation and mitigation of the care burden ", effectiveness of interventions was inconclusive. Only tactile care was partially effective to alleviate care burden but was not conclusive. None of the assessment tool successfully quantified family caregivers' burden.

Conclusions

1. Thirty articles on family caregivers' burden who take care of the home-dwelling elderly with dementia were identified by literature search and were classified into six categories.

2. The burden of the family caregivers who take care of the elderly with dementia are influenced by BPSD, family function, length of care period, the degree of caregivers' acceptance of care, the relationship between a caregiver and the elderly, their environment, and caregivers' self-evaluation.

3. Improvement of systems in medical institutions and care facilities is warranted to avoid additional burden of the family care givers of elderly with dementia.

4. Strategies including nursing intervention to mitigate the burden of the family taking care of elderly with dementia need to be developed.

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Effects of Self-Directed Feedback Practice Using Smartphone Videos on Basic Nursing Skills, Confidence in Performance and Learning Satisfaction

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Introduction

Nursing is a professional and practical study to meet the health needs of human in the advanced medical care and aging society[1], practical education is occupied very large proportion.

Nursing practical education can be divided into clinical practice it takes place in a hospital or community and school practice using laboratory of the university. Recently, many universities are in need of an efficient clinical practice teaching model of development that the clinical practice site in conjunction with the university campus to promote the training of students performing experience[2].

Self-directed practice is autonomous practice method to acquire practice skills students themselves. And it needs checking effects of nursing practical education utilizing the advantages of smartphone video to enable the active learning in consideration of student's characteristics in response to society that changes rapidly.

So this study was done to verify the effects of a self-directed feedback practice using smartphone videos on nursing students' basic nursing skills, confidence in performance and learning satisfaction and to contribute to increasing efficiency of self-directed practice and improving systematic nursing practice.

Methods

Study design: This study was an experimental study with a randomized control group post-test design.

Participants: The randomly assigned participants were from the Department of Nursing at Y. University located in Gangwon-do and final participants for analysis were 29 students in the experimental group and 29 students in the control group.

Measurements: The main point of the intervention in this study was the exchange feedback on deficiencies through smartphone recording videos of the nursing practice process taken with peers during self-directed practice. And the items for basic nursing skills in this study were the 3 items of 'vital signs',

'wearing protective equipment when entering and exiting the quarantine room and the management of waste materials', and 'L-tube feeding'.

Data analysis: Collected data were analyzed, using χ^2-test and independent t-test with IBM PASW for Windows Version 21.0 Program.

Results

The results of this study are summarized as follows.

1) Basic nursing skills were higher for all three items in the experimental group compared to the control group, and the differences were statistically significant (t=-2.10, p=.039; t=-4.74, p<.001; t=-2.70, p=.009). (Table 1)

2) Confidence in performance was higher for each of the three items in the experimental group compared to the control group, but the differences were not statistically significant (t=-1.77, p=.081; t=-1.35, p=.181; t=-1.88, p=.066), and after the practice of the three items, there were statistically significant differences in the overall score for confidence in performance (t=-3.07. p=.003). (Table 2)

3) Learning satisfaction was higher in the experimental group than in the control group, but there were no statistically significant differences (t=-1.67, p=.100). (Table 3)

Table 1. Comparisons of Basic Nursing Skills between the Experimental and Control Group

Basic nursing skills	Exp. G (n=29)	Con. G (n=29)	t	p
	Mean±SD	Mean±SD		
Item 1	79.88±8.80	73.87±12.56	-2.10	**.039**
Item 2	89.45±7.45	78.13±10.45	-4.74	**‹.001**
Item 3	94.28±4.41	89.90±7.53	-2.70	**.009**

Table 2. Comparisons of Confidence in Performance between the Experimental and Control Group

Basic nursing skills	Exp. G (n=29)	Con. G (n=29)	t	p
	Mean±SD	Mean±SD		
Item 1	75.79±11.51	69.87±13.75	-1.77	.081
Item 2	78.96±11.14	73.94±16.51	-1.35	.181
Item 3	85.39±12.81	78.65±14.43	-1.88	.065
Overall Confidence	76.74±10.99	64.98±17.42	-3.07	**.003**

Table 3. Comparisons of Learning Satisfaction between the Experimental and Control Group

Basic nursing skills	Exp. G (n=29)	Con. G (n=29)	t	p
	Mean±SD	Mean±SD		
Learning Satisfaction	4.27±0.39	4.04±0.62	-1.67	.100

Conclusions

This study verified that self-directed feedback practice using smartphone videos could improve basic nursing skills. It has significance that it could help nursing students gain confidence in their nursing skills in the future through the improvement of basic nursing skills and perform quality patient care by providing patients with safer care. In addition, it is expected that, in the future, actively applying the self-directed feedback practice using smartphone videos, which can be used regardless of time and place, in the education of nursing practice will improve the nursing students' basic nursing skills.

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Abstracts

Physical Therapy

2015 Yonsei-Nagoya University Joint Symposium on Physical Therapy

11:00~12:00	Session I	Chair: Prof. Heon-Seok Shin

11:00~11:30   Comparison of Psoas Major Muscle Thickness measured sonography during Active Straight Leg Raising

In-Chul Jeon (Yonsei Univ.)

11:30~12:00   Selective muscle activation with visual electromyographic biofeedback during scapular posterior tilt exercise in subjects with round-shoulder posture

Jae-Ik Son (Yonsei Univ.)

12:00~13:30   Lunch

13:30~14:10	Session II	Chair: Prof. Sachiko Lee

13:30~13:50   Development of animal model of post-stroke spasticity and study of its mechanisms

Sachiko Lee (Nagoya Univ.)

13:50~14:10   The kinematic analysis of passive stretching by physical therapists for equinovarus after stroke

Naomi Yamada (Nagoya Univ.)

14:10~14:30   20 Minute Coffee Break

14:30~15:10	Session Ⅲ	*Chair: Prof. Chung Hwi Yi*

14:30~14:50	The Validity of a dynamic neuromuscular stabilization-Heel sliding test for core stability
	Young-Joo Cha (Yonsei Univ.)

14:50~15:10	Event related desynchronization(ERD) of Mu rhythm during concentric and eccentric contraction
	Joo-Hee Park (Yonsei Univ.)

15:10~15:30	20 Minute Coffee Break

15:20~16:00	Session Ⅳ	*Chair: Prof. Sumio Yamada*

15:20~15:40	Intensensory facilitation and interference during stepping task
	Tatsunori Watanabe (Nagoya Univ.)

15:40~16:00	Relationship between self-reported walking time and objectively measured moderate to vigorous physical activity in middle-aged: Cross-sectional, correlational research
	Masaki Kato (Nagoya Univ.)

※ 15 minutes presentation and 5 minutes Q&A

Comparison of Psoas Major Muscle Thickness measured by sonography during Active Straight Leg Raising in Subjects with and without Uncontrolled Lumbopelvic Rotation

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Introduction

Recent studies have shown that the psoas major (PM) contributes to stabilization of the lumbar spine (LS) (Santaguida and McGill, 1995). Hu et al. (2011) stated that during active straight leg-raising (ASLR), various muscles are active, including the iliacus, rectus femoris, and ipsilateral PM (iPM); the contralateral PM (cPM) is also active. In addition, most authors agree that PM activity increases with greater hip flexion, while Yoshio et al. (2002) even concluded that the PM mainly works as a stabilizer of the lumbar spine and the femoral head over the first 15°of hip flexion, and does not become an effective hip flexor prior to 45°of flexion. ASLR evaluates the ability to transfer a load between the spine and legs via the pelvis. Therefore, the optimal movement pattern for the lumbopelvic region must be controlled by the stabilizing muscles and remain neutral (Sahrmann, 2002). Comerford and Mottram (2012) defined ipsilateral lumbopelvic rotation in the transverse plane during ASLR as uncontrolled lumbopelvic rotation (ULPR). ULPR may contribute to the asymmetric symptoms, leading to pain in the lumbopelvic region (Comerford and Mottram, 2012). Repetitive unwanted rotation in the lumbopelvic region during ASLR might result in lower back pain (Sahrmann, 2002). Although recent studies agree that iPM activity increases with the angle of hip flexion (Andersson et al., 1995), whether the cPM acts as a lumbar stabilizer remains controversial (Santaguida and McGill, 1995; Yoshio et al., 2002; Hu et al., 2011). Therefore, this study compared the relative cPM thickness ratios (thickness during ASLR / thickness at rest) in subjects with and without ULPR, during ASLR. We hypothesized that the thickness of the cPM would be significantly greater during ASLR (10º) in subjects without ULPR.

Methods

Subjects: Thirty-seven healthy males were recruited for this study (18 without ULPR, 19 with ULPR). To screen for ULPR, a pressure biofeedback unit (PBU) was located on either side of the lumbopelvic region. The pressure of each PBU was adjusted to 40 mmHg. ULPR was regarded as present when the difference in the pressure between the sides of the lumbopelvic region exceeded 5 mmHg during a 90° single-heel slide in the supine position (Comerford and Mottram, 2012).

Kinematic data collection procedure An electromagnetic tracking device (LIBERTY™; Polhemus) was used to measure pelvic rotation at 120 Hz (accuracy of 0.08 cm for position and 0.15° for orientation). The electromagnetic motion sensor was attached to the pubic symphysis on tight- fitting clothing worn by the subjects. The orientation of the electromagnetic tracker system (global reference frame) was defined in alignment with the orientation of ASLR, with +Z vertically upward, +X parallel to the line of both anterior superior iliac crests (ASIS), and +Y directed along the anterior–posterior axis. The difference between the angles of the initial and final positions in the transverse plane during ASLR was determined to measure the pelvic rotation. During ASLR, the contralateral

ASIS ascends 0.5 inch, which identifies subjects with and without ULPR (Sahrmann, 2002). Therefore, subjects with ULPR exhibited pelvic rotation of ≥ 6 º which can be converted to 0.5 inch. The mean angle of three trials was used for analysis.

US imaging A high-resolution US machine (Sonoace X8; Samsung Medison, Seoul, Korea) with a 7.5-MHz linear transducer and a 50-Hz wall filter setting was used to measure the thickness of the cPM (de Oliveira et al., 2013). The transducer was placed transversely on the cPM medial to the ASIS and observed below the level of the inguinal ligament (Sajko and Stuber, 2009). Using a marker pen, the location of the transducer was marked with a straight line on the skin to maintain the contact area between the two surfaces (the transducer and the skin). We used the inbuilt program to capture and save images for calculation of cPM thicknesses.

Procedures The subjects' arms were crossed over their chests, and their legs were straight and positioned 20 cm apart. The target bar was placed 10 cm above the table. Each subject raised the dominant leg and touched the target bar with the straight leg. The subjects were asked to maintain contact between the leg and target bar for 5 s. An examiner with 5 years of experience measured the thickness of the cPM in each subject group. All measurements were performed on the same day. The order of measurements with loading on the dominant ankle joint and between the groups was random. The examiners were blinded to the results of the measurement and the subjects' information.

Statistical analysis The one-sample Kolmogorov–Smirnov test was employed to ensure a normal distribution of the measurement data. Two-way mixed-model analysis of variance (ANOVA) was used to identify statistically significant differences in the cPM thickness during ASLR / cPM thickness during rest ratio between the two groups (with vs. without ULPR). The level of statistical significance was set at $\alpha = 0.05$. If a significant interaction was observed between the loading status (with vs. without loading) or groups (with vs. without ULPR), the simple effect was compared using Bonferroni correction ($\alpha = 0.05 / 4 = 0.0125$). The angle of lumbar rotation was compared using the paired t-test for both no loading and loading within each subject group. The Statistical Package for the Social Sciences for Windows, ver. 18.0 (SPSS, Chicago, IL, USA) was used for statistical analysis.

Results

No statistically significant differences were found in initial cPM thickness between groups with and without ULPR (0.64 ± 0.06 mm in subjects without ULPR vs. 0.64 ± 0.05 mm in subjects with ULPR; t = 0.41, p = 0.69). There was significant interaction effect between the loading status and the group (F = 225.87, p < 0.01). Therefore, the simple effect was compared using Bonferroni correction. The relative muscle thickness (thickness during ASLR /thickness at rest) in subjects without ULPR was significantly greater that in subjects with ULPR (p < 0.01). The angle of lumbar rotation was significantly

different in subjects without ULPR (2.84 ± 1.06 for ASLR, 3.10 ± 0.89 for ASLR with 1-kg loading; p = 0.09) and with ULPR (7.27 ± 1.12 for ASLR, 8.49 ± 1.82 for ASLR with 1-kg loading; p < 0.05).
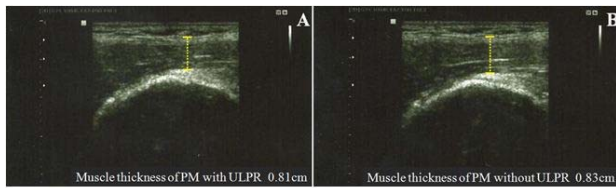

Figure 1. Muscle thicknesses as determined by ultrasound imaging of the cPM muscle at rest in a subject with (A) and without (B) uncontrolled lumbopelvic rotation. PM, psoas major; ULPR, uncontrolled lumbopelvic rotation.
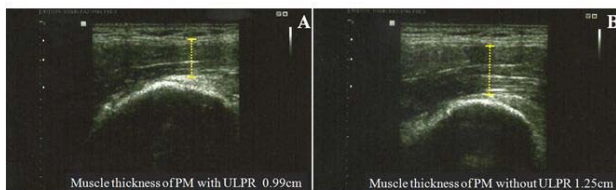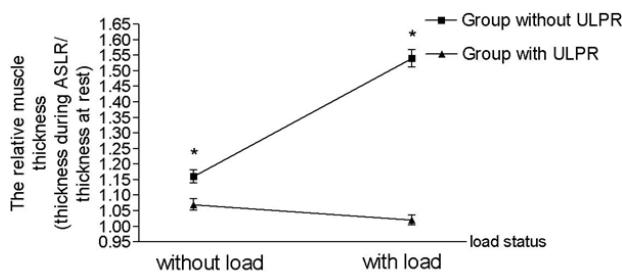

Figure 2. Muscle thicknesses as determined by ultrasound imaging of the cPM muscle during active straight-leg raising in a subject with (A) and without (B) uncontrolled lumbopelvic rotation. PM, psoas major; ULPR, uncontrolled lumbopelvic rotation.

Figure 3. Comparison of the difference in the relative muscle thickness on the contralateral side between subjects with vs. without uncontrolled lumbopelvic rotation. ASLR, active straight leg raise; ULPR, uncontrolled lumbopelvic rotation. *p < 0.05.

Discussion

The thickness of the **cPM** was measured during ASLR in subjects with and without ULPR. The thickness of the **cPM** was significantly greater in subjects without ULPR, but was not significantly changed in subjects with ULPR even with 1-kg loading. This implies that the **cPM** acts to stabilize the LS during ASLR. The cPM was thicker, and became increasingly thicker upon 1-kg loading, during ASLR in subjects without ULPR. This result supports our study hypothesis. A possible explanation for this finding is that the cPM may be activated for lumbar stabilization rather than hip flexion to control ipsilateral lumbar rotation during ASLR. Hu et al. (2011) found that during ASLR, the muscle activity of the **iPM** using needle EMG was consistent as a hip flexor, that the **cPM** was recruited to stabilize the LS in the frontal plane, and that the muscle activity of the **cPM** also increased as weight was applied during ASLR. That study also found that the **cPM** contributed to lumbar stability during ASLR in healthy subjects (Hu et al., 2011). Some possible reasons that contraction of the cPM acts to stabilize the LS are as follows. First, during the initial ranges of ASLR, the greatest moment arm from the leg passes through the pelvis. This moment might evoke ipsilateral pelvic rotation, and the LS also rotates with the pelvis in the same direction. From this viewpoint, contraction of the cPM might be activated to control this ULPR. Nachemson (1966) suggested that

contraction of the PM provides compressive forces that stabilize the LS by increasing stiffness in the spinal joints. The contraction of the cPM can act as a lateral stabilizer of the LS in the frontal plane. We found that the cPM was thicker in subjects without than with ULPR in the present study. Therefore, contraction of the cPM might contribute to stabilization of the LS during ASLR in subjects without ULPR. Second, it is possible that the cPM muscle thickens due to co-contraction with the external and internal obliques and transversus abdominis as well as the diaphragm and pelvic floor muscles for lumbar stability during ASLR in subjects without ULPR (Hodges, 1999). Further investigation of the interaction between the cPM and other stabilizing muscles, such as the abdominal muscles, pelvic floor muscles, and diaphragm, is needed. This study had several limitations. First, contraction of other muscles—such as the diaphragm, pelvic floor muscles, and abdominal muscles—was not taken into account. Second, the findings in this study cannot be generalized to females because all subjects in the study were healthy males. Finally, further investigation of the mechanism underlying the lack of increase in the thickness of the cPM in subjects with ULPR is needed.

Conclusion

The thickness of the cPM as determined by US imaging was significantly greater during ASLR (10°) in subjects without than with ULPR. This finding indicates that the cPM can be activated to stabilize the LS during ASLR. Activating the cPM before lifting a leg might increase lumbopelvic stability during ASLR exercises when managing individuals with ULPR.

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Selective Muscle Activation with Visual Electromyographic Biofeedback during Scapular Posterior Tilt Exercise in Subjects with Round-Shoulder Posture

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Introduction

Round-shoulder posture (RSP) is typified by a protracted, anterior tipped, and downwardly rotated scapular position [1]. One of the commons factor that contributes to RSP is weakness of the lower trapezius (LT) and serratus anterior (SA) muscles [1-3], the main muscles of scapular posterior tilting. A decrease in scapular posterior tilting causes subacromial impingement [1]. Therefore, strengthening the LT and SA is often included in exercise programs for subjects with RSP. Scapular posterior tilting exercise (SPTE) in the prone position was highly efficient in activation of the LT and SA [3,4], but subjects with RSP typically tend to use the upper trapezius (UT) and high activation of the UT is regarded to cause the decrease of scapular posterior tilting [2]. So, the selective activation of LT and SA while reducing the UT activity is needed for effective exercise. One of the methods for selective activation is visual electromyographic (EMG) biofeedback. The visual EMG biofeedback is recommended approach for learning functional motor control in rehabilitation settings [5,6]. Thus, the purpose of this study was to investigate whether using visual EMG biofeedback can reduce the UT activity while increasing LT and SA activities during SPTE, and to determine changes in the scapular upward rotation angle after visual EMG biofeedback.

Materials and methods

Subjects: Twenty-four subjects (15 males and 9 females) with RSP participated in this study. The RSP was identified by measuring the distance between the posterior border of acromion and the table in the supine position. The subjects with distance ≥2.5 cm were included in this study [1]. The subjects with current shoulder pain or problems and history of neurological, musculoskeletal, or cardiopulmonary disease that could interrupt shoulder motion were excluded [4].

Instrumentation: Surface EMG (Noraxon TeleMyo DTS, Noraxon Inc., AZ, USA) was used to collect muscle activity. LT electrodes were attached obliquely upward and laterally along the line between the intersection of spine of the scapula and the 7th thoracic spinal process [4,7]. SA electrodes were attached anterior to the latissimus dorsi and posterior to the pectoralis major [4,7]. UT electrodes were attached midway between the spinous process of the 7th cervical vertebra and the posterior tip of the acromion process [7]. Raw signals were filtered using a band-lass filter (10-450 Hz), while 60 Hz and 120 Hz notch filter were used to diminish electrical noise. EMG data were processed by the root mean square.

Experimental procedure: EMG activities in two conditions (SPTE with and without visual EMG biofeedback) and scapular upward rotation angles in three different conditions (baseline, after performing SPTE with and without visual EMG biofeedback) were collected. The experimental procedure of this study was as follow: (1) Before the exercise, the investigator measured the subject's scapular upward rotation angle; (2) Subject performed SPTE; (3) After the SPTE, the investigator immediately measured subjects' scapular upward rotation angle; (4) Subject performed a 10-min session to familiarize themselves with visual EMG biofeedback for 10; (5)

After the familiarizing session, subjects performed SPTE with visual EMG biofeedback; (6) After the SPTE with visual EMG biofeedback, the investigator immediately measured subjects' scapular upward rotation angle.

Scapular posterior tilting exercise: In the quadruped position, the researcher instructed the subjects to rock backward and place the non-dominant hand under the forehead. The researcher passively abducted subjects' arm until 145° and the subjects lifted their arms while maintaining arm extension until the target bar, which was set at the subjects' earlobe level [1,4].

Scapular upward rotation angle measurement: The scapular upward rotation angle was measured in shoulder abduction at 135° by two inclinometers. One inclinometer was used to measure shoulder abduction angle and the other one was used to directly measure the scapular upward rotation angle with manually aligned along the scapular spine [1].

Visual EMG biofeedback session: EMG biofeedback measurement option of MyoResearch Master Edition 1.07 XP software (Noraxon Inc., AZ, USA) was used. Biofeedback information was displayed on the computer screen and the researcher instructed the subject to reduce UT activity while increasing the LT and SA activities [7,8].

EMG data collection: The EMG data of LT, SA, and UT were collected for 6-s for each trial during the isometric phase and data of 2-5 seconds were analyzed. The subjects performed each exercise (SPTE with and without visual EMG biofeedback) for three trials with a 2-min resting time between trials to prevent muscle fatigue. A 5-s maximal voluntary isometric contraction (MVIC) was calculated to determine a basis for EMG signal normalization; normalized muscle activities were presented as %MVIC [4].

Statistical analysis: SPSS ver. 21.0 (SPSS Inc., Chicago, IL, USA) was used to analyze statistical significance, and the significance level was set at $\alpha < 0.05$. The paired t-test was used to analyze the EMG activities (LT, SA, and UT) and the EMG activity ratio (LT/UT and SA/UT). The one-way repeated measures analysis of variance was used to analyze scapular upward rotation angles among the three conditions (baseline, after performing SPTE without and with visual EMG biofeedback). The Bonferroni correction was used for clarifying differences among three conditions (0.05/3=0.017).

Results

EMG activities and EMG activity ratios: The EMG activities of LT and SA were significantly increased during SPTE with visual EMG biofeedback (LT: p=0.006, SA: p<0.001). Also the EMG activity of UT was significantly decreased during SPTE with visual EMG biofeedback (p=0.002) (Figure 1). The LT/UT and SA/UT EMG activity ratios were significantly increased during SPTE with visual EMG biofeedback (LT/UT: p=0.001, SA/UT: p<0.001) (Figure 2).

Scapular upward rotation angle: The scapular upward rotation angle was significantly different among the three conditions (p<0.05). The scapular upward rotation angles in both, with and without visual EMG biofeedback, conditions were significantly increased when compared to the baseline

(both p<0.001). No significant difference in scapular upward rotation angles was noted between with and without visual EMG biofeedback during SPTE (p>0.017) (Figure 3).
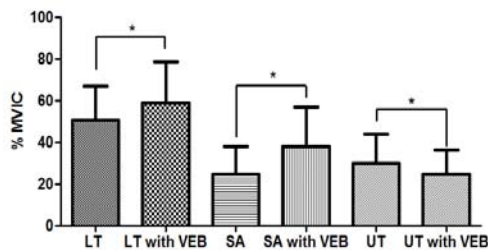

Figure 1. The muscle activities of LT, SA and UT during scapular posterior tilting exercise with and without visual EMG biofeedback (LT: lower trapezius, SA: serratus anterior, UT: upper trapezius, VEB: visual EMG biofeedback, *p<0.05).
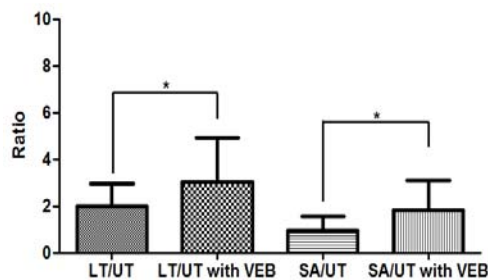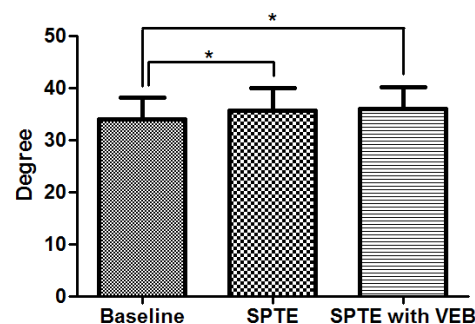

Figure 2. The muscle activity ratios of LT/UT and SA/UT during scapular posterior tilting exercise without and with visual EMG biofeedback. (LT: lower trapezius, SA: serratus anterior, UT: upper trapezius, VEB: visual EMG biofeedback, *p<0.05).

Figure 3. The scapular upward rotation angles in the three different conditions (SPTE: after performing scapular posterior tilting exercise without visual EMG biofeedback, SPTE with VEB: after performing scapular posterior tilting exercise with visual EMG biofeedback, *p<0.017).

Discussion

The results of this study indicate that using visual EMG biofeedback during SPTE can successfully reduce the UT activity while increasing LT and SA activities. The use of visual EMG biofeedback during SPTE may be beneficial because it is user-friendly and easy to learn. In particular, visual EMG biofeedback can help persons with RSP because it can selectively facilitate weak muscles while selectively inhibiting the overactive muscle [5,6,7,8]. In addition, EMG activity ratios of LT/UT and SA/UT were improved. Increased activity of the LT and the SA would contribute to prevent subacromial impingement [4], and reduced activity of the UT would lead to decreased compensation in subjects with RSP.

Scapular upward rotation angles in both with and without visual EMG biofeedback conditions were significantly increased compared with the baseline. However, contrary to our expectation, there was no significant difference in the scapular upward rotation angle between with and without visual EMG biofeedback during SPTE. This finding could have been due to the immediate effect of visual EMG biofeedback (because this study was a cross-sectional study). A longitudinal study is therefore needed to determine the long-term effect of visual EMG biofeedback on muscle activity and kinematic data in pathological patient groups.

Conclusion

Visual EMG biofeedback is user-friendly and easy to learn. The SPTE using visual EMG biofeedback could be an effective method to reduce the UT activity and increase LT and SA activities, as well as EMG activity ratios of LT/UT and SA/UT. Therefore, visual EMG biofeedback should be advocated to reduce overactivation of the UT while selectively enhancing the LT and the SA activity during SPTE.

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Development of animal model of post-stroke spasticity and study of its mechanisms

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Introduction

Spasticity is common in patients with brain and spinal cord injuries. Approximately 20% to 40% of patients with stroke exhibit spasticity, whereby neurologic damage disrupts voluntary movement control. Consequently, these patients' quality of life is significantly lower compared to that of patients without post-stroke spasticity.[1]

It is clear that stroke can cause inhibitory and excitatory impulse imbalance, leading to upper motoneuron symptoms, and it is known that lesion location and extent can result in differing symptoms and degrees of spasticity severity; however, the pathophysiologic basis of spasticity remains poorly understood. It is accepted that spasticity involves over-reactivity of alpha motoneurons and alterations in primary Ia reciprocal inhibition and Renshaw recurrent inhibition, further understanding of the underlying mechanisms is hindered by the lack of animal models. In one study, Fulton and colleagues used primates to demonstrate that lesions in both primary and premotor areas can induce spasticity;[2] however, a rodent model is needed to analyze the precise mechanisms underlying spasticity after cortical injuries, such as those in stroke.

Here, we investigated whether spasticity is induced after photothrombotic injury to the rostral and caudal forelimb motor areas of mice, which are considered the premotor and forelimb primary motor cortices in rodents, respectively.[3] Given that enhanced excitability of affected motoneurons has frequently been reported in studies of spasticity after stroke and spinal cord injury, we further examined whether a similar phenomenon occurred in our mouse model of post-stroke spasticity.

Materials and methods

Photothrombotic cortical lesion

Focal cortical ischemia was induced by cortical microvessel photothrombosis, as described previously. Rose Bengal (30 mg/kg body weight) was injected into the tail vein 5 min before illumination, and the skull was exposed via a midline incision of the skin. Focal illumination of the rostral and caudal forelimb motor areas was carried out with a cold light source [4] through the intact skull; the brain was illuminated for 15 min. Control mice either received the same injection of Rose Bengal without illumination (n = 10) or were photostimulated after an intravenous injection of 0.9% NaCl solution (n = 4).

Electrophysiological recordings

We modified a previously described method to use the rate-dependent depression (RDD) of the H-reflex as a measurement of spastic symptoms[5-6] We transcutaneously inserted a pair of stainless needle electrodes fixed with micromanipulator (SM-15, NARISHIGE, Tokyo, Japan) into nerve bundles, including the ulnar nerve and stimulated with a stimulator (1 - 3 mA in 0.1 mA increments, SEN - 7103, Nihon Kohden Corporation, Aichi, Japan). For recording, a pair of stainless needle electrodes fixed with manipulator was transcutaneously placed into the abductor digiti minimi muscles and obtained recordings with an amplifier and an A/D converter.

Immunohistochemical analysis

The tissues were embedded in optimal cutting temperature compound and stored at –80°C. Coronal sections of the spine (20–30-μm thick) were prepared with a cryostat. We pre-incubated the tissue in blocking buffer (5% normal bovine serum and 0.25% Triton X-100 in PBS) for 1 h at 25°C, followed by incubation with a first antibody in blocking buffer for 24 h at room temperature. After washing in PBS, the tissue was incubated for 1 h in a solution containing second antibody. The sections were counterstained with DAPI (4',6-diamidino-2-phenylindole).

Statistical analyses

Group measurements are expressed as mean ± standard error of the mean (SEM). H-reflex RDDs were determined as a measurement of spasticity and analyzed with one-way analysis of variance (ANOVA) and Tukey–Kramer Tests. For immunohistochemical analysis, we used ANOVA, Tukey–Kramer tests, and Spearman's correlation coefficient by rank test. p values less than 0.05 were considered significant.

Results

Reduction of H-reflex RDD after stroke

To test whether an affected muscle exhibited spastic symptoms after stroke, we measured H-reflex RDDs in the affected and unaffected abductor digiti minimi muscles 3 days and 1, 2, 3, 4, 6, and 8 weeks after stroke. The H-reflex magnitudes were attenuated by repeated activations at frequencies higher than 0.1 Hz. In particular, we observed a reduction of more than 80% of the H-reflex magnitude at 5 Hz in sham-operated mice (Figure 1A, upper panel). In contrast, the H-reflex magnitude in 4-week stroke mice was not strongly attenuated by repeated activation (Figure 1A, lower panel). Moreover, we found that RDDs for the affected muscles were significantly weakened in stroke mice (n = 6) compared to sham-operated mice (n = 7) 3 days after stroke, and this was still observed on week 8 after stroke ($p < 0.01$, Figure 1B); however, the RDDs were not significantly weakened at week 3. In addition, the RDDs of stroke mice were significantly smaller at week 6 than at weeks 4 and 8 ($p < 0.01$). Four weeks after stroke, the RDDs induced at all frequencies higher than 0.1 Hz were significantly smaller in stroke mice than in sham-

operated mice (Figure 1C). This indicates that the affected muscles exhibited spastic post-stroke symptoms in our model.
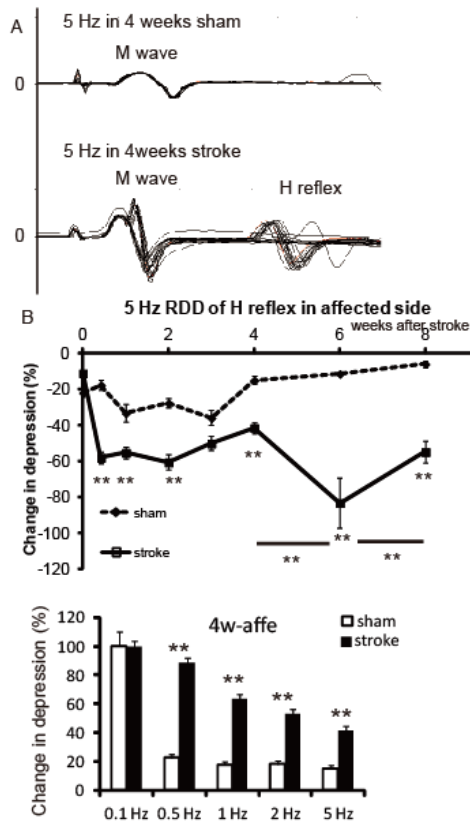

Figure 1: Rate-dependent depression (RDD) of Hoffmann's reflex (H-reflex) in sham-operated and stroke mice. A: Repeated stimulation at 5 Hz weakened H-reflex amplitude in normal mice (upper). In stroke mice, H-reflex was not weakened upon repeated stimulation at 5 Hz (lower). B: Changes in H-reflex depression (%) with 5-Hz stimulation on the affected side in stoke and sham-operated mice. C: H-reflex RDD 4 weeks after stroke. Response data are expressed as percentages relative to the mean responses at 0.1 Hz in the same series of measurements. Data are shown as the mean ± standard error of the mean (SEM). *$p < 0.05$, **$p < 0.01$ (n = 7 for sham-operated mice and n = 6 for stroke mice, one-way ANOVA followed by Tukey–Kramer tests).

Motoneuron hyperactivation after stroke

It has been reported that one of the mechanisms underlying spasticity in stroke patients is increased neuronal excitability of the propriospinal neurons and motoneurons. We measured c-Fos immunoreactivity in motoneurons labeled for choline acetyltransferase (ChAT) using spinal sections from the cervical to the thoracic level (C4–T1) obtained 1, 2, 4, and 8 weeks after stroke. At 1 week after stroke, c-Fos induction in the affected and unaffected neurons was significantly increased in stroke mice compared to sham-operated mice at most spinal levels (n = 3 for groups; **$p < 0.01$, in C4–T1, compared between sham-operated and stroke mice on the affected side; [#]$p < 0.05$, in C4, [##]$p < 0.01$, in C6–T1, compared between sham-operated and stroke mice on the unaffected side)

Discussion

Spasticity is a common complication after stroke; however, the underlying pathophysiology remains unclear, and research into this area is hampered by the lack of appropriate animal models. The present study reveals that lesions in the rostral and caudal forelimb motor areas of the mouse brain induce spasticity, as indicated by weakened H-reflex RDDs, increased motoneuron excitability of affected muscles, and recovered RDDs in stroke mice following baclofen treatment. Our findings raise the possibility that this protocol may yield a viable animal model of post-stroke spasticity.

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The kinematic analysis of passive stretching by physical therapists for equinovarus after stroke.

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Introduction

Stretching is one of major intervention for spasticity. But in a systematic review, the evidence of the effects of stretching in spasticity was inconclusive because of a wide diversity in studies included this review which investigate the effects of stretching on spasticity [1]. And this review suggested there were no criteria of intervention to measure the effects of stretching, especially manual stretching by therapists.

So we are establishing an analyzing system for identifying kinematic properties of passive stretching by physical therapist (PT) for ankle joint. In this study we investigated whether an established system could be used in clinical application as a measure of therapists' manual stretching techniques.

Materials and Methods

An analyzing system of stretching techniques
1) Measurement method

We made the instrument to measure forces applied to both the forefoot and heel, as shown in Fig 1, because, in clinical, PTs generally push the plantar surface using their forearms while gripping the heel of the patient in order to stretch the ankle plantar flexors. This instrument could be fastened to the patient's foot using fabric bands, and the gaps between the foot and brace were filled with rubber plates and sponges to tightly fix them while avoiding pain. This tightening allowed the therapists to apply sufficient forces to the instrument as they clinically do for the barefoot of patient.

A three-dimensional motion capture system (VENUS3D, Nobby Tech. Ltd., Japan) was used for measuring the motion during stretching, which also allowed for synchronization of the force sensors and cameras. The system recorded the positions of reflective markers attached to the patient's thigh and brace at the rate of 120 Hz. Seven reflective markers were used for the motion capture system (Fig. 1). Two markers were placed on the anterior border of the patient's tibia shin bone. One marker was also attached on the bone's medial surface. The instrument had four markers attached. Two of them were located on the frontal part, and the other two markers were on the medial part of the instrument. Using these markers, two coordinate systems were defined: lower leg ($\sum_l$) and foot ($\sum_f$), as shown in Fig. 2.

2) Kinematic properties of stretching

In order to investigate stretching techniques, the following three types of kinematic data were used: foot posture, foot force, and torques.

The foot posture was defined as the roll-pitch-yaw angles between the lower leg and foot coordinate systems. For this end, we computed the rotation matrix ^lR_f between the two coordinate systems and decomposed it into roll, pitch, and yaw angles ($^l\theta_x$, $^l\theta_y$, $^l\theta_z$). The six-axial torque sensor on the heel output three force components (^ff_x, ^ff_y, ^ff_z) and moments (^fm_x, ^fm_y, ^fm_z). These properties are almost equivalent to motions and forces along axes of ankle (Table.1).

Note that it was not possible to acquire the outputs from another force sensor on the forefoot owing to a problem of electronic circuits; therefore, data from the forefoot sensor was not used in the analysis.

Experiment in clinical
1) Subjects

We applied the previous system to PT stretching for equinovarus in clinical. A male PT with twenty years of experience in rehabilitation and three stroke survivors were invited to participate in this experiment (Table. 2). This study was approved by the local ethics committee (Graduate School of Medicine, Nagoya University, approval no. 14-501).

2) Experimental task

The patients wore the measuring instrument on their paralyzed foot and lay relaxed on a bed. PT stretched the patient's foot through the instrument The PT was instructed to perform the stretching as they did in a clinical setting. One trial of stretching lasted ten seconds, and in a single set of the experiment, three trials were repeated with a rest period of five seconds between trials. In total, three sets were conducted for each therapist, with a one-minute break after each set.
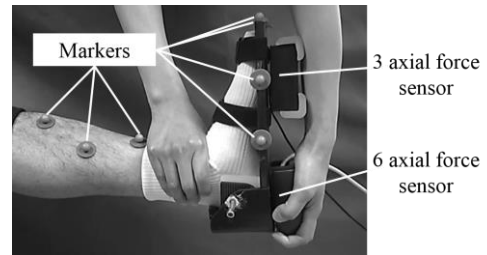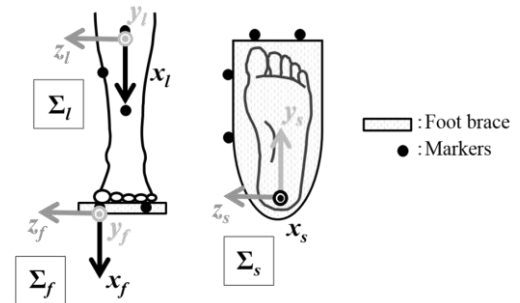

Fig. 1 Foot brace with two force sensors.

Fig. 2 Coordinate systems ($\sum_l$, $\sum_f$ and $\sum_s$).

Table. 1 Meanings of each kinematic properties

property	+x / -x	+y / -y	+z / -z
posture (θ)	adduction / abduction	eversion / inversion	dorsiflexion / plantarflexion
force (N)	distal direction / proximal direction	fore direction / rear direction	medial direction / lateral direction
moment (mN·m)	adduction / abduction	eversion / inversion	dorsiflexion / plantarflexion

Table. 2 Characteristics of patients

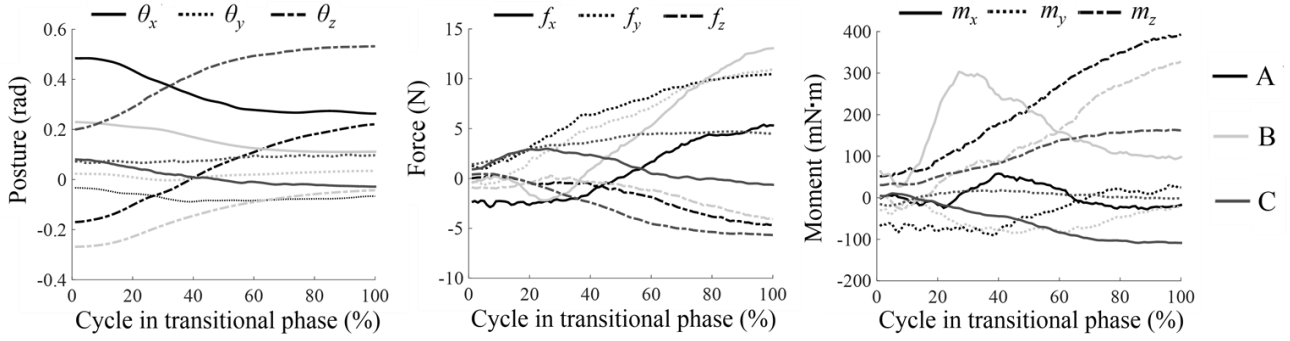| patient	sex/age	affected side	since onset	severity
A	female / 83	right	4 months	BRS V
B	male / 82	right	5 months	BRS II
C	male / 41	right	6 months	BRS IV

(BRS: Brunnstrom Recovery Stage)

Fig. 3 Average of kinematic properties each stretching trial for patient A, B and C.
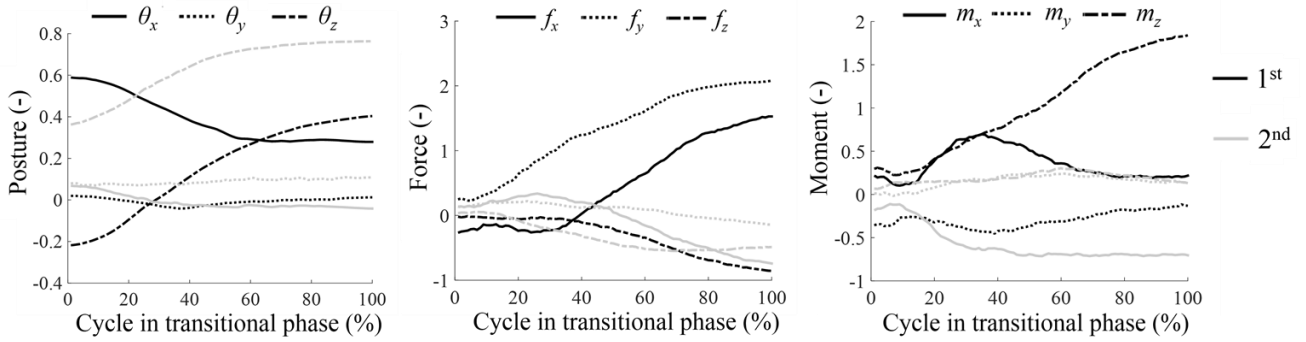

Fig. 4 1st and 2nd Components of kinematic properties.

Data analysis of stretching

We used a spectrum analysis for identifying PT stretching techniques. Nakanishi et al. suggested a spectrum analysis could be used for motion analysis including time series data [2]. But their method included only posture angles to analysis, so we expanded their methods to use not only angles but also forces and moments.

For the spectrum analysis, a single foot stretching was split into two phases: transitional and keeping. The transitional phase spans from the beginning of the stretching to the point at which the foot was dorsiflexion. The keeping phase is the period during which the muscles were continuously stretched with relatively large manual forces. A border between these two phases was defined using the velocity of the dorsi/plantar flexion angle of the foot. In this study, the main focus was on the transitional phase in the analysis because it was possible to see the movement to correct the equinovarus in this phase.

After the segmentation, each time-sequence data were downsampled to the length of 100 and normalized, and we defined the extended vector as

$$v = (\ ^l\theta_x^T \ ^l\theta_y^T \ ^l\theta_z^T \ ^ff_x^T \ ^ff_y^T \ ^ff_z^T \ ^fm_x^T \ ^fm_y^T \ ^fm_z^T)^T$$

which had a length of 900. This extended vector was used for each stretching. Secondly, data matrix of all stretching trials were performed and we decomposed DD^T into the matrix of eigen vectors and values using spectrum expansion.

$$D = A\Lambda^{\frac{1}{2}} = (\sqrt{\lambda_1}a_1 \ \sqrt{\lambda_2}a_2 \ \cdots \ \sqrt{\lambda_m}a_m), \quad (\lambda_1 > \lambda_2 > \cdots > \lambda_m)$$

Then we looked at the eigen vectors with large eigen values to specify the principal components.

Results

The averages of foot position, force, and moment of all trials which applied to each patients are shown in Fig.3. According this figure, we could find some properties, such as θ_y, f_z, m_y, had the tendency in their change during stretching whereas other properties, such as θ_z, f_x, m_x, had different change among trials of each patient. So we couldn't define the characteristic of PT stretching techniques from kinematic properties averages.

On the other hand, from the spectrum analysis, two principal components ($\sqrt{\lambda_1}a_1$, $\sqrt{\lambda_2}a_2$) were acquired, with the contribution ratios of each component being 64.8% and 15.9%. Fig. 4 shows the primary and secondary components for the foot posture, force, and torque. We could find 1st component corresponds to the average profile of the techniques in other wards similarity of the techniques because this component showed summarized all trials, and 2nd component expressed where there were individual differences by the change of properties value. For example, value of θ_z was increasing in 2nd components and this indicated that there were individual differences in dorsi or plantar flexion of stretching. Thus, according to these results, we could identified the mainly PT stretching techniques for all patients and the differences properties in stretching for each patient.

Discussion & Conclusions

In this experiment, the primary component with 64.8 % contribution ratio was statistically extracted as similarity despite the diverse severity of included patients. This suggests it is possible to separate a commonality of the stretching techniques from a specificity of each patient by this analyzing system.

Using the kinematic analysis of manual stretching for ankle which we are developing, we identified the mainly stretching techniques and differences among patients. So this system could be useful for standardization of each PT stretching techniques for several patients and contribution of education in PT.

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The Validity and Reliability of A Dynamic Neuromuscular Stabilization-Heel Sliding Test for Core Stability

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Introduction

Conventionally, core stability has been measured by various methods, including straight leg lowering test (SLLT) prone formal test [1-7], and the global muscular endurance test [8].Basically, SLLT is a mostly widely used, reliable and valid test to measure core abdominal muscle strength in supine.

To accommodate the shortcomings associated with severe core instability and pain during conventional core stabilization tests, we have recently developed a dynamic neuromuscular stabilization based heel sliding (DNS-HS) test. The DNS-HS test is conceptually derived from the DNS technique which involves subconscious coactivation of the diaphragm-transverse abdominis-multifidus in coordination with other superficial core muscles to provide uprighting and stability of the lumbopelvic system in a supine position [9].

The present study was to establish the validity and reliability of the DNS-HS core stability test by comparing the conventional SLLT core stability.

Materials and methods

Instrumentation: The ultrasound (SonoAce, 6000, Medison Co., Ltd, korea) in M-mode with a 3.5 MHz curved transducer (HC2-5) was used to measure diaphragm movement. The pressure biofeedback unit (PBU, Chattanooga Group, Hixon, TN, USA), which contains a 3-chamber pressure bag connected to a pressure gauge and inflation device, was used to detect core instability [10]. The motion analysis system (Simi Aktisys GmbH, Unterschleissheim, Germany) was used to determine hip joint angle during the core stability tests. The core stabilization tests included the SLLT and DNS-HS.

Experimental procedure: A total 20 subjects were recruited. All subjects underwent a physical health screening and SLLT for checking core instability [11, 12]. A procedural checklist along with the standardized verbal instructions was followed to ensure a consistent experimental procedures. All measurement systems were calibrated for each participant before data acquisition.

Validity: Criterion validity was determined by comparing hip joint angle data that were sequentially assessed by the SLLT and DNS-HS methods. The hip joint angle during the SLL test was first determined. For the SLLT, the participant was initially positioned in supine with both hips and knees at 90° flexion. Participants were asked to contract abdominal muscle concentrically into the lumbar spine and consciously to maintain this stabilization position and then was gradually lowering both legs toward the floor without any lumbopelvic movement. For DNS-HS, the participant was initially positioned in a hook-lying position with 70° of hip flexion. Participants were asked to breathe in and subconsciously or automatically descend the diaphragm so as to activate the TrA, multifidus, and pelvic floor chain muscles. The investigator palpated anteriorly the xiphoid process; laterally 10~12 ribs; and posteriorly angulus costae to ensure the symmetrical activation against the therapist's fingers while expanding the lower ribs (10~12th ribs) in a lateral direction. The corrective movement involves caudal movement and widening of the intercostal spaces, and relatively stable rib motion (no cranial motion) in a transverse plane [13] .

Once this core stabilization was obtained, participants were asked to breathe naturally and then slide the both heels along the floor without any lumbopelvic movement.

Test-retest reliability: The test-retest reliability was established for determining the intra-rater consistency of DNS-HS measurement. The reliability test was performed on 2 separate occasions, approximately 24 hours apart. All the testing conditions were maintained as consistent as possible, including the same investigators, experimental procedures (i.e., consistent instruction, calibration, testing sequence, the same established hook-lying positions), time of day and interval, and testing environment (lighting, temperature).

Statistical design and analysis: SPSS ver. 21.0 software (SPSS, Inc., Chicago, IL, USA) was used for all statistical analyses. Intra-rater reliability and validity were determined using intraclass correlation coefficients, [ICC (1,2)]. The significance level was set at 0.05 for all statistical analyses.

Results

The validity of the DNS-HS test was determined by comparing conventional SLLT that were recorded by Simi Reality Motion Systems. ICC between DNS-HS and SLLT was good on 20 different subjects (ICC = 0.700, p<0.05) (Table 1).

Table 2 shows results of the test-retest reliability of performers' repeated measure by using Simi Reality Motion Systems. ICC was calculate one examiner test respective 2 measure approximately 24 hours apart subjects (ICC = 0.953, p<0.05).

Discussion

The present study established the validity and test-retest reliability of a novel core stability test because there is a dearth of clinical evidence regarding established validity and test-retest reliability of core stability measurements. Core instability is one of the most perplexing and clinically challenging neuromusculoskeletal conditions, which involve multiple components including core stabilization, strength, power, endurance, flexibility, motor control, and function. Furthermore, it lacks a universal definition about core stabilization, and currently, there has been no gold standard assessment of core stability with established evidence for validity and reliability.

The present study compared the DNS-HS core stability test with the SLLT because it is a universally accepted clinical assessment of abdominal muscle strength and is presumed to characterize abdominal core stability [1-6, 14].

The test-retest data in the present study revealed ICC = 0.953, representing an excellent consistency or repeatability in the DNS-HS core stability measurements. This finding was

consistent with pervious intra-session measurements of SLLT [1].

Zannotti et al examined the kinematics of the double-leg-lowering (DLL) test (or also known as 'SLLT') of abdominal muscle strength in healthy young adults using ICC for intra-session measurements of pelvic tilting occurring at 5 hip joint angles (15°, 30°, 45°, 60°, 75°) during DLL under controlled or uncontrolled pelvic stability conditions [1]. The intra-session ICC measures recorded early in the DLL maneuver were less than acceptable although ICCs for the latter hip angles were found to be more acceptable and higher than for the initial angles, ranging from 0.63-0.95 [1]. In fact, for the angle of first (1°) pelvic tilting, the ICCs were observed to be 0.55 for the controlled pelvic stability condition and 0.24 for the uncontrolled pelvic stability condition [1]. Furthermore, the DLL maneuver can provide a considerable challenge to the abdominal muscles and none of the tested young healthy subjects were unable to successfully stabilize the pelvic tilting, which jeopardizes internal validity of the scoring system associated with the DLL.

However, the DLL test was incapable of discriminating essential core stability function from abdominal muscle strength because the DLL test identifies only global differences in abdominal strength capability. The majority of the subjects were able to complete the grade 1 level test only and it was not able to provide appropriate resistance necessary for accurate evaluation of trunk muscle strength in individuals with a history of low back pain. For these reasons, the DLL test has been challenged and questioned as a valid or reliable measure of core instability which is also applicable for most clinical populations with low back pain [1, 2, 5-7].

Table 1. Validity obtained by comparing the SLLT and DNS-HS measurement data

	SLLT[a]	DNS-HS[b]	ICC[c] (1,2)	p-value
Hip angle (°)	79.45±6.49[d]	49.37±9.29	0.700	0.006*

[a]Straight leg lowering test
[b]Dynamic neuromuscular stabilization based heel sliding
[c]Intraclass correlation coefficient
[d]Mean ± SD; Validity ICC was computed based on 95% CI with 0.241-0.881 range.

Table 2. Test-retest reliability of the DNS-HS measurement

	Test	Re-test	ICC [a] (1,2)	p-value
Hip angle (°)	49.37±9.29[b]	51.60±8.43	0.953	<0.001*

[a]Intraclass correlation cofficient
[b]Mean ± SD; Reliability ICC was computed based on 95% CI with 0.882-0.981 range.

Conclusion

Clinically, the core stability test using the DNS-HS test is a new approach, and the potential efficacy of the DNS-HS for patients who have a core instability with low back pain. The DNS-HS measure may be useful for examination, prevention, and training of patient who have a back pain, older adult with impaired core instability. Objective quantification of core stability may help early detection in evaluation and monitor even minute progress after rehabilitation.

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Event Related Desynchoronization (ERD) of MU Rhythm During Concentric and Eccentric Contraction

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Introduction

Concentric contractions are achieved by the shortening of muscle fibers when a person performs movements against gravity and external force. Eccentric contractions are achieved by the lengthening of muscle fibers when a person performs movements in line with gravity or that lower the load. Previous studies using electroencephalography (EEG) and functional magnetic resonance imaging (f-MRI) reveal differences between the brain activities associated with these two types of contractions in patients. This study designs an experiment to examine the changes in cortical activation patterns as subjects undergo familiarization with tasks by repeating concentric and eccentric elbow flexor contractions. We speculate that previously observed differences in brain activities are possibilities induced by the level of required attention and familiarity with motor tasks, rather than due to fundamental differences in the biomechanical characteristics of the tasks. Accordingly, the purposes of our study are, first, to compare the EEG pat-terns and reaction time (RT) of electromyographic (EMG) between concentric and eccentric biceps brachii (BB) contractions under the RT paradigm, and subsequently, to evaluate how the EEG patterns and RT of EMG change after the same amount of practice.

Materials and methods

Subjects: For this study, we recruited 16 volunteers (male = 12, female = 4; mean age ± standard deviation = 22.43 ± 2.149). . Inclusion criteria were age (between 20 and 29 years), and dominant use of the right hand. That is, to prevent the possible interference of age and dominance of the brain on EEG cortical signals (Klimesch 1999), only right-handed young adults were included in this experiment. Furthermore, anyone suffering from pain or with any history of psychiatric, neurological, and/or musculoskeletal dis-orders was excluded from this experiment.

Experimental procedure: The entire experiment consisted of three phases. Each phase included 30 trials of concentric contractions and 30 trials of eccentric contractions, together with three maximum isometric contractions. The order of muscle contractions was randomized within each phase using drawing lots (eccentric → concentric or concentric → eccentric). Phase II was exclusively for practice, and phase II data was not analyzed. Only data from phases I and III were used for comparing concentric and eccentric contractions among participants. After finishing the muscle contractions, three maximum isometric contractions were performed at the end of each phase to determine whether fatigue was developed by the repetitive muscle contractions. Ten-minute rests were given between phases.

Data analysis: All the EMG and isokinetic data were processed and analyzed using MyoResearch 1.08 software. EMG onset determined that EMG amplitude increased over two standard deviations in comparison to the baseline level for a minimum of 50 ms (Hodges and Bui 1996). The median frequency of the left BB was analyzed by the fast Fouri-er transform method. Reaction time (RT) was defined as the duration of time between the Go signal (yellow circle) and the onset of BB EMG.

The MATLAB R2008a (MathWorks Inc. Natick, Massachusetts, USA) was used to analyze recorded EEG data. To process the spectral analysis of EEG, each single-trial event-related potential was applied using a continuous wavelet transform (CWT) of a complex Morlet wavelet (Tallon-Baudry et al. 1996). In mu rhythms, suppression occurs when the neurons in the somatosensory area receive inhibitory inputs from other areas of the brain, particularly during preparation for motor acts. This phenomenon is called Event related desynchronization (ERD). The variables of ERD onset and ERD amplitude of mu rhythms were used for data analysis.

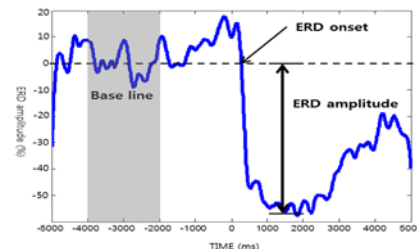$$ERD\ amplitude\ (\%) = \frac{A-B}{B} \times 100 \quad \text{(figure 1).}$$

Figure 1. Detection of the baseline, onset time, and amplitude of ERD.

Statistical analysis: PASW Statistics version 18 (SPSS, Inc., Chicago, IL, USA) was used for statistical analyses of the data herein. The median frequency and peak torque values of the before phase (I) and after phase (III) were compared using paired t-tests to determine whether fatigue was developed among the participants by repeated submaximal muscle contractions. The RT was analyzed using two-way repeated analysis of variance (ANOVA; phases x contraction types). Three-way repeated ANOVA (contraction types x phases x hemisphere) was used to analyze ERD onset and ERD amplitude (contraction type: concentric contractions and eccen-tric contractions, phase: phase I and phase III, and hemisphere: C3 and C4). The Greenhouse-Geisser epsilon correction of degree of freedom was applied due to repetition of the measure. When interaction effects were observed, the Bonfer-roni comparison was used as a post hoc test. Statistical significance was set at 0.05.

Results

Fatigue Effects: To evaluate whether or not any fatigue of the BB developed among the participants, we compared the values of EMG median frequency and peak torque before and after completion of the experimental procedures. Neither the EMG median frequency nor peak torque values after

completion of phase III were significantly changed from the initial values (p > 0.05).

RT of EMG: Interaction effects were observed (p < 0.05). The results of the post hoc test re-vealed that, in phase I, the RT was significantly longer in eccentric contractions than in concentric conditions (p < 0.05). In contrast, there was no significant dif-ference in RT between the two contraction types in phase III (p > 0.05). In the concentric condition, the RT in phase I was not significantly longer than the RT in the concentric condition of phase III (p > 0.05). However, the RT of the ec-centric contraction condition decreased significantly from phase I to phase III (p < 0.05) (Figure 2).
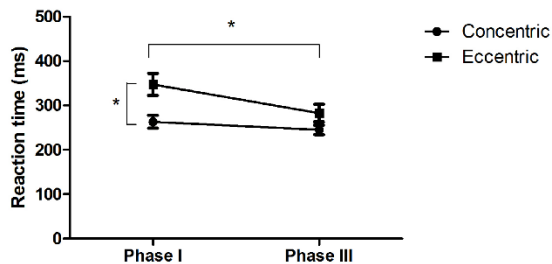
Figure 2. Two-way interaction plot for the RT (Contraction type x Phase).

ERD Onset Time of Mu Rhythms: There were interaction effects between contraction types, phases, and hemi-spheres (p < 0.05) (Figure 3). In the post hoc test, the ERD onset times were significantly faster for eccentric contractions than the ERD onset times of concentric contractions in both phases I and III (p < 0.05). While the ERD onset was faster in phase III than phase I for both types of contractions, the difference was found to be statistically significant only in the concentric contraction condition (p < 0.05). ERD onset times in both C3 and C4 were significantly faster for ec-centric contractions in comparison to concentric contractions (p < 0.05). ERD onset in the performance of both concentric and eccentric contractions occurred significantly earlier in C4 than C3 (p < 0.05).
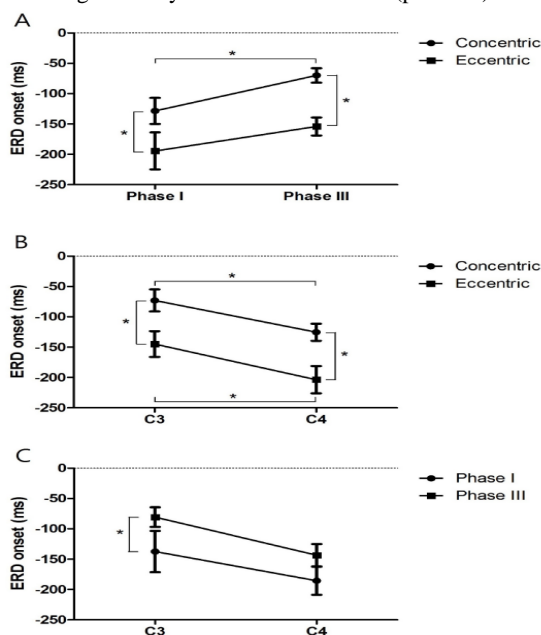
Figure 3. ERD onset time plot
A: Interaction between Contraction type and Phase
B: Interaction between Contraction type and Hemisphere
C: Interaction between Phase and Hemisphere

Topography of Averaged ERD Activity of Mu Rhythms: In phase I, substantial ERD was observed bilaterally during both types of muscle contractions. In phase III, however, bilateral ERD activity was observed only during eccentric contractions. ERD mu rhythms tended to be localized in the C4 region (contralateral) during concentric contractions (figure 4).
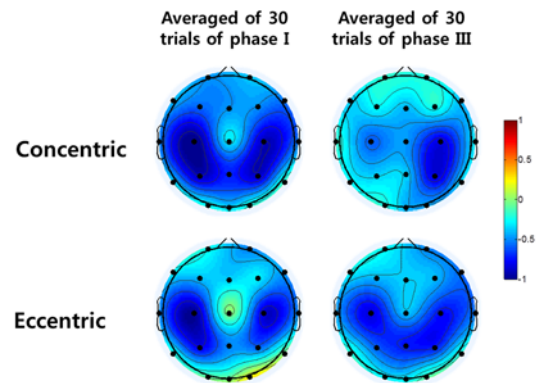

Figure 4. Topography of averaged mu rhythm ERD in 1000 ~ 2000 ms prior to the EMG onset

Discussion

Reaction time represents the amount of information to be processed by the central nervous system (CNS) before initiation of a given motor action. In the same way, early ERD onset of mu rhythms in the sensory motor cortex is related to less preparation required for a given motor task. Therefore, these results seem to suggest that eccentric contractions require the brain to work harder in preparation for the task. Furthermore, in the case of both types of muscle contraction herein, the mental demand decreased as familiarity with the motor action increased with practice, which supports the observed changes in both ERD onset and amplitude in repetitive contractions. However, in contrast to our expectation, eccentric contractions still required more brain activity for preparation and cognitive load, even after repetitive training to familiarize the subjects with the task. Therefore, we conclude that the differences in brain activity during eccentric and concentric muscle activity do not disappear with motor learning or practice.

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Intersensory facilitation and interference during stepping task

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Introduction

Taking a quick correct step response while inhibiting an incorrect one to environmental stimuli is a fundamental human function. When there is uncertainty about the appropriate postural response, however, errors in the direction of initial weight transfer (i.e., anticipatory postural adjustment (APA) errors) could occur [1]. Increased stepping reaction errors [2], and delayed step initiation and completion of a voluntary step [3] are associated with falls in the elderly. The presence of an APA error can result in those situations. Most previous studies, however, examined the stepping behavior using only one sensory modality, even though in reality humans receive information simultaneously from multiple sensory modalities. Moreover, the control of balance and posture in fall prevention is a complicated central sensorimotor function that integrates information from visual, vestibular, and audiosomatosensory systems. Therefore, to advance our understanding of the control of gait initiation and falls associated with it, it is necessary to investigate such executive functions as stimulus identification, response selection, and postural preparations during stepping movement, in the context of intersensory integration. The purpose of the current study was to investigate the effects of an acoustic stimulus simultaneously presented with a visual imperative stimulus on stepping performance.

Materials and Methods

Subjects

Eleven participants (5 males, 6 females, mean age ± SD = 22 ± 2.24) without a history of hearing, neurological, or orthopedic disorders that could influence the balance function were recruited from Nagoya University School of Health Sciences. All participants had normal or corrected-to-normal vision. The study was approved by the Ethics Committee of Nagoya University, and written informed consent was obtained before their participation.

Apparatus and procedures

Participants were required to maintain a stationary standing posture on a force plate with their bare feet and stepped forward in response to a visual imperative stimulus that appeared on a computer screen set just below the eye level at a 1.0 m distance from the participant. Acoustic accessory stimuli (1000 Hz, 80 dB) were also delivered randomly and simultaneously with the visual stimuli from two speakers, one placed on each sides of the monitor.

The visual stimulus was an arrow (< or >) appearing either right or left side of the fixation point on the computer screen, and the participant stepped forward with the leg that corresponded to the direction of an arrow (< was assigned to the left leg and > was assigned to the right leg) onto a wood plate placed right front of the force plate, and brought the other leg alongside. Participants were instructed to execute the movement as quickly and accurately as possible, and after the stepping, they were required to move back to the same starting position and prepare for the next trial.

Stimuli

Each participant performed two blocks of the CRT task and four block of the Simon task which consisted of congruent and incongruent conditions (Fig. 1). For all blocks, acoustic accessory stimuli were presented randomly in 50 % of the trials.
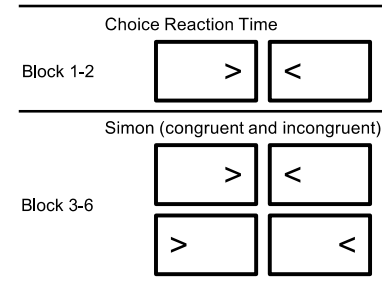

Figure.1 Visual imperative stimuli

Data collection and analysis

The data of ground reaction forces during step executions were collected using a force plate at a sampling rate of 1000 Hz, and the following temporal parameters were identified offline using programs written in Matlab (MathWorks, Natick, MA, USA); reaction time (RT), APA duration, and foot-lift time (Fig. 2A). APA errors were identified by the first mediolateral deviation of COP toward the stance leg, indicating the presence of two or more postural adjustments before the final mediolateral shift toward the stance leg in one step execution (Fig. 2B).
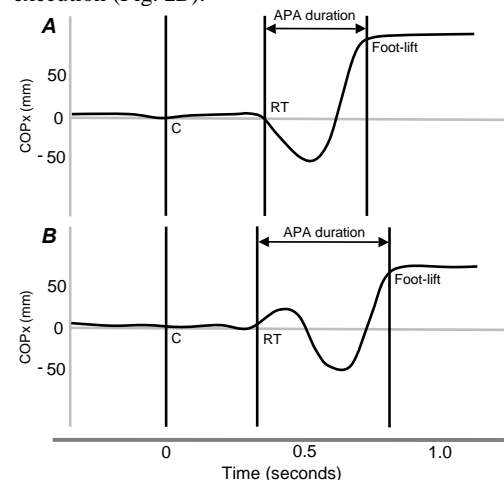

Figure. 2 Examples of force plate data for forward step execution with the right leg

First, two-way repeated-measures analysis of variance (ANOVA) was conducted to determine the effects of acoustic accessory stimuli and task conditions on APA errors. Next, we used a linear mixed model to determine the effect of accessory stimuli and task conditions on RT, APA duration, and foot-lift time with sound (off and on) and the condition (CRT, congruent, and incongruent) as fixed factors and participant as a random factor. Bonferroni post-hoc analyses were performed to test interaction effects and to determine the locus of the difference.

Results

APA error rates of trials with sound were significantly higher than trials without sound in the incongruent condition ($p = 0.001$) but not in other conditions. RTs of trials with sound were significantly shorter than trials without sound in all conditions ($p < 0.001$). APA durations of the trials with sound were significantly longer than the trials without sound in the incongruent condition ($p < 0.001$). Foot-lift times of the trials with sound were significantly shorter than the trials without sound in CRT ($p = 0.028$) and congruent ($p = 0.016$) conditions, but not in the incongruent condition.
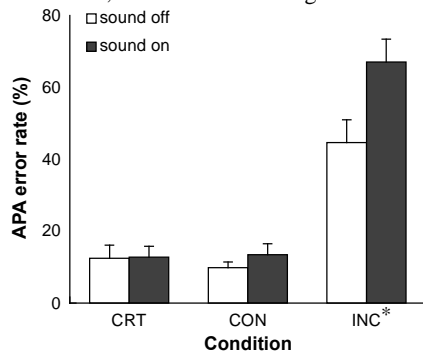
Figure. 3 Mean anticipatory postural adjustment (APA) error rates for sound off and on trials obtained from all the participants in three different conditions.

Discussion

The APA error rate of the trials with accessory stimuli was higher than the trials without accessory stimuli only in the incongruent condition (i.e., when there is a spatial incompatibility) (Fig. 3). In contrast, the RTs were shortened in all the conditions (Fig. 4*A*). Facilitation of RTs indicates that accessory stimuli speed stimulus-encoding process (identification of visual stimuli) or lower the decision threshold regardless of the stimulus type (direction or location). An increase in the APA error rate solely in the incongruent condition suggests that accessory stimuli additionally facilitate automatic response activation toward the stimulus location under spatial incompatibility. The lengthened APA durations in the incongruent condition (Fig. 4*B*) were most likely caused by the increased APA error rate, since more than one APA would occur in the APA error trials. The foot-lift time of the incongruent condition was delayed by the lengthened APA duration and thus APA errors (Fig. 4*C*).
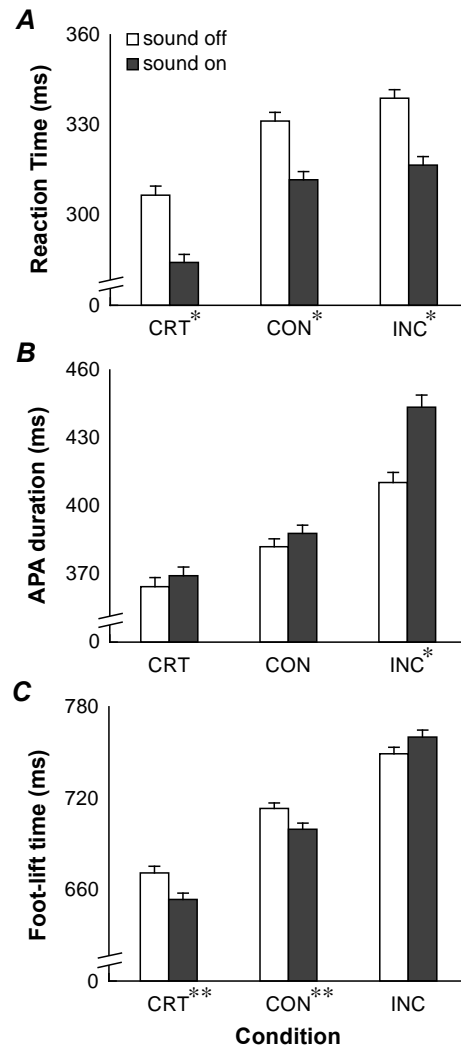

Figure.4 Changes in temporal parameters of step execution for the sound off and on trials.

Conclusion

This study revealed that acoustic accessory stimuli simultaneously presented with visual imperative stimuli modulate the initial motor programming of stepping. Consequently, they caused an increase in the anticipatory postural adjustment error rates under spatial incompatibility, and the facilitation effects of them on reaction times did not remain until foot lift in the incongruent condition.

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Relationship between self-reported walking time and objectively measured Moderate to vigorous physical activity in middle-aged: Cross-sectional, correlational research

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Introduction/Objectives

The prevalence of cardiovascular disease (CVD) is increasing in 60 years or older[1]. Therefore, it is important to focus on the younger population less than 60 years to improve lifestyles and prevent incidence of CVD. The main cause of CVD is atherosclerosis which is related with excess diet/drinking, smoking, physical inactivity and psychological stress. Especially, increasing physical activity is considered as a key method to control lipid profile, blood pressure and insulin resistance which are related to incidence of CVD[2-4]. In Japanese population, physical activity had been yearly decreasing[5]. Low intensity physical activity, such as light walking, is not associated with reduced risk of CVD, while moderate to vigorous physical activity (MVPA), such as brisk walking, swimming and up- and down- stairs, is reported to possibly lower the risk[6]. Accelerometer is an objective method to measure physical activity. It takes a long time to measure, and the cost is high. Instead of accelerometer, questionnaires have been widely used to measure physical activity. However, there is not fully valid and reliable questionnaire to measure MVPA. Therefore, the aim of this study was to investigate the relationship between self-reported walking time and objectively measured MVPA during commuting in Japanese office workers over thirty years old to develop a physical activity questionnaire for MVPA.

Materials and Methods

Participants

We enrolled workers sampled from a company. Eligible participants were 30 to 59 years who were free from disease and pain which restrict exercise participation. A total of 330 individuals (264men) completed the physical activity questionnaire. 29 subjects were excluded from the analyses due to missing values of physical activity questionnaire or accelerometer data. Finally, data from 301 participants (239men) were included in this study. This study was approved by the ethics review board of the Nagoya University Graduate School of Medicine (approval no. 14-508). Written informed consent was obtained from each of the participants prior to enrollment in this study.

Data collection

Self-reported physical activity was measured by the PAQ. PAQ consists of commuting, working and leisure time activities (fitness/sports and recreational activity) in a week. Commuting section consists of 1) means of commuting, 2) commuting time, 3) walking time and 4) the frequency of brisk walking (none, a little, often, very often). Participants completed the physical activity questionnaire (PAQ). In this study, self-reported walking time and the frequency of brisk walking were used for analysis.

MVPA was measured by using an accelerometer (Kenz Lifecorder EX/GS, Suzuken Co., Ltd., Nagoya, Japan) attached to the lateral side of a waist belt for the whole day, except for sleeping, bathing or swimming. Participants were asked to conduct their lives normally while wearing the accelerometer. The maximum pulse (i.e., the gravity value of an acceleration) detected by the accelerometer during the manufacturer determined 4-second sampling interval is taken as the acceleration value. Each interval is categorized into one of 11 activity-intensity levels (0, 0.5 and 1-9). MVPA is defined as $\geqq$ 4 which had been validated in adults (1-3= light intensity, 4-6= moderate intensity, 7-9= vigorous intensity)[7].

Statistical analysis

First, participants were divided into three groups which are 30-39 years, 40-49 years and 50-59 years group. Then, we performed spearman correlation coefficient to investigate the relationship between self-reported walking time and objectively measured MVPA during commuting in each age groups. All data were analyzed using SPSS version 23.0. A P value < 0.05 was regarded as statistically significant.

RESULTS

Table 1 shows the participants characteristics, self-reported physical activity (measured by PAQ), and objectively-measured duration of the MVPA. Of the 301 participants 79.4% were men, and 20.6% were women (aged 47.4 ± 7.8 years [mean $\pm$ SD]).

Self-reported and objectively measured Physical activity

Median of self-reported walking time was five minutes (Inter quartile range : IQR 5-10 minutes), the prevalence of answering "none" to the question "How often do you take a brisk walking during commuting?" was 31.8% (a little 30.8%, often 23.1%, very often 14.4%). Self-reported walking time and objectively measured MVPA during commuting was significantly correlated each age groups. But the relationship was poorer in 50-59 years group (r=.493, P<0.01, y=0.53x+3.59) than 30-39 years (r=.610, P<0.01, y=0.7x+3.16) and 40-49 years groups (r=.641, P<0.01, y=0.8x+1.49). Furthermore, 50-59 years group was divided into two groups; which were defined as brisk walker (n=55) and non-brisk walker (n=78). The non-brisk walker group consists who answered "none" or "a little" to the question of the frequency of taking a brisk walking during commuting to work, while the brisk walker group consists who answered "often" or "very often" to it. In these groups the correlation coefficients of the relationship between self-reported walking time and objectively measured MVPA remained lower (r=.392, P<0.01) in non-brisk walker, while it became moderate (r=.612, P<0.01) in brisk walker. Secondary analysis, each age groups were divided into two groups by gender. In each age groups, the association of walking time and MVPA were higher in men than women (30-39years men/women r=.627/r=.434, 40-49years men/women r=.679/r=.479, 50-59years men/women r=.587/r=.067).

Table : Participant characteristics

Item	All subjects N=301	30-39 years n = 64	40-49 years n = 104	50-59 years n = 133
Male n.[%]	239 (79.4)	54 (84.3)	75 (72.1)	110 (82.7)
Commuting				
*Walking time [min]	5 [5-10]	5 [5-10]	5 [4-10]	5 [5-10]
*Commuting MVPA [min]	7.2 [4.5-10.3]	7.2 [5-12.4]	6.9 [4-10]	7 [4.7-10]
Brisk walking n.[%]				
None	95 (31.8)	24 (37.5)	32 (31.4)	39 (29.3)
A little	92 (30.8)	15 (23.4)	38 (37.3)	39 (29.3)
often	69 (23.1)	13 (20.3)	22 (21.6)	34 (25.6)
Very often	43 (14.4)	12 (18.8)	10 (9.8)	21 (15.8)
*Daily MVPA [min/day]	29.4 [20.5-40.2]	29.3 [20.5-42.7]	24.4 [20.1-34.9]	33.1 [22.2-44.5]

*Median [IQR: Inter quartile range]
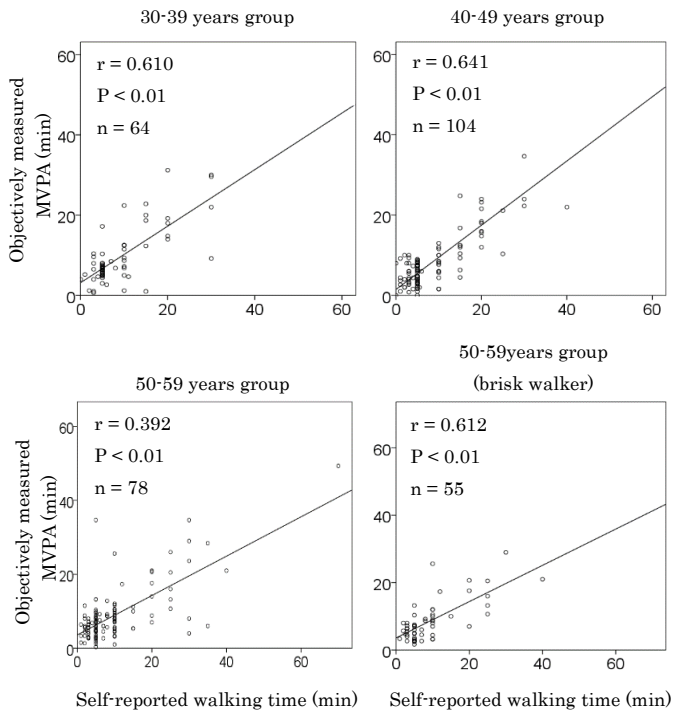
Figure : Relationship between walking time and MVPA during commuting in each age groups (30-39, 40-49, 50-59 years)

Discussion

The main findings of this study as follows. First, self-reported walking time during commuting might be able to predict objectively measured duration of MVPA. Second, stratification of subjects by age, gender and the frequency of taking a brisk walking would be key method to predict duration of MVPA. In 30 to 49 years Japanese workers, walking time and MVPA during commuting were closely-correlated. However, in 50-59 years group, some of them could not be predicted duration of MVPA from walking time.

Kinugasa et al[8] reported physical function is declining with age, for example, maximum walking speed in 30-39 years were equivalent to 85% of that of 20-29 years, while 50-59 years are equivalent to 70%. In other words, in 50-59 years, usual walking speed was slower than walking speed which was approximately equal to moderate to vigorous intensity. Slopes of the linear regressions lines showing the relationship between walking time and duration of MVPA during commuting were difference in each age groups. Thus, it might suggest that participants in 50-59 years

group declined physical function and a few of them further declined who walked more than 20 minutes during commuting plotted below the regression line in non-brisk walker. The frequency of taking a brisk walking might be useful information to detect them (brisk walker r=0.612, non-brisk walker r=0.392). In addition, because men walk faster than women[8], we performed analysis stratified by gender. Duration of MVPA could be predicted accurately from walking time in men but could not in women. Most women in each age groups walked less than 20 minutes in this study participants. Therefore, small variation might be one cause of small correlation coefficients in women. Based on the above, not only physical function, but also gender might effect on the prediction of MVPA during commuting.

Limitations

This study has several limitations. First, study sample was relatively small. We performed analysis stratified by gender, but the data in women from small samples. Therefore, the results of this study might not reflect the general office workers. Second, test-retest reliability of PAQ have not investigated. Finally, duration of MVPA during commuting might not precisely-measured. Because accelerometer could not measure cycling and up- and down- stairs. However, this study suggested several key points of view to develop a physical activity questionnaire for predicting duration of daily MVPA in Japanese office workers.

Conclusion

The findings of this study suggested the need to consider characteristics of the subjects when using a physical activity questionnaire.

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Abstracts

Occupational Therapy

2015 Yonsei-Nagoya University Joint Symposium on Occupational Therapy

11:00~12:00	Session I	Chair: Prof. Ji-Hyuk Park

11:00~11:30	Improvement of Attention and Short-term Memory of Dementia Using iPad: A Single Case Study

Seung Woo Hwangbo (Yonsei Univ.)

11:30~12:00	Change in connectivity among cortices of auditory evoked response by music learning

Haruko Kahsiwagi (Nagoya Univ.)

12:00~14:00	Lunch

14:00~15:00	Session II	Chair: Prof. Makoto Chshima

14:00~14:20	Prospective Memory of the People with Schizophrenia: Relationship between Experimental Tasks and Daily Living Tasks

Kil Choon Cho (Nagoya Univ.)

14:20~14:40	Effect of Horticultural Therapy for Elderly with Schizophrenia : Discriminating between Active and Passive Aspects of Horticultural Therapy

Takuya Kenmochi (Nagoya Univ.)

14:40~15:00	Heart rate variability in anorexia nervosa

Tatsuya Omori (Nagoya Univ.)

15:00~15:20	20 Minute Coffee Break

15:20~16:00	Session III	Chair: Prof. Hae Yean Park

15:20~15:40	The relationship between participation and health related quality of life(HRQoL) in persons with spinal cord injury
	Ye Jin Lee (a) (Yonsei Univ.)

15:40~16:00	Effectiveness of Occupational Therapy for Improving Participation: A Systematic Review
	Yeon Ju Kim (Yonsei Univ.)

16:00~16:20	20 Minute Coffee Break

16:20~17:00	Session IV	Chair: Prof. Sumio Yamada

16:20~16:40	Activities Outside the Home of the Parents of Children with Movement Disorders
	Asuka Suzuki (Yonsei Univ.)

16:40~17:00	Home environment modification for safe activities of daily living of dementia: A single case study
	Ye Jin Lee (b) (Yonsei Univ.)

※ 15 minutes presentation and 5 minutes Q&A

Improvement of Attention and Short-term Memory of Mild Dementia Using iPad Applications: A Single Case Study

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Kim, Jong-bae[2], Ph.D., Park, Hae Yean[2], Ph.D., O.T.

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Introduction

Due to rapid ageing, it is reported that prevalence of elderly with dementia is increasing every year in Korea[1]. Since dementia is a progressive disease which requires long-term treatment and care, it is important to prevent or delay functional decline and maintain current functional status if once diagnosed[2]. Therefore, delaying the progress of dementia is crucial especially to people with mild dementia whom are in the early stage of dementia[3].

Elderly people recently started to use smartphones, portable computers like iPad, and tablet PC[4, 5]. These devices have lately been utilized for blind, deaf, and cognitive impairment for therapeutic purposes and shown the effectiveness[6, 7].

Several studies indicate that cognitive training and computerized cognitive rehabilitation improved memory and attention of the mild dementia[8, 9]. Considering these results, cognitive training is necessary for preventing and inhibiting progress of dementia. Therefore, the purpose of this study was to identify whether using iPad applications could improve short-term memory and attention of people with mild dementia.

Methods

Subjects: A female elderly diagnosed dementia participated in this study. The participant was recruited from H elderly welfare center in Wonju, Korea. The participant was 84 years old, living alone, and had no education. The inclusion criteria were: a diagnosis of dementia from a specialist, MMSE-K score below 24, CDR score over 0.5, and the agreement of participation. The participant scored 23 in MMSE-K and 0.5 in CDR. This research was approved by the Yonsei University Wonju Institutional Review Board.

Study design: The study design was single-subject ABA design.

Procedure: The study consists of 5 sessions of baseline, 10 sessions of treatment, and 5 sessions of baseline, 20 sessions total(Figure 1). In the baseline phases, no intervention was provided. During treatment phase, the intervention was provided for 30 minutes based on the previous study[10]. The intervention was using "Memorado" and "Circles" applications to improve short-term memory and attention. An iPad Air 16GB with 9.7 inch (2048x1536) touch screen and a touch pen was used for intervention. Before proceeding the study, the participant was provided sufficient explanation about the applications and the trial was given only once. Not any clues were offered but however, if the participant showed any possibility of giving up, soem clues were than provided flexibly. Before and after the intervantion phase, MMSE-K, Korean Trail Making Test for Elderly persons part A & B(K-TMT-E A, B), Digit Span Test Forward & Backward(DST-F, B) were used for identifying the improvement of short-term memory and attention. In the treatment phase, the application "Fit brains" was used for evaluating short-term memory and attention every session.
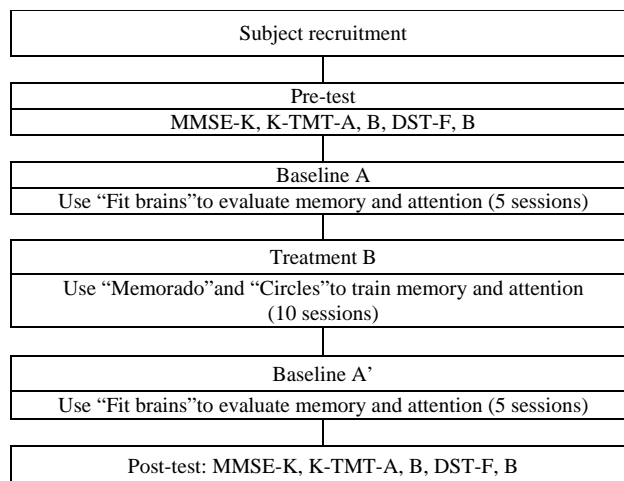
Subject recruitment

| Pre-test |
| MMSE-K, K-TMT-A, B, DST-F, B |

| Baseline A |
| Use "Fit brains"to evaluate memory and attention (5 sessions) |

| Treatment B |
| Use "Memorado"and "Circles"to train memory and attention (10 sessions) |

| Baseline A' |
| Use "Fit brains"to evaluate memory and attention (5 sessions) |

Post-test: MMSE-K, K-TMT-A, B, DST-F, B

Figure 1. Study process

Instruments: The application "Memorado - Moving balls" was used for improving attention. The application "Circles" was used for improving short-term memory. The application "Fit brains – Matching game" and "Fit brains – Remember items" were each used to evaluate and compare particpant's short-term memory and attention. MMSE-K, K-TMT A, B, DST F, B were used before and after intervention to identify the rate of change in scores of memory and attention.

Data analysis: The correct scores obtained from "Fit brains" application during 20 sessions were presented by visual graphs. The results of pretest and posttest were compared and indicated in tables.

Results

The attention score increased during treatment phase compared to baseline phases(Table 1). Moreover, the memory score increased sharply during treatment phase compared to baseline phases(Table 2). The baseline A' indicates the remaining effects of intervention when comparing the scores with baseline A.

The results of K-TMT-E A, B, DST F, B, MMSE-K showed no significant differences. In K-TMT-E A, the partipant took more time in post-test than pre-test to complete the evaluation (Table 3). However, more corrects and less errors were found in post-test compared to pre-test. Since completing the assessment earlier indicates the better result, it is difficult to insist whether there were any improvements between pre-test and post-test. The participant failed completing the K-TMT-E B in both pre-test and post-test but more corrects and no errors were recorded in post-test(Table 4). Both DST F, B and MMSE-K showed same scores or just slight different scores meaning no significant differences(Table 5, 6).
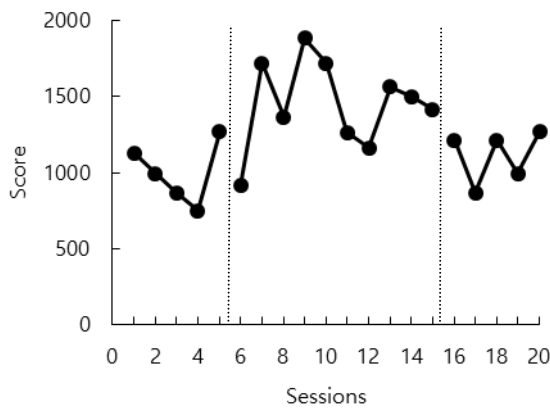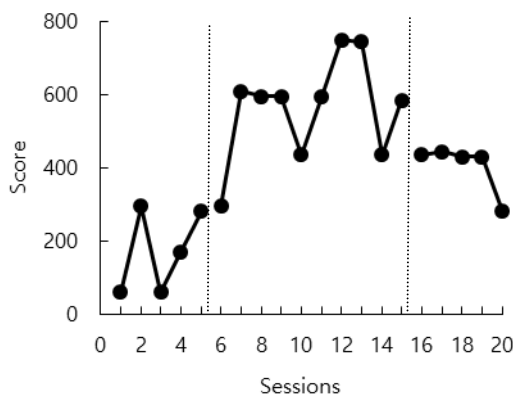
Table 1. Attention Results

Table 1. Attention Results

Table 2. Memory Results

Table 2. Memory Results

Table 3. K-TMT – E Part A Results

Trial	Time	Corrects	Errors
Pre-test	1min 42sec	11	5
Post-test	2min 54sec	13	3

Table 4. K-TMT – E Part B Results

Trial	Time	Corrects	Errors
Pre-test	5min over	4	2 (failure)
Post-test	14min 40sec	11	0 (give-up)

Table 5. Digit Span Test Results

	Pre-test (score)	Post-test (score)
Forward	4	5
Backward	2	2
Total (score)	6	7

Table 6. MMSE-K Results

	MMSE-K
Pre-test (score)	19 + 4 = 23
Post-test (score)	19 + 4 = 23

Conclusions

The iPad applications were positively effective on improving short-term memory and attention of the elderly with mild dementia. Therefore, more interesting and motivating contents of conitive training applications should be developed and also utilized.

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Change in connectivity among cortices of auditory evoked response by music learning

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Introduction

Brain activities relating sensory input and output were modulated by learning. Change in the brain activity by learning has been known as adaptation and priming. Many previous studies reported the brain activity regarding adaptation and priming [1], recent studies have emphasized that change in temporal relationship among cortices was important. The temporal relationship means the similarity of brain activity between two different regions of brain. In other words, the similarity was termed as connectivity between the brain regions. However, it has not been clear that the change in the connectivity among cortices by learning processes.

Therefore, the objective of the present study was to clarify change in connectivity among cortices in auditory evoked response. I used music for auditory stimulation and the difference in the connectivity among auditory related cortices was investigated before and after learning the music. For the present analysis, I used the latest system of magnetoencephalography, MEG, which enabled to collect and analyse the brain activity with high temporal and spatial resolutions.

Materials and Methods

Subjects: Seven healthy subjects participants in this study (2 males and 5 females, age range: 21-22 years). All subjects had no history of auditory and cognitive disturbance in their daily life. Each subject gave informed consent prior to measurement. This study was approved by the Ethical Committee of Nagoya University, School of Health Science.

Experimental Procedures: Subjects lay supine on the experimental table in a magnetically shielded room and wore earphones. Two series of music were delivered though the earphones, a well-known piece of music, Do-Re-Mi, and a newly developed music, as described below. During the listening of the music, the MEG signals were recorded. After the initial measurement, subjects were asked to memorize the new melody for within a couple of weeks, and the second measurement was applied. Prior to the second measurement, subjects were asked to hum the melody to be checked whether they had memorized the piece of music.

Auditory stimulation: New melodies, which the subjects had never heard, were produced using tones in the Do-Re-Mi. The tones were re-ordered in random order, using software (Allegro, Mi7, Japan). Thus, the content of sound in the pieces of the music was identical between the Do-Re-Mi and the new melody. Duration of the Do-Re-Mi and the new pieces of music were approximately 1 minute.

MEG recording: I used the whole-cortex 160-channel MEG system to measure auditory evoked response, auditory evoked magnetic field (AEF). The MEG signals were collected after the onset of each sound in the pieces of music delivered for 300 ms. Sampling frequency was 5,000 Hz, and bandpass filter was 0.2-2,000 Hz.

Data analysis: Coherence analysis was applied to assess connectivity among auditory related cortices, primary auditory cortex, left posterior section of superior temporal gyrus (Wernicke's verbal area for the left side), and dorsolateral prefrontal area (DLP) in each hemisphere. In the right side, Coherence analysis can be used to see synchronicity between two cortices. The analysis showed similarity between waveforms in different locations, and high coherence value indicated the neural signals spread from one to the other cortex. I chose the three brain areas, because I thought that learning of a piece of music included prediction of the rhythm and a kind of translation of the music into verbal information. The Wernicke's area and DLP area was responsible to verbal and timing processing, respectively.

In the present study, study gamma-bands were assessed to analysis, gammma-1: 30-60 Hz and gamma-2: 60-100 Hz. The gamma activity was related with various cognitive processes, such as memory, learning and attention [2]. The coherence values were statistically compared between before and after the learning. A p-value less than 5% was considered to be significant.

Results

The coherence value in gamma-1 band after the learning was lower than that before learning in between the right primary auditory cortex and the posterior section of superior temporal gyrus, and between the right primary auditory cortex and the DLP area (p<0.05, Fig. 1). In the right hemisphere, the coherence value also decreased significantly between those areas (Fig. 2). Distribution of brain areas with high coherence values were more before learning than after learning (Figs. 3 and 4).

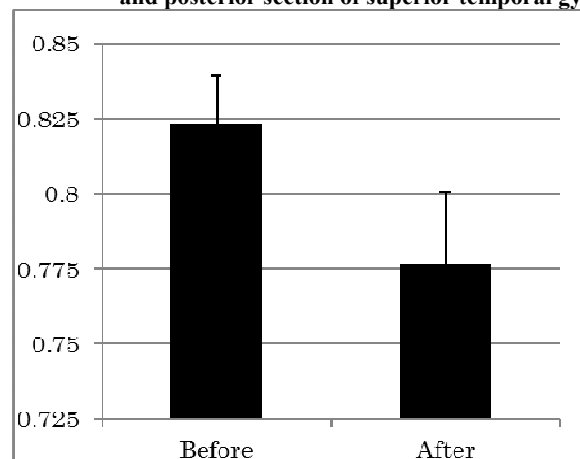**Fig. 1: Coherence value in right primary auditory cortex and posterior section of superior temporal gyrus.**

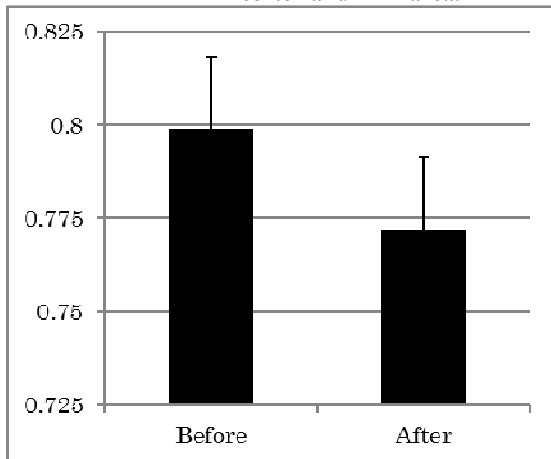**Fig. 2: Coherence value in right primary auditory cortex and DLP area.**

Fig. 3: The brain distribution of areas with high coherence value of the primary auditory cortex before learning.
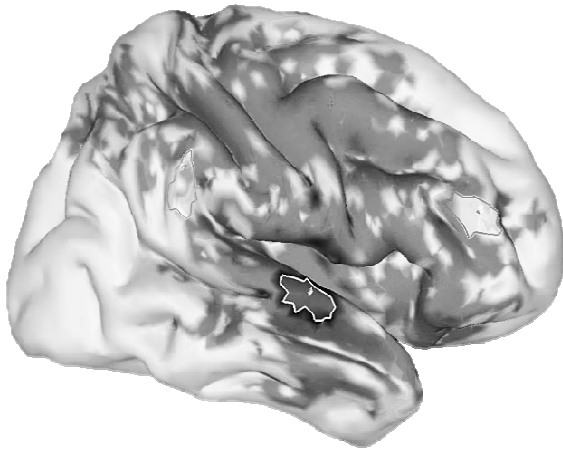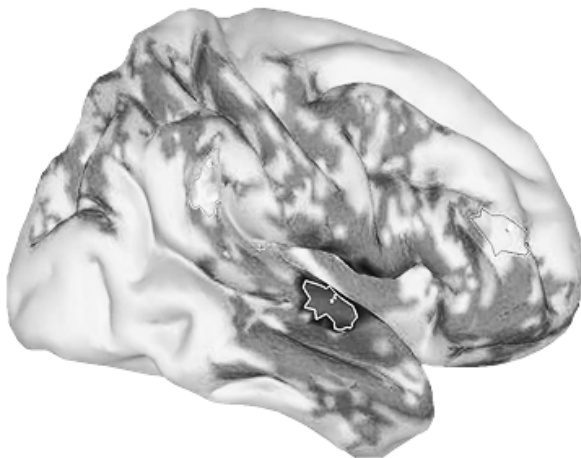

Fig. 4: The brain distribution of areas with high coherence value of the primary auditory cortex after learning. Note gray area was decreased, compared with the areas in Fig. 3.

Discussion

The present results indicated that decrement in synchronicity, de-synchronization in other words, was recognized before and after the learning of the piece of music. In the previous studies, presentation of an unfamiliar stimuli resulted in an increase of gamma band responses [3][4], and that brain activity at gamma band synchronized during memory [5][6]. In this study, the stimuli of before learning were unfamiliar. Thus, it was considered that brain activity before learning showed more synchronization among cortices than that after learning. In addition, since the subjects hear the unfamiliar music repeatedly in the initial MEG recording, memory processes might be partially occurred during the record.

In the second MEG recording after learning, the music had become familiar and the memory consolidation could be established. Therefore, relatively less synchronization was observed than before learning.

In this study, the coherence value decreased significantly in the right hemisphere and there was no significant difference in left hemisphere. The results suggested that right hemisphere involved in melody process. Also it was found that listening in this melody resulted of the translation of the music into verbal information.

Conclusion

In the present study, the connectivity among auditory related cortices changed before and after learning a piece of music. The coherence values decreased compared between before and after learning the music, which indicated regional de-synchronization of neural activity relating to memory/learning.

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Prospective Memory of the People with Schizophrenia:

Relationship between Experimental Tasks and Daily Living Tasks

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2) Department of Occupational Therapy, HOKUSEI Hospital, Mie, Japan

Introduction

Prospective memory (PM) is the ability to keep in mind and carry out future intentions. PM is divided into two, in terms of characteristics of the cues when people recall: Event-based PM and Time-based PM. Also, PM has two elements, one is just recalling "I have something to do" (existence recalling) and another is recalling the contents of the things have to do (contents recalling)[1], [2]. Several previous studies reported the PM performance of the people with Schizophrenia (Sz) from the experimental tasks [3]. However, we found no study examining PM in terms of daily living tasks. Therefore, the purpose of this study was to examine the relationship between the performance of experimental tasks and daily living tasks of PM. In addition, the relationship between PM task performance and the severity of schizophrenia was also investigated in terms of experimental tasks and daily living tasks respectively.

Materials and Methods

Subjects

23 Sz (20 males and 3 females) age from 30 to 73 (mean age: 56.2±12.2) who used day-care service in one hospital were recruited in this study. The inclusion criteria were: a diagnosis of schizophrenia, normal cognitive function (score of HDS-R was higher than 20), and to agree to participate with this researches both themselves and their attending psychiatrists.

Evaluation

1. Experimental tasks (Fig.1)

Experimental tasks were conducted one participant-on-one examiner in quiet surrounding by reference to Einstein and McDaniel, and Umeda. Participants did a 100-piece jigsaw puzzle, in total, 22 minutes. After 10 minutes passed, they took three minutes break. To motivate them, examiner told them to take a photograph of the puzzle, during the break and after finished.

Event-based task was offered before starting the puzzle. Examiner gave a card and asked them to return the card when they take a break. If the participants could not return the card, examiner provided two steps of cue, asking as follows: step 1, "Don't you forget something?" and step 2 "I gave you something" to evaluate existence recalling and contents recalling.

Time-based task was offered after the break. Examiner asked them to raise their hand every five minutes. Analog clock was set on the front wall of the participants.
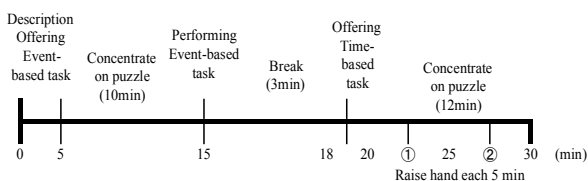

Figure1 Protocol of Experimental Task

2. Daily living tasks

Daily living tasks were randomly conducted when they came to day care facility, and tasks were offered by the day-care facility staff, not them to realize that the tasks were a part of experiments. The tasks were offered after daily morning meeting. Implementation of the tasks were four hours and over after offering. Those tasks were conducted one by one at a time, and once a day.

Event-based tasks were offered to implement a controlled chore; such as asking staff "Have you finished replacing fluorescent?" after finished the meeting, which held before going back to their home. This task was conducted third times.

Time-based task was also offered to implement a controlled chore, but the period was designated. Sample chore was as follows: asking staff "Have you finished doing the laundry?" at 14 o'clock. This task was conducted once for each of participants.

3. Severity of schizophrenia

The severity of schizophrenia was evaluated by Positive And Negative Syndrome Scale (PANSS). PANSS was consisted by three components, positive scale (delusions, conceptual disorganization, etc.), negative scale (blunted affect, emotional withdrawal, etc.), and general psychopathology scale (somatic concern, anxiety, etc.). This evaluation was conducted by participants' attending psychiatrists.

Data analysis

The results of experimental and daily living task performance were divided into two groups: Higher-scored and Lower-scored group respectively. For the analysis of the relationship between experimental tasks and daily living tasks, the Chi-square test was used, and relationship between PANSS and each tasks, the Mann-Whitney U test was used. Significance was set at $P<0.05$.

Results

1. Relationship between experimental tasks and daily living tasks

21 participants' data were analyzed. Two participants' data were excluded because they could not continue to using day-care service by hospitalization. Participants were divided into following two groups respectively.

i. Experimental tasks

Event-based task: Nine participants could perform the task: they could return the card (existence recalling intact group), and 12 participants required clues to recall the task (existence recalling impaired group).

Time-based task: 14 participants could perform the task at least once: they could (Experimental Time-based task intact group), and seven participants could not do that (Experimental Time-based task impaired group).

ii. Daily living tasks

Event-based task: Nine participants could perform all the tasks: they could recall staff's offer (Daily living Event-based

task intact group), and 12 participants failed once or more (Daily living Event-based task impaired group).

Time-based task: 14 participants could perform the task: They could recall staff's offer at around the designated time, from before 15 minutes to after 30 minutes (Daily living Time-based task intact group). Seven participants could not do that (Daily living Time-based task impaired group).

There were no significant differences of the number of participants between intact group and impaired group in both Experimental Tasks and Daily living tasks respectively.

2. Relationship between PM task performance and PANSS
i. Experimental tasks

Event-based task: There were significant differences between intact group and impaired group of the following general psychopathology scale score of PANSS: Anxiety, Unusual thought content, Lack of judgment and insight, and Disturbance of volition.

Time-based task: There were significant differences between intact group and impaired group of the following negative scale score of PANSS: Blunted affect, Emotional withdrawal, Lack of spontaneity and flow of conversation, and Stereotyped thinking.
ii. Daily living tasks

There were no significant differences between intact group and impaired group of the score of PANSS.

Discussion
1. Relationship between experimental tasks and daily living tasks

The result shows that there is no relationship between experimental tasks and daily living tasks, both Event-based task and Time-based task. Generally, human's memory function declines with aging. The mean age of participants is 56.2, hence the performance of experimental tasks is perhaps affected by their aging. However, since daily living tasks include the elements of interpersonal relationship and social adaptation, metacognitive strategy possibly enhance the memory function and reduce the effect of aging. For example, people who have a consciousness of being apt to forget become attentive at work. Therefore, further study is required to clarify the participants' strategy, with increasing the number of participants.

2. Relationship between PM task performance and PANSS
i. Experimental tasks

In Event-based task, there were significant differences between intact group and impaired group of the following general psychopathology scale score of PANSS: Anxiety, Unusual thought content, Lack of judgment and insight, and Disturbance of volition. "Disturbance of volition" is defined the disturbance in the willful initiation, sustenance and control of one's thoughts, behavior, movements and speech. Umeda states that existence recalling has a deep connection with willful initiation and control one's thoughts, behavior, movements and speech[1]. This result shows that severe disturbance of volition caused the impairment of prospective memory.

In Time-based task, there were significant differences between intact group and impaired group of the following negative scale score of PANSS: Blunted affect, Emotional withdrawal, Lack of spontaneity and flow of conversation, and Stereotyped thinking. Time-based task requires several strategies such as time monitoring and changing the task to Event-based task by themselves because surrounding environment does not become a clue of existence recalling.

These results show that disturbance of volition and several negative symptoms affect prospective memory, especially existence recalling.

It is said that people with schizophrenia tend to fail performing prospective memory tasks when they have low motivation, and it is dual or multiple task. Umeda reported that prospective memory performance is enhanced when the person is highly motivated. The motivation in daily living is affected by the necessity and certainty of doing the task for the person. In addition, experimental situation sometimes enhance or decease participants' motivation improperly[2]. We made effort that participants not to realize that the tasks were a part of experiments. However, in consideration of negative symptoms of patients with schizophrenia, they have lower motivation to implementing things for other people than for themselves.

Furthermore, there are a lot of situations to perform dual or more tasks simultaneously in daily life. Hiruta reported that people with schizophrenia tend to have some trouble creating priorities and performing multiple tasks together. Therefore, it enhances their operation efficiency to give instructions concretely and one by one step to them[4].

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Effect of Horticultural Therapy for Elderly with Schizophrenia:

Discriminating between Active and Passive Aspects of Horticultural Therapy

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Introduction

Large number of psychiatric hospitals in Japan faced with problem of aging their inpatients caused by the patients who have been hospitalized for a long time. The data reported by Ministry of Health, Labor and Welfare showed that 51.5 % of psychiatric inpatients were at the age of 65 or over in 2012 [1]. Therefore, intervention for these patients to maintain physical and mental function is required.

Horticultural Therapy (HT) is practiced in not a few medical and welfare institutions, mainly for elderly because of its mild effect of enhancing physical and mental health states, both in Korea and Japan [2], [3]. Although the research concerning about effects of HT has been already started in early 1990s, there are few reports that shows the evidence of HT [4]. Figure 1 shows an example of HT's components. In general, HT's components were conceptually divided into two: active and passive [5]. The fact that it is difficult to discriminate various components of HT, and its intervention methodology depends on the therapists, prevents HT research to establishing evidence of the effects. Hence, the study that distinguishing the effects of each components is currently demanded. The aims of this study were to examine the effect of HT intervention programs consisted by active components HT (A-HT) and passive components HT (P-HT) respectively and generate hypothesis to explain the effects of HT for elderly with schizophrenia.
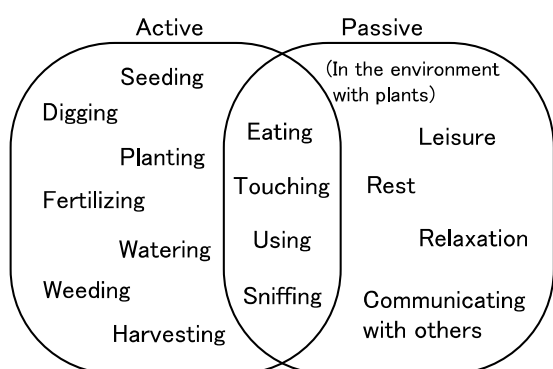
Materials and Methods

Participants

Twenty elderly with schizophrenia were randomly recruited from the inpatients of a psychiatric hospital. The inclusion criteria were as follows: (1) aged 65 years or older, (2) chronic phase of schizophrenia, (3) normal cognitive function (score of HDS-R was higher than 20), (4) ability to communicate and make their wish known, and (5) good physical function to participate the program regularly. Informed consent was obtained from each participant before the study.

Intervention

Participants were divided into two groups in matching age, sex and experience of HT. They participated in 45 minutes group HT program once a week for 10 weeks. Crossover comparison study was adopted (Figure 2).

A-HT: Participants cultivated vegetables in planters: seeding Japanese radish and Boston lettuce, observing their growth, and fertilizing them. After harvested, participants cooked them and enjoyed eating. After the each program, participants recorded the growth of plants by taking a note.

P-HT: Therapist brought some flowers and vegetables, and facilitated participants to talk about them reflecting participants' own experiences with touching, sniffing and eating them every time.

Data collection

A combined quantitative and qualitative study was adopted. Quantitative data: The evaluation we used were as follows: Positive and Negative Syndrome Scale (PANSS) for evaluating the severity of schizophrenia, Philadelphia Geriatric Center Morale Scale (PGC Moral Scale) for evaluating subjective quality of life, and Experimental Time Perspective Scale for evaluating standpoint for the future. These evaluations were conducted three times: baseline, interval between A-HT and P-HT, and the endpoint of all programs.

Qualitative data: Semi-structured group interviews were conducted three times: a week before the first intervention (baseline), interval between A-HT and P-HT, and the endpoint of all programs. The contents of the baseline interview were: impression before participating HT program, and the things for pleasure in daily life. On the other hand, the contents of the interval and final interviews were: review of attending A-HT or P-HT, and the things for pleasure in daily life.

Figure 1 Active and passive components of horticultural therapy

Figure 2 Schedule of the experiment

Qualitative analysis: For the analysis of the effect of participating HT, the Wilcoxon singed rank test was used to compare the scores of PANSS, PGC Morale Scale, and Experimental Time Perspective Scale between before and after participate of each HT program. Statistical significance was set at $p < 0.05$ and 0.01.

Qualitative analysis: Modified-Grounded Theory Approach proposed by Kinoshita was used to analyze transcribed data obtained by the group interviews [6].

Results

Eighteen participants' data were analyzed. Two participants' data were excluded because they could not continue to participate this study by their physical problems etc.

Quantitative analysis: The score of PANSS was improved significantly after practiced A-HT. On the other hand, there were no significant differences neither other test scales in A-HT nor any test scales in P-HT (Table 1). In detail comparison of PANSS sub scales, General pathology scale of PANSS was only improved significantly. However, there were no significant differences in other sub scales: Positive scale and Negative scale (Table 2).

Table 1 Comparison of positive and negative syndrom scale (PANSS), phiradelphia geriatric center morale scale (PGC morale scale), time perspective scale between baseline and post intervention

		A-HT (N=18)		P-HT (N=18)	
		Average	(±SD)	Average	(±SD)
PANSS	baseline	86.9	17.0	84.7	15.6
	post	82.4 *	14.9	84.5	15.2
PGC Moral Scale	baseline	11.2	3.9	10.8	3.8
	post	11.3	3.9	11.7	3.5
Time perspective scale	baseline	51.9	9.3	51.9	12.1
	post	52.3	12.3	52.7	9.9

Wilcoxon signed rank test (*p<.05)

Table 2 Detail comparison of PANSS in A-HT

		A-HT (N=18)	
		Average	(±SD)
Positive scale	baseline	18.6	5.5
	post	18.0	5.6
Negative scale	baseline	24.7	6.6
	post	23.7	5.7
General psychopathology scale	baseline	43.7 **	7.4
	post	40.7	5.9

Wilcoxon signed rank test (**p<.01)

Qualitative analysis: Several specific characteristics of A-HT and P-HT were revealed by participants' statements. In A-HT, participants were surprised and pleased at growing plants. For example, one participant stated "It was very fun…and surprising for me to observe the growth of radish and lettuce." In P-HT, on the other hand, they enjoyed interacting with members each other. For example, one participant stated "Well... chatting with peers about the vegetables you (therapist) brought was so nice, especially about cooking. I really enjoyed interacting and chatting

with them."

During both programs, participants always looked forward to participating the program. Furthermore, a number of participants' final statements regarding goals of daily life were increased comparing to contents of first semi-structured interviews.

Discussion

In terms of quantitative analysis, scores of Positive and Negative Syndrome Scale, especially, general psychopathology scale decreased significantly after the intervention of active horticultural therapy program. This result shows the therapeutic effect of active horticultural therapy programs in reducing general symptoms of schizophrenia. Besides, in terms of qualitative analysis, several specific characteristics of active horticultural therapy and passive horticultural therapy were revealed by participants' statements. Active horticultural therapy brought participants surprise and pleasure at growing plants. These positive emotions possibly improve the modality of time perspective. In contrast, passive horticultural therapy facilitated comfortable communication with peers. While previous study showed that people with schizophrenia have some difficulties spending time and communicating with others [7], participants can be relaxed and interact each other by intervening plants.

Conclusions

Our study showed the possibility of the usefulness of horticultural therapy as a non-invasive therapeutic methodology. Therefore, further study is required to clarify our hypothesis, such as multicenter study.

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Heart rate variability in anorexia nervosa

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Introduction

Anorexia nervosa (AN) has been known as an eating disorder, which is characterized by abnormally low body weight with intense fear of gaining weight and abnormal body perception. Besides various metabolic and hormonal abnormalities reported [1], autonomic dysfunction has been reported in AN [2]. One major complication was cardiovascular dysfunction due to hyperactivity of parasympathetic system, which could contribute to the higher rate of sudden death in patients with AN [3]. Patients with AN in critical state with extremely low body weight less than 30 kg often requires inpatient hospitalization, although the effectiveness of additional treatment to the diet control has been unclear [4].

Occupational therapy (OT) has been also applied to patients with AN [5], and in the psychiatric department of Nagoya University Hospital has been provided OT in the recovery phase after critical state of AN. During the OT for the patients in the recovery phase, cardiovascular trouble with autonomic dysfunction should be avoided. However, little has been known regarding recovery of autonomic function after acute phase of AN. In the present study, heart rate variability was measured during the acute and recovery phases, and during OT in the recovery phase in the patients with AN to clarify the physical condition of patients during OT.

Heart rate variability (HRV) is calculated from the fluctuation of heart rate, and it indicates sympathetic and parasympathetic activity applicable to various physical and mental disorders [6]. The HRV can be obtained non-invasively simply by recording hear beat or electrocardiogram, and the calculation has been convenient with computational development.

Materials and Methods

Subjects: Four inpatients with AN (all females, age range 17-53 years old) were participated in the study. All patients were diagnised by DSM-VI, and they were addmitted to Nagoya University Hospital because of theier critical weight loss and were given intensive nutritional treatment. Each patient, during recovery phase of AN after critical state, gave informed consent prior to evaluation of HRV from the record of electrocardiogram recorded during acute and recovery phases. Patients with severe psychological symptom, physical complication, or drug abuse were excluded. The present study was approved by the Ethical Committee of Nagoya University, School of Health Science.

Experimental Procedures: HRV was obtained by two methods, electrocardiography (ECG) and pulse oxymeter, during acute and recovery phase of AN, respectively. All patients were monitored their heat rate by mobile ECG in the intensive care units during acute phase of AN, which were stored in a data recorder. During the recovery phase of AN, including during OT, heart rate was obtained by a wearable pulse oxymeter (OxyTrue, Bluepoint Medical, Germany, Fig. 1), since the patients in recovery phase were not monitored by ECG, and some patients hesitated to wear the ECG monitor with electrodes. The pulse oxymeter collected heart beats throught a tip of infrated light sensor attached on a earlobe or finger tip. The heart beats obtained from the ECG monitor or pulse oxymater were stored in a data recorder (Voice-trec V-801, OLYMPUS,Japan). Heart rate was recoreded for 10 minutes in acute and recovery phase at rest on bed and in sitting position, respectively, and during OT in sitting position.

Figure 1: Pulseoxymeter used in the present study. Peripheral pulse was obtained from a sensor attached on the finger tip (left) or earlobe (right).

A series of OT was provided for the patients. The OT included sewing, japanese crape work, beadwork , and knitting activities for 60 minutes on OT room in sitting potision.

Data analysis: The heart beats was expressed as events on a software (Spike2, CED, UK), and each inter-events interval between adjacent heart beats was measured. After fast Fourier Transformation (FFT) of the intervals, low (LF) and high (HF) frequency HRV were calculated. The LF and HF was a value of HRV between frequency of 0.05-0.15, and 0.15-0.40, respectively. The HF indicates parasympathetic activity, and a ratio LF/HF indicates for sympathetic activity [7].

Results

Figure 2 shows a trend of heart beats, inter-beats interval, and FFT analysis recorded from a patient. The HF and LF/HF changed during the state of patients (Figs. 3, 4), The LF/HF value was more during OT than those values during acute and recovery phases at rest. Mean body weight of the patients was increased from 29.05 kg in the acute phase to 35.88 kg in the recovery phase.

Discussion

In the present study, the HRV values was changed between acute and recovery phase. During the OT intervention during the recovery phase, change in HRV suggested that the cardiovascular responses might be appeared by the time for the intervention. In patients with AN, abnormal HRV [8] and high mortality rate with cardiovascular dysfunction [9] were reported. Sympathetic activity revealed by HF was changed among condition, but the parasympathetic activity was relatively unchanged to the sympathetic activity in the present study. Although the HRV might be abnormal even in the recovery phase of the patients, change in HRV might be indicator for the

recovery phase after critical state of AN. Decrease HRV, i.e., unchanged HRV values, suggested a risk factor of sudden death in cardiovascular and neurological disorders [10]. Since the HRV recording is convenient and non-invasive, the recording might be informative during rehabilitation to monitor the patient's condition. Amount of rehabilitation, including OT intervention, should be re-considered when poor response in HRV during rehabilitation was observed during the intervention.

The indicator for the tentative goal of treatment in hospitalization for patients with AN is a body weight more than 65 % of normal weight in our University Hospital. However, as Lachish et al. [11] reported, the patients with AN showed sustained abnormality in HRV, i.e., hyperactivity of parasympathetic system, after tentative weight gain. The change in HRV reflected not only physical state, but also emotional and psychiatric conditions [12]. Since one of psychiatric problems in patients with AN was abnormal emotional function [13], HRV might be psychiatric indicator for the patients with AN.

The present study was limited in number of patients and in duration for observation. Long-term follow-up of HRV during daily living outside hospital might give information for physical and emotional recovery from AN [14].
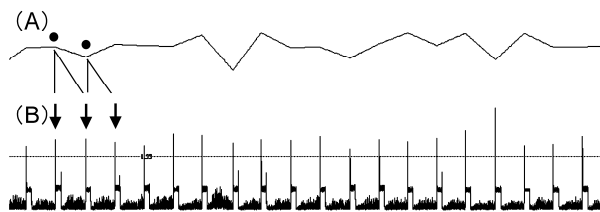
Fig. 2: Signals of heart beats transferred from the pulseoxymeter (B). An arrow indicates each heartbeat, and the vertical line indicates threshold to calculate an inter-beats interval (A).
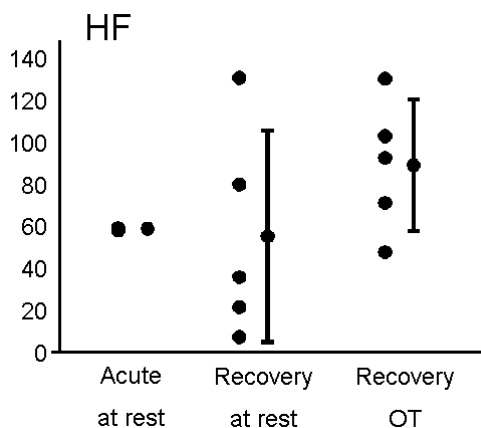
Fig. 3: High frequency HRV (HF) recorded from the patient with AN. Sympathetic activity, revealed by HF, was relatively higher during OT (Recovery OT).

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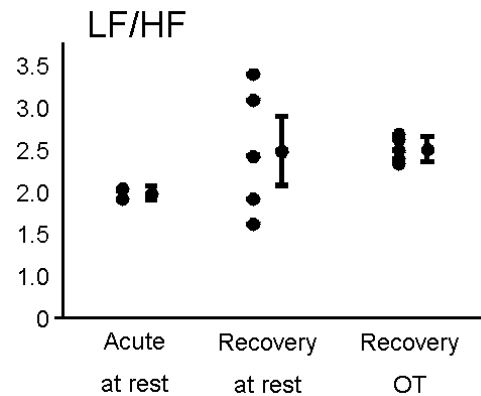
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Fig. 4: Ratio of High (HF) and low (LF) frequency HRV recorded from the patient with AN. Parasympathetic activity, revealed by LF/HF seemed unchanged among conditions.

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The Relationship Between Participation and Health Related Quality of Life (HRQoL) in Persons with Spinal Cord Injury

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Introduction

Life expectancy for persons with spinal cord injury (SCI) has improved significantly during the last two decades [1]. Research has moved from survival to long term consequences such as quality of life including Health-Related Quality of Life (HRQoL) [2]. Persons with SCI also face problems across various participation domains, such as work and leisure activities [3]. In rehabilitation, therefore, both participation and HRQoL are discussed as the ultimate goals for persons with SCI [4]. Participation is a multifaceted process resulting from interactions and transactions among persons and occupations within physical, social, cultural, and political environments and communities [5]. On the other hand, HRQoL indicates the restrictions related to a specific health condition [6]. HRQoL refers to the specific impact of an illness or injury, medical treatment, or health care policy on an individual's well-being and functioning [7]. Thus, participation needs to be considered as the different concept with HRQoL. However, in some studies, participation was measured merely as a part of the general HRQoL concept [8]. Also, there were some measurements of HRQoL focusing on the individual's satisfaction which is a similar concept with participation [9] Although participation and HRQoL are essential concepts, little is known about the relationship between participation and HRQoL [10]. Consequently, the purpose of this study is to examine the relationship between participation and HRQoL in persons with spinal cord injury using K-USER-P and K-LHS.

Methods

Participants : In South Korea, A total of 112 persons with SCI living in community were recruited for this study. The participants were gathered from an athletics competition for people with SCI for 2 days in June, 2014 in South Korea. Inclusion criteria were persons with SCI and ability to read and comprehend the questionnaire written by Korean. Exclusion criteria were persons have diagnosis with other neurologic or psychological disorders such as stroke and depressive disorders etc.

82 questionnaires were included in the final analysis, excluding 29 questionnaires of insufficient responses and 1 respondent as not diagnosed with SCI but with limb amputation. 82 participants were aged between 24 and 75 years and an average age was approximately 46 years (46.48±11.23). The majority of participants was male (n=70, 85.4%). In level of injury, cervical injury was 25 (30.5%), thoracic injury was 47 (57.3%), and lumbar was 5 (6.1%). Participants with complete injury were 47 (57.3%) while 32 participants were incompletely injured (39.0%). More details of demographic features are displayed on table 1.

Table 1. The general characteristics of participants

Characteristics	N	%	Mean (SD)
Age	-	-	46.48 (11.23)
Gender			
Male	70	85.4	-
Female	12	14.6	-
Level of injury			-
Cervical	25	30.5	-
Thoracic	47	57.3	-
Lumbar	5	6.1	-
Unawareness	5	6.1	-
Completeness of injury			-
Complete	47	57.3	-
Incomplete	32	39.0	-
Unawareness	3	3.7	-
Education			
Middle school	9	11.0	
High school	41	50.0	
University	29	35.4	
Others	3	3.6	
Employment			
Employed	49	59.8	
Unemployed	33	40.2	
Marital status			
Married or living as married	40	48.8	
Not living as married	42	51.2	
Assistive device			
None	1	1.3	
Manual wheelchair	74	90.2	
Powered wheelchair	7	8.5	

Procedure : This study is the cross-sectional study. Participants were provided with instructions about the purpose and procedures of the study and agreed to participate this study voluntarily before they were requested to fill out the questionnaires. The questionnaires, consisted of The Korean version of Utrecht Scale for Evaluation of Rehabilitation–Participation (K-USER-P), The Korean version of London Handicap Scale (K-LHS) and Korean version of the World Health Organization Quality of Life assessment instrument-BREF (K-WHOQOL-BREF), were explained by two occupational therapists and one student studying occupational therapy in the university. The participants were handed out the questionnaires individually.

Mesurements : K-USER-P and K-LHS were applied to examine participation as the independent variables. We also used K-WHOQOL-BREF for HRQoL as a dependent variable.

Data analyses : All statistical analyses were conducted using IBM SPSS 21.0 on windows. Descriptive analyses were carried out for the general characteristics. Pearson's correlation efficient was used for the correlation among HRQoL, K-LHS and the three scales of K-USER-P. And Hierarchical multiple regression analysis was applied to examine the most predictable factors for HRQoL. The total score of K-WHOQOL-BREF was treated as the dependent variable. The independent variables were the three scales of K-USER-P and the total score of K-LHS. Significance level was set at 0.05.

Results

Correlation between participation and HRQoL : Before we proceeded with the regressions, the correlations was applied to the data. Pearson correlations between participation and HRQoL were shown in table 2. Results showed that the 3 scales of K-USER-P had a significant negative correlation with the total score of K-LHS(r=-0.34~-0.46, p<0.01). The satisfaction scale of K-USER-P was only significantly correlated with the total score of K-WHOQOL-BREF (r=0.23, p<0.05).

Hierarchical multiple regression analyses examining the three scles of K-USER-P and K-LHS in predicting HRQoL : To examine the most important factor of HRQoL, participation was regressed on HRQoL. The total score of K-LHS was in Step 1. The frequency scale, the restrictions scale and the satisfaction scale of K-USER-P were entered in Step 2, 3 and 4 respectively. The results of hierarchical multiple regression analyses indicate that model 4 showed higher explanatory power than other models. Its statistically significant contribution added another 6% to the previous model, so that the final variance of the model was 11% (p<0.05). More specifically, of these variables, the satisfaction scale of K-USER-P was the strongest predictor of HRQoL (p<0.05) (Table 5).

Table 2. Correlation between participation and HRQoL

`		K-LHS Total score	Frequency	K-USER-P Restrictions	Satisfaction	K-WHOQOL-BREF Total score
K-LHS	Total score	1	- 0.34**	- 0.52**	-0.46**	-0.14
K-USER-P	Frequency	- 0.34**	1	0.45**	0.45**	0.19
	Restrictions	- 0.52**	0.45**	1	0.59**	-0.20
	Satisfaction	- 0.46**	0.45**	0.59**	1	0.23*

*p<0.05, **p<0.01

Table 3. Hierarchical multiple regression analysis : HRQoL regressed on Participation

		Model 1 B	β	t	Model 2 B	β	t	Model 3 B	β	t	Model 4 B	β	t
K-LHS	Total Score	-0.46	0.35	-1.30	-0.29	-0.09	-0.79	-0.57	-0.18	-1.39	-0.40	-0.13	-0.33
K-USER-P	Frequency				0.23	0.19	1.69	0.30	0.24	2.00	0.21	0.15	1.37
	Restrictions							-0.07	-0.13	-1.05	-0.16	-0.28	-2.05*
	Satisfaction										0.24	0.32	2.31*
	F	1.69			2.86			1.99			**3.17***		
	R^2	0.02			0.04			0.05			0.11		
	Adjusted R^2	0.01			0.02			0.02			0.07`		
	Change in R^2	0.02			0.04			0.01			0.06		

B, Unstandardized regression coefficients; β, Standardized regression coefficients
*p<0.05
Dependent variable : The total score of K-WHOQOL-BRE

Conclusions

Both subjective and objective perspective of participation are of important for participation. It was found from this study that subjective participation (satisfaction of participation) was related with HRQoL while objective participation was not. Therefore, participation and HRQoL are distinctive constructs. The most predictable factor on HRQoL was the subjective participation. It is expected that subjective participation need to be contributed to plan for HRQoL in persons with SCI in rehabilitation.

Although these are important findings, this study had some limitations. First, the participants were gathered from an athletics competition for people with SCI. So, generalizability could be limited. Furthermore, in this study, we considered the global HRQoL based on the total score of K-WHOQOL-BRFE. However, HRQoL is divided into mental and physical area. The relationship between participation and HRQoL may vary with mental area or physical area of HRQoL. Therefore, future studies are needed to address such shortcomings.

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Effectiveness of occupational therapy for improving participation
: A systematic review

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Introduction

In the International Classification of Functioning, Disability, and Health (ICF), 'Participation' is one of the components, which is defiend by one's involvement in life situation[1]. Restricted participation is derived from several functional impairments of individuals with stroke [2], traumatic brain injury [3], multiple sclerosis [4], or age-related vision loss [5] who is the clients of occupational therapy. Christiansen, Baum, and Bass-Haugen reported that the occupational therapists have to focus on improving the 'participation' [6]. Therefore, It is essential to list and analyze the information about interventions for improving participation. So, the purpose of this study is to summarize that information and establish evidence to clinicians for helping the clinical reasoning.

Materials and Methods

Data sources: For the main key-words of a database search, "Participation AND Occupational therapy AND Intervention" were used. We systematically examined papers pulished in journals from January 2005 to April 2015, using Scopus, PubMed, and Google scholar. First, the 718 articles were searched. After the screening of titles and abstracts based on the 1st exclusion criteria (non-English, overlapped articles among databases, either 'participation', and 'intervention' were not in the abstract), 48 articles were retrieved. And then 2nd screening based on exclusion criteria: 1)single-subject design, case study ($n=15$), 2) systematic review, meta-analys ($n=4$), 3) no use of measure for participation ($n=2$), 4) no intervention ($n=6$), 5) different meaning of participation based on ICF definition ($n=7$), measuring participation at one spcific point ot for pre-post comparision ($n=2$). Finally, 12 studies were included in the final reveiw (figure 1).
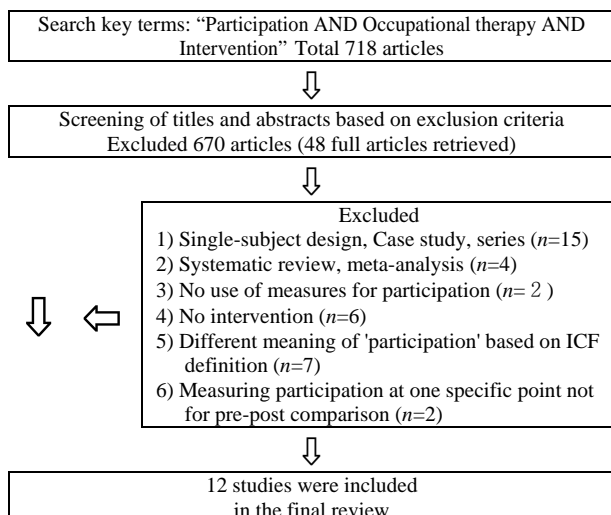
Analytical methods: The 12 articles were appraised using the hierarchy of levels of evidence for evidence based practice for 5 different levels. The details of each study were summarized according to the author (year), participants, intervention, intervention intensity/duration, dependent variables, measurement for the participation, and the results.

Results

The results were about level of quality and trend of each study, types of intervention, environments provided the intervention, participants'disease, applied tools, dependent variables measured with the participation. The quality and quantity of studies are improving. And the interventions were mostly provided on chronic conditions in a form of self-management program in community setting. The tools were used by researchers following their researcher's intention. The 'Quality of Life (QoL)'was the most frequently measured with participation.

Table1. Level of Quality Among Each Study N (%)

Evidence level	Definition	Frequency
I	Systematic reviews	7 (58.3)
	Meta-analyses	
	Randomized controlled trials	
II	Two groups non-randomized studies	0 (0.0)
III	One group non-randomized studies	5 (41.7)
IV	Single subject designs	0 (0.0)
	Surveys	
V	Case reports	0 (0.0)
	Narrative literature reviews	
	Qualitative researches	
Total		12(100.0)

Table 2. Types of Intervention for Participation N (%)

Types	Frequency
Self-management program	6 (50.0)
Exercise program	2 (16.7)
Client-centered approach	2 (16.7)
Intervention using digital device	1 (8.3)
Complex intervention	1 (8.3)
Total	12 (100.0)

Table 3. Environments Provided the Intervention on Participants N (%)

Environments	Frequency
Community	10 (83.4)
Hospital	1 (8.3)
both community and hospital	1 (8,3)
Total	12(100.0)

Figure 1. Search Process

Table 4. Classification of Participants' Disease *N* (%)

Classification of disease	Frequency
Stroke	5 (41.7)
Multiple chronic conditions	2 (16.7)
Amyotrophy	1 (8.3)
Arthritis	1 (8.3)
Multiple Sclerosis	1 (8.3)
Older adults with age-related vision loss (ARVL)	1 (8.3)
Traumatic Brain Injury (TBI)	1 (8.3)
Total	12 (100.0)

Table 5. Analysis About Applied Tools for Participation *N* (%)

Applied measurement tools for participation	Frequency
Frenchay Activities Index (FAI)	2 (15.4)
Reintegraton to Normal Living Index (RNLI)	2 (15.4)
Stroke Impact Scale (SIS) -'social participation' domain	2 (15.4)
Activity Card Sort (ACS)	1 (7.7)
Craig Handicap Assessment and Rating Technique-Revised (CHART-R)	1 (7.7)
Canadian Occupational Performance Measure (COPM)	1 (7.7)
Impact Participation and Autonomy (IPA)	1 (7.7)
Occupational Gaps Questionnaire (OGQ)	1 (7.7)
Physical Activity Scale for Individuals with Physical Disabilities (PASIPD)	1 (7.7)
Social/ Role Limitation Scale	1 (7.7)
Total	13 (100.0)

Table 6. Dependent Variables Measured With the Participation *N* (%)

Variables measured with the participation	Frequency
Quality of life	5 (26.3)
Emotional status (depression, anxiety)	4 (21.1)
Self efficacy	4 (21.1)
Functional independence in ADL	3 (15.8)
Occupational performance	3 (15.8)
Total	19 (100.0)

Discussion

When we examine the result about the trend in level of evidence of intervention for participation by separated the two terms from 2005 to 2015, there was improving of quality and quantity of articles. These trends support the repot of Christianse, Baum, and Bass-Haugen's that the primary purpose of rehabilitation was getting focus on the participation after publishing the ICF [6]. The most frequently used intervention was Self-management program in the community setting on the people with stroke. Except the stroke, the interventions were for people with multiple chronic conditions, amyotrophy, arthritis, multiple sclerosis, older adults with age-related vision loss, traumatic brain injury who need to long-term manage of disorders. Self-management, in fact, is lifelong occupation and important for people with chronic condition.

This study had a limitation because we excluded the domestic study and case study. So we couldn't include all the articles about intervention improving participation.

Conclusions

Through this systematic review, we could find and understand the trend of occupational therapy service for participation. In the future, based on this study, the research about intervention for improving participation might be more developed.

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Activities Outside the Home of the Parents of Children with Movement Disorders

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Introduction

Previous studies reported that the parents of children with disabilities had lower quality of life (QOL) and more stresses than the parents of typically developing children. These studies also suggested that part of the factors affecting QOL and stress of the parents was a degree of social participation, and support from family, community or officials[1]–[3]. In addition, the relationship between parents and their children, especially the mother-and-child relationship is significantly important from the perspective of attachment theory. Accordingly, it is also important to support not only children with disabilities, but also their parents. In this study, we focused on the performance of activities outside the home (AOH) of the parents of children with movement disorders (CWMD). A qualitative approach was taken to explore the problems and self-solving processes regarding the current status of AOH, and to develop questionnaire regarding the current status of AOH for the parents of CWMD.

Significance of the study

It is possible for this study to clarify the role of community based institutes such as development support center by comprehending the actual situation of AOH of the parents of CWMD. Furthermore, the developed questionnaire could also be used to garner information easily at these institutes, schools or other facilities.

Materials and Methods

Participants: 15 parents of CWMD (under age 18) were recruited in this study.

Data collection: The data were collected via semi-structured interviews. The questions were determined by literature review. The articles published between 2001 and July 2014 were searched online, Japan Medical Abstracts Society, with keywords of cerebral palsy with activities outside home, support or family. From the articles selected, phrases related to the problems and needs of AOH were extracted, and they were categorized by similarities. The categories were used as questions in the interview guideline. All interviews were recorded with an informed consent.

Data analysis: All recorded data were transcribed word by word. Since there were two objectives: to explore the problems and self-solving process regarding the current status of AOH, and to develop questionnaires regarding the current status of AOH for the parents of CWMD, the data were analyzed using qualitative and quantitative cording method [4] respectively.

I. Exploring the problems and self-solving process

For the first step, the transcripts were examined line by line. Important contents, and meanings of the sentences were extracted with taking the reasons into consideration. These data were categorized as subcategories. For the second step, these developed subcategories were divided into 5 groups according to the children's ages and motor function. Then, the similarities of the subcategories were examined and the final categories were developed by condensing similar subcategories. Moreover, conceptual diagrams were created to explore the correlations between each category.

II. Developing questionnaires for the parents of CWMD

First, the transcripts were examined line by line. Second, the phrases from the transcripts were extracted with titles. These data were examined by similarities of the titles, and subcategories were developed. Then, the similarities of the subcategories were examined and the final categories were developed by condensing similar subcategories. The processes of the cording are as follows (Figure 1). Types of parents' AOH were divided into two. One was AOH with their children (Type I) and the other was AOH without the children (Type II). In Type I, AOH were grouped into productive activities (PA), leisure activities (LA). In addition, there were some problems and self-solutions of AOH that had common characteristics in both PA and LA (it was named common characteristics: CC). Categories were arranged into five items of the processes of going out.

In type II, AOH were divided into three: the child is in school (or other institutions for education), the child is in day care, someone's house etc., and the child stays at home.
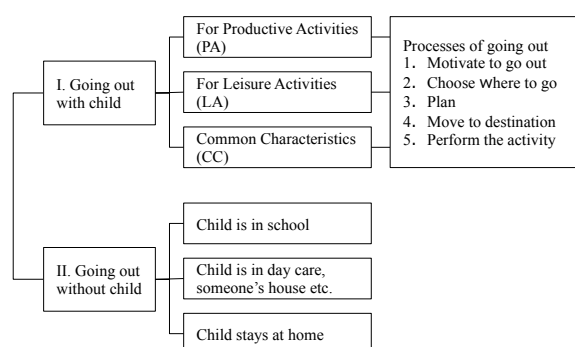

Figure 1   Processes of cording

Trustworthiness: one experienced supervisor who is familiar with qualitative research collaborated the analysis. Additionally, five parents of CWMD will be recruited to check the conceptual diagrams and questionnaires for internal validity.

Results

14 participants' data were analyzed. One participant's data did not cover all part of interview guideline questions.

I. Exploring the problems and self-solving processes

Total number of subcategories; problems, self-solutions, received support, and necessary support were as follows respectively: 153, 83, 55, and 22. After dividing into five groups, the similarities of the subcategories were examined and the final categories were developed by condensing similar

subcategories. Then, conceptual diagrams were created respectively. Finally, integrated conceptual diagrams were created. The number of developed categories; problems, self-solutions, received support, and necessary support were as follows: five, two, one, two.

II. Developing questionnaires for the parents of CWMD

Table 1 shows the number of categories and examples of Type I. These developed categories will be used as question items for the further study. In total, 53 problems and 25 self-solutions were developed.

Table 1   Number of categories and examples of Type I

Processes of going out	Number of categories	PA	LA	CC	Examples of categories
1	Problems	0	1	1	Decrease motivation for going out because of physical burdens for caring child
	Self-solutions	0	0	3	Remade the entrance into barrier free
2	Problems	0	4	1	Lack of options of where to go because of bad weather
	Self-solutions	2	0	0	Choose the place where it is accessible to wheelchairs
3	Problems	0	5	1	Restriction because of child's medical care
	Self-solutions	0	4	1	Gather the information about the place
4	Problems	0	0	19	Physical burden of transferring child
	Self-solutions	0	0	4	Have no luggage when transferring child
5	Problems	4	9	8	Lack of restroom for people with disabilities
	Self-solutions	2	5	4	Pay attention to child's safety and sign of ill-health

Besides, six categories of problems and one category of self-solution were developed in Type II. In addition to this, nine categories of necessary support for AOH regarding both Type I and II were developed. In total, the number of categories developed by this analysis was 96.

Discussion

I. Exploring the problems and self-solving processes

Integrated conceptual diagram (Figure 2) describes parents' physical burdens for caring their children and psychological burdens for caring their children regardless of the ages of parents and children, the child's motor function, and family background. Moreover, these burdens cause a collateral problem: anxiety of going out. To solve this problem, parents make an effort to reduce the number of times going out for productive activities such as going to a grocery store with their children. In addition to this physical solution, parents also solve this problem by changing their mindset, for example, trying to get used to the problems as they are, and feeling supported by people around them when they go out (Positive). On the other hand, some of the parents regard the anxiety of going out as stress (Negative). These results show the significance of developing individualized and flexible support. Furthermore, irrespective of the parents personality, most of them complain of anxiety about the future. To solve this

issue, parents think it is necessary that the government provides excellent respite services which meet these parents' needs. This represents that current respite services in Japan do not meet parents' needs and they are quantitatively deficient.

II. Developing questionnaires for the parents of CWMD

The categories developed in parents' activities outside the home with their children cover the entire range of going out processes from one to five. The categories of problems developed in parents' activities outside the home without their children also cover the whole processes: the child is in school (or other institutions for education), the child is in day care, someone's house etc., and the child stays at home. Compared to the number of problem categories, the number of self-solution categories was few; this might reflect the current situations that parents have no way of solving the problems by themselves.

For the further study

The categories developed will be used as question items. After assessing the internal validity of the questionnaire by five parents of children with movement disorders, three-rounds of Delphi's method will be conducted at the children's facilities or hospitals all over the country. Question items that validated by Delphi's method will be adopted as question items of the questionnaire regarding the current status of activities outside the home for the parents of children with movement disorders.

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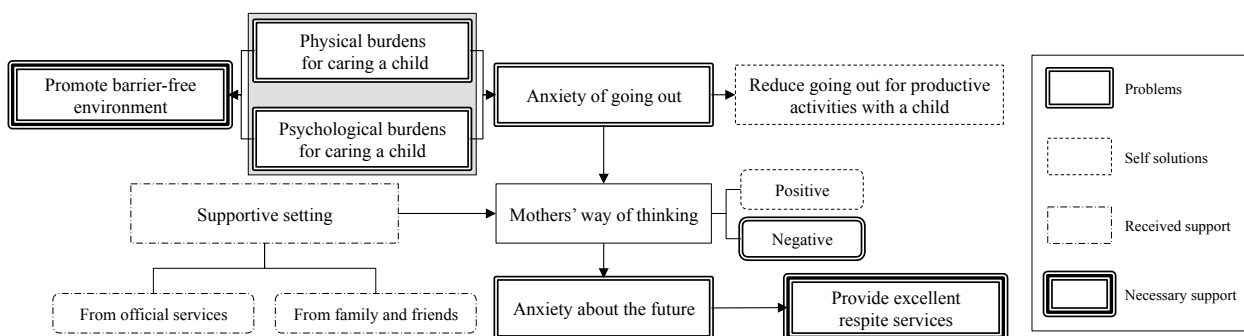E-Mail: suzuki.asuka@a.mbox.nagoya-u.ac.jp

Figure 2   Integrated conceptual diagram

Effect of Home Modification and Caregiver Education on Activity Performance of Person with Early Dementia: Case Study

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Introduction

Participation in activities has close relationship with aging. To elderly people, participation in activities mean not only leisure but satisfaction of their lives[1]. Nevertheless dementia experience difficulties of performance goal-directed occupation because of decreased cognitive function[2]. Restricted participation of activities of daily living and community living derives depression and deterioration of cognition[3]. Furthemore psycological problem such as depression and anxiety cause mental burden to care geivers[4]. People with dementia need individual intervention in accordance with deterioration of cognitiven function. The purpose of this study was to investigate effect of home modification and caregiver education on activity level changing of person with mild dementia in home environment by selecting items for intervention by using client centered approach and confirming approach method according to cognitive level of client.

Materials and Methods

Participants: 84-years old woman who diagnosed alzhheimer's dementia. She lives in community with her spouse. General cognition assessed by MMSE-K and CDR and got scores 17 means definite dementia and 1 means mild dementia. Caregiver report she still maintain her ADL but have difficulties with her IADL.

Evaluation

Canadial Occupational Performance Measure (COPM)

COPM is Client-centered assessment which format semi-structured interview understanding performance of self-care, productive activities, leisure. To this study, COPM used to select target activities.

Assessment of Home-based Activities (AHA)

AHA assess independent, difficulty, safety scales of 26 items include ADL, IADL, Leisure. To this study, select activities which need improvement or modify.

Figure 1. Process of the research

Allen Cognitive Level Screen Test (ACLS)

ACLS based cognitive disability frame of reference(FOR), means cognitive state causes functional state. To this study, assess cognitive level and search intervention method suit to client cognitive state. Figure 1 is process of the research.

Intervention

Result from COPM and AHA(table 1), managing stairs, getting in/out of house, bathing/showering, using toilet, washing hair, walking indoors, using bed/bedclothes, taking medication, using household appliances, and controlling indoor lights activities were selected as target intervention. ACLS was used to assess cognitive level of client, home modification and caregiver education were confirmed as intervention method according to the result. The effectiveness of intervention was assessed by AHA.

Table 1. Modification Required Activities

Selection standard		Activities
COPM	ADL	Bathing/showering
	IADL	Taking medication
		Watching TV
		Using household appliances
AHA	ADL	Managing stairs
		Getting in/out of house
		Bathing/showering
		Using toilet
		Washing hair
		Walking indoors
		Using bed/bedclothes
	IADL	Taking medication
		Using household appliances
		Controlling indoor lights

Analytical methods: To understanding effectiveness of home modification and caregiver education on activity performance of person with early dementia, we assess AHA pre-post intervention also evaluate 6 month after intervention.

Results

Persons with mild dementia has been declining in independence level of activities are required higher cognitive level. Throughout the intervention, however, the score of AHA; independence, difficulty, and safety, was improved and the effect of intervention was still maintaining after 6 months.
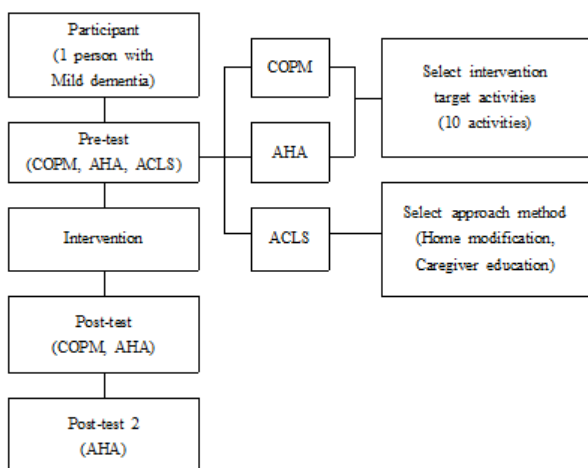
Table 2. Home Modification for Person with Mild Dementia

Selection Standard	Modification	Modification place : Method and Education	Purchase Method	Price(₩)
BADL	Bath Chair	Bath: Placing a bath chair to prevent accidents could be happened while standing and sitting and also occur of musculoskeletal disorders.	LCIA	27,450
BADL	Non-slip tape	Stair: Installing non-slip tape to prevent falling due to decrease of depth perception arising from low vision and aging.	Personal	27,400
BADL	Non-slip mat	Front of doorway and bathroom: Installing non-slip mat to prevent falling due to slip or level difference between floors.	LCIA	8,550 × 3 = 25,650
BADL	Non-slip socks	Indoor: Buying non-slip socks to prevent falling could be happened while walking on the slippery floor	LCIA	720×6 = 4,320
BADL	Grab bar	Side of toilet and sink: Installing grab bars to prevent falling could be happened while using toilet or bath room.	LCIA	9,540 (T form)×2 +11,740 (L form) =30,820
BADL	Folding bed rail	Bed: Installing rails to prevent falling from bed while sleeping because of client's sleeping habits.	Personal	60,500 × 2 = 121,000
IADL	Transparent container	Refrigerator: Changing containers to transparent container to help client on discriminating between side dishes and other foods.	Personal	3,000×10 = 30,000
IADL	Pill case	Table: Buying pill cases and setting an alarm to help client on taking proper drugs with proper dosage at proper time.	Personal	1,000×2 = 2,000
IADL	Sticker	TV remote controller: Writing down channel numbers the clients usually watch on the controller. Marking with sticker to help client on using number pad of controller.	Personal	500
		Micro wave: Marking with sticker to prevent confusion with other buttons, on a button is frequently used.		
		Light switch: Marking with sticker to prevent confusion with other light switches, on switches are frequently used.		
Etc. Planning	White board	Indoor: Installing time table to help planning what kinds of activities does the client wants to do and to train the client performing those activities independently.	Personal	6,800

LCIA=Long-term Convalescence Insurance for the Aged

Table 3. Result of Changes in COPM Score

Item	Importance	Performance		Satisfaction	
		Pre	Post	Pre	Post
Taking medication	8	1	3	1	3
Bathing/showering	8	6	7	6	8
Watching TV	7	5	5	5	5
Using household appliances	3	3	5	2	7

Table 4. Pre-Post Result of AHA Score

Item	Independence (3 points)			Difficulty (4 points)			Safety (4 points)		
	Pre	Post	6m Post	Pre	Post	6m Post	Pre	Post	6m Post
Managing stairs	3	3	3	2	2	2	2	3	3
Getting in/out of house	3	3	3	2	2	2	2	3	3
Bathing/showering	3	3	3	3	3	4	3	3	4
Using toilet	3	3	3	3	3	4	3	3	4
Washing hair	3	3	3	3	4	4	3	3	3
Walking indoors	3	3	3	3	3	3	2	3	3
Using bed/bedclothes	3	3	3	3	3	4	3	3	4
Taking medication	1	1	1	1	2	1	2	2	2
Using household appliances	1	2	2	2	2	2	2	2	3
Controlling indoor lights	3	3	3	3	3	3	3	3	3
Average Score	2.6	2.7	2.7	2.5	2.7	2.9	2.5	2.8	3.2

Discussion

In this study, we select intervention using client-centered approach such as COPM and AHA that give information which activities are important and meaningful to client. The results give us more information about how she doing well in her ADL situation.

In addition ACLS score show the client needs help the way compensation not the remediate approach. When we examine the result from pre intervention AHA cognitive activities score is more decreased than physical activities. It was just like previous research result that person who has more decreased cognitive function perform activities with difficulty which need high cognitive level. However activities already show decreased performance improved and maintain activity performing by individual intervention.

It was meaningful to examine cognitive intervention with physical factors to dementia client. For future study, we expect that providing intervention not only client-centered approach but also caregiver education program will show better result about increased performance and maintaining the effectiveness.

Conclusions

Occupational Therapist have to provide intervention to not only person with dementia but also their caregiver to improve and maintain activity performing level of person with dementia.

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Abstracts

Biomedical Laboratory Science

2015 Yonsei-Nagoya University Joint Symposium on Biomedical Laboratory Science

11:00~11:10 Opening Session   *Prof. Jong-Bae Kim (Yonsei Univ.)*

11:10~11:55   Session I   *Chair: Prof. Takaaki Kondo and Jong-Bae Kim*

11:10~11:30   Theranostic Aptamer-conjugated Liposomal Nanoparticle for Triple Negative Breast Cancer

     Min Woo Kim (Yonsei Univ.)

11:30~11:50   Influence of adipose-derived stem cell administration on cytotoxic T lymphocyte-mediate liver injury in mice

     Kenta Nakagiri (Nagoya Univ.)

12:00~14:00   Lunch

14:00~16:30   Session II   *Chair: Prof. Tetsuhito Kojima and Bo Young Jeon*

14:00~14:20   Enterotoxigenic Bacteroides fragilis-based wild type mouse model of colorectal cancer

     Soon Jae Hwang (Yonsei Univ.)

14:20~14:40   Association of Meteorological Factors with Ambulance Transports for Ischemic Heart Disease between 2002 and 2007 in Nagoya, Japan

     Ryosuke Fujii (Nagoya Univ.)

14:40~15:00   Trends of Antibiotic Resistance Rate of Helicobacter pylori Isolates from 2009-2010, 2011-2012, and 2014-2015 in a Single Center in Korea

     Ji Yeong Yang (Yonsei Univ.)

15:00~15:30   Coffee break

15:30~15:50   Human Exposure to Neonicotinoid Pesticides Has Increased the Last Two Decades

     Arisa Aoi (Nagoya Univ.)

15:50~16:10   Use of hTERT and HPV E6/E7 mRNA RT-qPCR TaqMan Assays in Combination for Diagnosing High-Grade Cervical Lesions and Malignant Tumors

Sun Young Park (Yonsei Univ.)

16:10~16:20   Closing Remark   *Prof. Takaaki Kondo (Nagoya Univ.)*

16:20~16:30   Group Photos

※ 15 minutes presentation and 5 minutes Q&A

Theranostic Aptamer-conjugated Liposomal Nanoparticle for Triple Negative Breast Cancer

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Introduction

Breast cancers are clinically classified depending on their expressions of estrogen receptor (ER), progesterone receptor (PR), and epidermal growth factor receptor 2 (HER2/neu). Usually HER2-positive breast cancer patients could be benefited from endocrine and HER2-targeted therapies. However, in case of triple-negative breast cancers (TNBCs), their lack of HER2 expression and aggressive progression make it difficult to utilize HER2-targeted therapeutics. An application of previously synthesized our cationic lipid, O,O'-dimyristyl-N-lysyl glutamate (DMKE) combining with aptamer oligonucleotides specific to epidermal growth factor receptor (EGFR) could be a noble strategy to solve this concern. In order to achieve effective siRNA complexation and provide with in vivo target specificity, the cationic liposomes were PEGylated in two different steps.

Here, we synthesized quantum dot-incorporating cationic liposomes (QCLs), which were then complexed with gene silencers such as Bcl-2 siRNA and PKC-λ/ι siRNA. Both siRNAs in QCLs were effectively and specifically transfected to TNBCs, resulting in apoptosis and reduced migration of the cells. In this study, we concluded that EGFR aptamer-conjugated QCLs can be utilized as a useful theranostic agent for TNBCs.

Materials and Methods

Preperation of liposome : Quantum dots-incorporating cationic liposomes (QCLs) were prepared according to the lipid thin layer methods. O,O'-dimyristyl-N-lysyl glutamate (DMKE, previously synthesized cationic lipid) (48 mol%), cholesterol (48 mol%), 1,2-distearoyl-sn-glycero-3-phosphoethanolamine-N-[methoxy(polyethylene glycol)2000] (DSPE-mPEG2000, Avanti Polar Lipids) (4 mol%) and quantum dots (CdSe/ZnS, Nanosquare) (5:1, w/w) were dissolved in a chloroform and methanol mixture (2:1, v/v). The organic solvent was evaporated under a stream of N_2 gas, followed by vacuum desiccation for 1 h. The dried films (0.5 mg lipids) were hydrated in 1 ml of normal saline and then continuously vortexed and sonicated. The therapeutic Bcl-2, PKC-λ/ι siRNA (Bioneer, Daejeon, Korea),

and prepared QCLs were gently vortexed (4:1 N/P ratio) at 500 rpm for 1 h.

To prepare immuno-QCLs, Cetuximab, a chimeric antibody against EGFR, was thiolated by reaction with Traut's reagent (Thermo Scientific, Rockford, IL, USA), and then conjugated to the maleimide group of 1,2-distearoyl-sn-glycero-3-phosphoethanolamine-N-[maleimide(polyethylene glycol)-2000] (DSPE-PEG2000-mal). Thiolated aptamer (Postech, Pohang, Korea) was also conjugated to the distal termini of DSPE-PEG2000-mal. Each of prepared EGFR targeting lipids (0.4 mol%) were post-inserted into QCLs complexed with therapeutic siRNAs at 60 ℃ for 1 h.

Cell lines and cell culture

MDA-MB-231 cell (Human breast adenocarcinoma) and MDA-MB-453 (human breast carcinoma), well known as triple negative breast cancer (lack of ER, PR, HER2 antigen), were maintained in DMEM (Gibco, Carlsbad, USA). The culture media were supplemented with 10% fetal bovine serum (Gibco, Carlsbad, USA), and 1% penicillin-streptomycin (Gibco, Carlsbad, USA).

Analysis of cell binding test in MDA-MB-231 and MDA-MB-453 cells

FACS analysis was performed with MDA-MB-231 and MDA-MB-453 cells treated with EGFR-Cetuximab labeled with Alexa fluor 488 and EGFR-aptamers labeled with Cy3.

To evaluate transfection efficiency, the various QCLs were complexed with fluorescein-labeled siRNA and transfected to both cells in serum-free media for 4 h. Then change of fluorescence shift in transfected cells were determined by FACS analysis.

RT-PCR analysis of *in vitro* gene silencing by various QCLs

To evaluate in vitro gene silencing by small interfering RNA, MDA-MB-231 cells (5 × 105 cells per well) were transfected with various formulations of QCLs containing various concentration of the therapeutic Bcl-2, PKC-λ/ι siRNAs in serum-free media for 4 h. The transfected cells were then incubated in medium containing 10% FBS media for 24 h. The mRNA level of both targets in transfected cells were determined by RT-PCR.

Analysis of Fluorescence imaging in MDA-MB-231 cells

MDA-MB-231 cells were transfected by various QCLs containing fluorescein-labeled siRNA and the fluorescences images were observed by confocal microscope (×400) 4 h later.
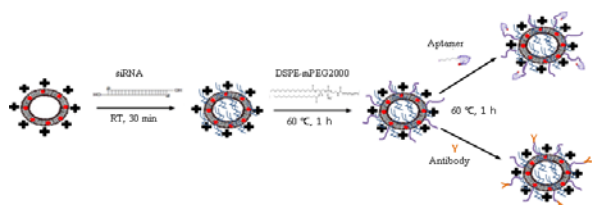
Results

Figure 1. Schematic illustration of Anti-EGFR-QCLs.

Anti-EGFR-QCLs were prepared by post-insertion of DSPE-mPEG2000 conjugated to antibodies or aptamers into quantum dot-encapsulating cationic liposomes, followed by siRNA complexation.
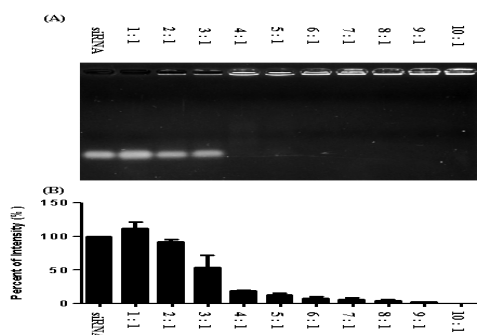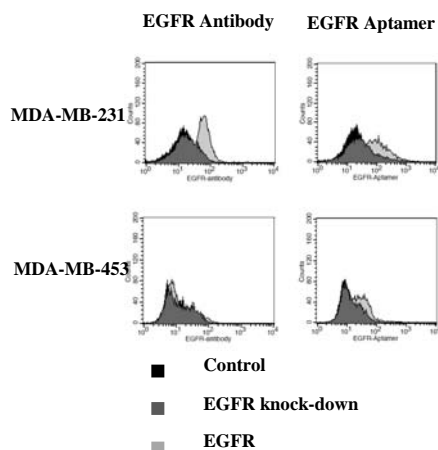

Figure 2. Determination of optimal N/P ratio of siRNA & QCLs.

Scrambled siRNA were complexed with QCLs in various N/P ratios and then incubated for 1 h with continuous vortexing at room temperature. Optimal N/P ratio was estimated by gel retardation assay (A) and their band intensities (B).

- ■ Control
- ■ EGFR knock-down
- ■ EGFR

Figure 3. cell binding test in MDA-MB-231 and MDA-MB-453 cells

FACS analysis was performed with MDA-MB-231 and MDA-MB-453 cells treated with EGFR-Cetuximab labeled with Alexa fluor 488 and EGFR-aptamers labeled with Cy3..
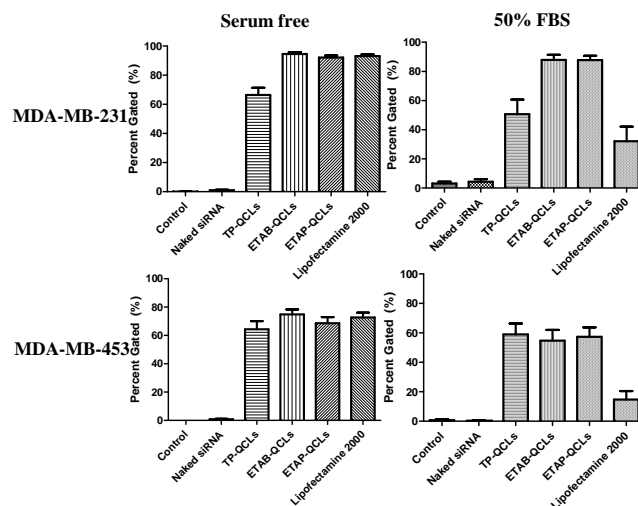
Figure 4. In vitro siRNA transfection efficiency of various QCLs.

The various QCLs were complexed with FITC-labeled siRNA and then were added to MDA-MB-231 cells. After 4 h incubation, the transfection of FITC-labeled siRNA to the cells were measured by FACS analysis.

.

Conclusions

In this study, we have developed a novel theranostic liposomal siRNA delivery system specific to EGFR-expressing MDA-MB-231 cells, one of triple negative breast cancers.

At 4:1 N/P ratio, QCLs exhibited the highest siRNA encapsulation and showed an appropriate particle size and zeta potential.

Bcl-2 and PKC-λ/ι siRNAs in the anti-EGFR-QCLs were able to significantly suppress the expression of the corresponding genes in MDA-MB-231 cells.

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Influence of adipose-derived stem cell administration on cytotoxic T lymphocyte-mediated liver injury in mice.

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Introduction

Cell therapy with mesenchymal stem/stromal cells (MSCs), has received much attention because these cells possess immunomodulatory properties as well as multilineage differentiation potential [1,2]. While bone marrow has been originally reported to be the source of MSCs, adipose tissue has been demonstrated to be the source of MSCs as well [3]. Adipose tissue-derived MSCs (ASCs) have shown to possess immunomodulatory properties that are comparable with those of bone marrow-derived MSCs (BSCs) [4,5]. ASCs may be better candidate of cell therapy, since they could be easily obtained with minimal invasive procedure and grow faster than BSCs [6,7]. Actually, the effects of ASCs on various inflammatory disease models have been demonstrated, and the trials for clinical applications of ASCs in various immune disorders, such as graft-versus-host disease (GvHD), are now in progress.

Fulminant hepatic failure (FHF) could be one of the targets for ASC therapy, since FHF is an incurable disease with significant mortality, composed of massive destruction of hepatocytes caused by excessive immune responses [8,9], and orthotopic liver transplantation is the only way to improves the survival rate.

We and others have demonstrated the therapeutic effects of ASCs on acute liver injury in mice models, such as concanavalin A (ConA)-induced and carbon tetracloride (CCl$_4$)-induced liver injury models, both of which are recognized as the models of FHF in human [10,11]. However, little is known about the effects of ASCs on cytotoxic T lymphocyte (CTL)-mediated liver injury; most prevalent cause of FHF as seen in hepatitis virus infection-related FHF.

In the current study, therefore, we evaluated the effects and influences of ASCs on CTL-mediated acute liver injury using hepatitis B surface antigen (HBsAg)-transgenic mice and HBsAg-specific CTLs.

Materials and Methods

Mice: HBsAg-transgenic mice, lineage 107-5D (official designation Tg[Alb-1,HBV]Bri66), (inbred B10.D2, H-2^d) in which the HBsAg coding region is under the control of the mouse albumin promoter [12], were subjected for the experiments in age of 8 to 10 week. Six- to 8-week-old B10.D2 mice with same background as 107-5D were used as the source of ASC administration and splenocytes. All the mice were housed in a controlled environment and fed a standard diet with water *ad libitum*. The experiments were approved by the Nagoya University Animal Experiment Committee.

HBsAg-specific CTLs: The CD3$^+$, CD4$^-$, CD8$^+$ CTL clone (designated 6C2) were used in the study. 6C2 is L^d restricted, recognizes an epitope (IPQSLDSWWTSL) that is located between residues 28-39 of HBsAg, and secretes IFN-γ and TNF-α after antigen stimulation in vitro [13]. They were maintained by weekly restimulation with mitomycin (MMC)-treated P815 cells (murine mastcytoma cell line, H-2^d) that stably express HBsAg (designated P815preS(1)).

Preparation of ASCs: Subcutaneous adipose tissues were taken from 6- to 8-week-old B10.D2 mice, placed in DMEM containing 10% FBS, and minced, adding Hank's balanced salt solution to prevent drying. These tissues were incubated in HBSS containing 0.1% collagenase, suspended with DMEM, passed through 100μm mesh, and resulting cell suspension was collected in 50mL tube. After centrifuge, the precipitated cells were washed twice with DMEM, and resuspended in a complete medium, 3:2 mixture of DMEM and MCDB 201 medium containing 20% FBS, supplemented with linoleic acid-albumin, Insulin-Transferrin-Selenium (ITS), ascorbic acid phosphate ester, and antibiotics. The cells were seeded in fibronectin-coated flask, and attached fibroblast-like cells were cultured as the progenitors of ASCs. The medium was changed every 1 or 2 days. When the cells grew confluent, they were treated with 1 mM EDTA-containing 0.25% trypsin, and the detached cells were replated on a new flask for further expansion, or used for the experiments [14].

Proliferation assay for CTLs co-cultured with ASCs: One × 10^5/well 6C2s were placed in a 96-well plate, with 1 × 10^5/well P815preS(1)s as stimulator cells and 1 × 10^6/well B10.D2 splenocytes as feeder cells, with or without 5 × 10^4/well syngeniec ASC (CTL:ASC=2:1), and incubated for 24 h. Then, BrdU incorporation assay was performed to assess proliferative responses of CTLs. As a control experiment, 1 × 10^6/well B10.D2 splenocytes stimulated with 5 μg/mL ConA were cultured with or without 5 × 10^4/well syngeneic ASC (splenocyte:ASC=20:1), incubated for 24 h, and subjected to BrdU incorporation assay.

Cytotoxicity assay for CTLs co-cultured with ASCs: Two × 10^5 or 1 × 10^6/well 6C2s (effector cells) were cultured with 2 × 10^5/well carboxyfluorescein diacetate succinidyl ester (CFSE)-labeled P815preS(1)s (target cells, effector to target ratios are 1:1 and 5:1, respectively) in a 24-well plate, with or without 1 × 10^5/well ASC (CTL:ASC=2:1 and 10:1, respectively). The cells were incubated for 4 h, non-adherent cells (except for ASCs) were collected, fixed with 4% paraformaldehyde (PFA), and subjected to the analysis with flow cytometer (LSRFortessa X-20 Analyzer, Becton, Dickenson, abd Co.). Mean fluorescence intensity (MFI) of target cells was determined, and % specific killing was calculated as follows: [(MFI of labeled target cells in control sample − MFI of labeled target cells in test sample) /(MFI of labeled target cells in control sample)] × 100. Control sample indicates target cells incubated without effector cells, and test sample indicates target cells incubated with effector cells.

CTL-induced liver injury model and treatment with ASCs: Eight- to 10-week-old male 107-5D mice were intravenously injected with 5 × 10^6 6C2s of 5 d after the last stimulation, suspended in 200 μL PBS. In ASC-treatment group, 1.0 × 10^6 ASCs in 200 μL PBS with heparin were intravenously injected to mice, 30 m before 6C2 transfer. Control group (without ASC treatment) were injected with PBS with heparin at the same time point. At 48 h after 6C2 transfer, the mice were sacrificed after collecting sera, and liver tissue specimens were resected. ALT levels in the sera were analyzed with by BBx system (Nittobo Medical Co.,Ltd, Tokyo, Japan). Liver specimens were stained with hematoxylin and eosin (H&E), and the extent of inflammation was asssessed under microscope. Each experimental group consisted of 3 to 4 mice.

Cytokine/Chemokine analysis for culture supernatants and mice sera: Cytokine and chemokine levels (IL-6, IL-10, MCP-1,

IFN-γ, TNF, IL-12p70) in the culture supernatants of 6C2s stimulated with P815preS(1) with or without ASC cocultivation, and in the sera of 107-5D mice 48 h after 6C transfer (with or without ASC transfer), were measured using Cytometric Bead Array (CBA) Mouse Inflammation Kit (Becton, Dickenson, abd Co.) according to the manufacture's instruction.

Results and Discussion

Influence of ASCs on CTL proliferation and cytotoxicity: As a control experiment, we examined the effect of B10.D2 ASCs on ConA-stimulated proliferation of syngeneic splenocytes. ASCs markedly suppressed proliferation of splenocytes to one-tenth of that without ASC cocultivation, indicating ASCs used in the study had immunomodulatory function compatible to that reported previously. When ASCs were cocultured with antigen (P815preS(1))-stimulated 6C2s, however, they did not effectively suppress proliferation of 6C2s: the reduction rate of proliferation was only 12%. Next, we tested the influence of ASC cocultivation on cytotoxic activity of 6C2 using P815preS(1) as target cells. Without ASCs, 6C2s effeciently killed targets: % specific killing was 80% at E/T ratio of 1 and 96% at E/T ratio of 5. In the coculture experiment with ASCs, % specific killing of 6C2 was 79% at E/T of 1, and 96% at E/T of 5, showing almost no suppresive effect of ASCs on cytotoxicity of 6C2s. The differenct effects of ASCs on ConA-stimulated splenocytes and antigen-stimulated CTLs may be explained by the characteristics and potentials of the individual cells. Namely, the splenocytes are heterogenious and include non-sensitive cells to ConA stimulation, such as B cells, macrophages, etc., while 6C2 is a CTL clone with strong proliferative and cytotoxic activity. On the other hand, Karlsson *et al.* reported that ASC did not have regulatory funcrtion on cytotoxic activity of CTL [15]. There are differences in experimental condition and characteristics of cells between the two studies, however, it may explain the results of our study as well.

Influence of ASCs on CTL-mediated liver injury: Then, we examined the *in vivo* effects of ASCs in CTL-mediated liver injury model, in which HBs-Ag-specific CTLs (6C2s) were transferred into HBsAg-transgenic mice (107-5D): transfer of the designated amount of CTLs (5×10^6) causes FHF-like liver injury (the peak of ALT elevation on d 2 to 3) in this model. The amount of ASCs (1×10^6) transferred to the mice was enough to alleviate liver injury in FHF models with ConA and CCl$_4$ administration. In the mice transferred with 6C2s alone, ALT levels on d 2 (48 h) were 3700 ± 2107 U/L. In the mice transferred with 6C2 and ASCs, ALT levels on d 2 were 5713 ± 3543 U/L, indicating that the immuno-regulatory effect of ASCs was not observed. Histological analysis also showed that ASC transfer did not relieve inflammation in the livers of mice. Serum cytokine /chemokine analysis showed increase in IL-6 and MCP-1 levels in the mice with 6C2 and ASC transfer compared to the mice with 6C2 transfer alone. From the results of *in vitro* study, we did not expect that CTL-mediated hepatocyte apoptosis was protected by ASCs, while we expected that inflammatory responses of antigen-nonspecific cells following CTL activation were lessened by ASCs. However, the results indicated that there was no relief of liver inflammation both antigen-specific and nonspecific levels. Elevation of serum IL-6 and MCP-1 in the mice transferred with 6C2s and ASCs may explain this phenomenon. Since the increases of IL-6 and MCP-1 levels in the supernatant of 6C2 and ASC cocultivation were also confirmed, the serum elevations of the both factors in the mice were possibly caused by the interaction of 6C2s and ASCs *in vivo*.

Although the reason why ASC could not exert regulatory function in CTL-mediated liver injury was not evident, it is possible that elevations of these inflammatory cytokine /chemokine played some roles in disturbing immune-regulatory function of ASCs.

Conclusions

The use of ASC in treating FHF should be careful, since the immune-regulatory function of ASC may not be exerted as expected depending upon the etiology of FHF. More detailed analyses are necessary to elucidate actual influence of ASC on CTL-mediated cytotoxicity and diseases, using other CTL clones or CTL cell lines, since the current study used only a single CTL clone.

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Enterotoxigenic *Bacteroides fragilis*-based wild type mouse model of colorectal cancer

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Introduction

Colorectal cancer is a major cause of death in the developed countries. Colorectal cancer develops spontaneously as a result of genetic mutation or as a long-term complication of chronic bowel inflammation such as in Crohn's disease and ulcerative colitis. Since the past, many scientists have been using azoxymethane (AOM) with dextran sulfate sodium (DSS) in order to study pathogenesis of colorectal cancer (1). AOM is a DNA alkylating agent, a chemical carcinogen. DSS is a chemical which is used to induce colonic inflammation in rodents. IL-6, one of inflammatory cytokines produced for inflammation, triggers the up-regulation of transcription factors such as c-myc and cyclin D1 through phosphorylated STAT3 (2). Therefore DSS is used to accelerate colonic tumor formation and progression (3).

However, AOM/DSS system is primarily influenced by condition of each animal facility. Same protocol applied to specific strain of mouse sometimes show different colonic tumorigenesis such as the number of colonic polyp and tumor progression. So researchers needs to try and adapt known protocol and method of AOM/DSS system in each laboratory. We developed an enhanced and very highly reproducible *Bacteroides fragilis*-applied mouse model with AOM/DSS system compared to prior AOM/DSS mouse model.

Bacteroides fragilis is a gram-negative and facultative anaerobe. *B. fragilis* is a human colonic commensal and known to be one of the most commonly isolated species from human intestine. Some strains of *B. fragilis* secretes *Bacteroides fragilis* toxin (BFT) and those strains are named as Enterotoxigenic *Bacteroides fragilis* (ETBF). The prevalance of ETBF colonization is 4~30% and the clinical manifestation of most ETBF carrier is asymptomatic. BFT is a 20 kDa secreted metalloproteinase. BFT induces ectodomain E-cadherin cleavage in vitro and in vivo, thereby inducing colitis in murine model (4, 5). Also, BFT activates beta-catenin signaling, MAPK pathway and NF-κB pathway in colonic epithelial cell lines.

Recently, it has been shown that ETBF infection increases colonic tumorigenesis through T helper type 17 immune response in APC/Min mice which are characterized by spontaneous tumor formation in small and large bowel in mouse starting at the time of 4~6 weeks age (6). In addition, studies using human stool samples indicated that an increase rate of detection of *bft* gene of ETBF in colorectal cancer patients when compared to control groups (7). Additionally, other study showed that ETBF-secreted nanoparticles induce secretion of the S1P containing exosome from colonic epithelium, thereby inducing T helper type 17 immune response in colonic mucosa in mouse (8). T helper 17 cell is regarded is as an aggravating factor of pathogenesis and progression of colorectal cancer (9). Here we explored a novel method of ETBF-based AOM/DSS mouse model. We show that ETBF infection showed enhanced colonic tumorigenesis in AOM/DSS-treated mice through enhanced colitis.

Materials and Methods

Animal and Treatment. 8 week-old female Balb/c mice were purchased from Raonbio and housed in a temperature-controlled environment (23°C ± 1) with a 12-h light/dark cycle. After an acclimation period of 1 wk, the mice were injected i.p with AOM (10 mg/kg). Control animals received saline as vehicle control. DSS 2% solution was substituted for animal drinking water 5 days after bacterial inoculation. One cycle consists of 5 day of DSS treatment and 16 days of distilled water.

Bacterial strains. Enterotoxigenic *Bacteroides fragilis* (WT-ETBF, *B. fragilis* 86-5443-2-2) expressing a biologically active BFT-2 was used in this study. *Bacteroides* strains used in this study are resistant to gentamicin and clindamycin.

Mouse Infection. All mice (Balb/c, female) were given water with clindamycin (100 mg/L) and gentamicin (300 mg/L) to promote colonization of *B. fragilis*. Antibiotics-containing water was initiated 7 days prior to bacterial inoculations. Bacteria were washed with sterile phosphate-buffered saline and adjusted to 2 x 10ˆ8 CFU/ml for mouse oral inoculations.

Fecal analysis. *B. fragilis* colonization (CFU / g stool) was monitored by diluting stool in brain heart infusion agar (BHIA) containing gentamicin and clindamycin. BHIA plates were cultured in an anaerobic chamber at 37°C for 2 days. Thereafter, ETBF colonies were enumerated.

Histology. Formalin-fixed (10%), paraffin-embedded intestinal tissues were sectioned (5 μm) and stained with hematoxylin and eosin (H&E). Spleen weight was measured by an electronic scale. Colon length was measured by a ruler from the beginning of the cecum to the end of the rectum. Images were taken using a Leica camera and rendered using Adobe Photoshop.

Data analysis. For statistical analysis, the Mann-Whitney U test was used to compare between-group distributions for unpaired data. All other data are presented as means ± standard errors of the means. A P value of ≤0.05 was considered statistically significant.

Results

Histologic grade of colonic polyps from AOM/DSS-treated mice generally showed low grade dysplasia and adenoma. In

contrast, colonic tumor histology of AOM/DSS/ETBF-treated mice indicated mostly aberrant hyperplasia, high grade dysplasia, adenoma and carcinoma in situ. AOM/DSS protocol was reported that colonic adenocarcinoma progresses in colon of mice treated with AOM/DSS. However, there was no invasion of colonic tumor throughout basement membrane in all groups. There was also no metastasis in liver and lung in AOM/DSS/ETBF group. Additionally, we performed immunohistochemistry for identifying the properties of tumor such as strong beta-catenin reactivity, Cox-2 and iNOS in order to verify characteristics of colonic polyps. Almost most of polyps of mice from AOM/DSS/ETBF group showed representative strong beta-catenin, Cox-2 and iNOS
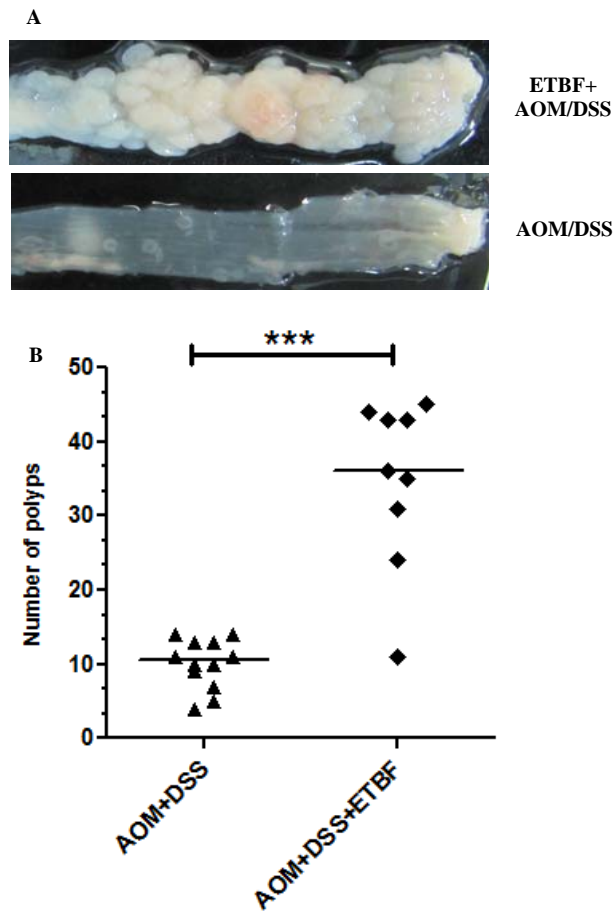
Figure 1. ETBF-based AOM/DSS protocol showed strong colonic tumorigenesis compared to conventional AOM/DSS mouse model.
A. Gross of large intestine of mice. B. Number of polyps in large intestine of mice. ***, P<0.001 Bar, median

Discussion

  Representative mouse models for colon cancer are APC/Min mice and AOM/DSS-treated mice. APC/Min mouse model is dependent on loss of Apc function and more sensitive system than AOM/DSS, which means that we can observe target effects of drug and factor as long with sensitively feasible formation of colonic polyps. However, the effects and costs of breading and separating heterogenous APC/Min mice mouse are highly laborious and expensive. Additionally, polyp formation also arises in small intestine which region is not common in most of colon cancer patients.

Merit of AOM/DSS method is the easy accessible availability of wild type mouse, which means that researchers can start in vivo study anytime if wild type mouse, AOM and DSS are ready for use. Typical AOM/DSS protocol is easily reproducible but most polyp size is so small that researchers might miss micro polyps. Therefore some drugs with a minimal effect for colon cancer can be ignored in AOM/DSS system. AOM/DSS/ETBF method presented here could have significantly accelerated the colonic tumorigenesis compared to control group of AOM/DSS. A human commensal-applied AOM/DSS mouse model provides a powerful framework for investigating the mechanism of tumor initiation, progression and promotion of colitis-associated cancer.

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Conclusions

  In this study, we demonstrated that ETBF plays a role in enhancing colonic tumor number and progression in AOM/DSS-treated Balb/c mice in vivo. Consequently, *Bacteroides fragilis* harboring bft gene could be used as a novel and sensitive tool in AOM/DSS-based wild type rodent model.

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Association of Meteorological Factors with Ambulance Transports for Ischemic Heart Disease between 2002 and 2007 In Nagoya, Japan

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Introduction

Forecasting health fron weather pattern has attracted a wide attention, particularly because information of weather-related risks for illness seems to be a useful tool of building strategy for disease prevention. Ever-accumulated evidence revealed the influence of weather factors on occurrence of ischemic heat disease (IHD) since the proposal by Rose G in 1966 [1]. According to the Hiroshima Prefectural Medical Association, acute myocardial infarction (AMI) has been likely to occur frequently in a day with mean ambient temperature of less than 10℃ and mean barometric pressure of less than 1005hPa [2]. In Helsinki, AMI mortality rate increased in the coldest day, and the number of incidents was higher when the barometric pressure quickly dropped, whereas ambient temperature was not significantly associated with AMI [3]. This Swedish study also indicated that AMI usually occurres on the day with low temperature, high humidity and low atmospheric pressure. Other Swedish researchers previously found no relationship between weather and lethal AMI [4]. Chinese researchers demonstrated that AMI increased at high atmosphere temperature, high relative humidity and low atmosphere pressure in summer [5]. These results suggest that the relationship between IHD and weather parameters is not consistent. Presumably, weather-related risks affects disease occurence from region to region, because otehr health-related risks such as the pattern of lifestyle and environmental situation tottaly vary. Therefore, investigation into the associations of weather condition with IHD onset in a particular area is warranted to design an area-specific prevention plan.

This study firstly aimed to summarize the frequency of IHD ambulance transports by every season, month, day of the week in Nagoya, and then to investigate the association between the emergency transports for IHD and meteorological factors.

Materials and Methods

Study site: Our study targeted Nagoya City, which is the fourth largest city in Japan (latitude 35˚11'N, longitude 136˚55'E). Its population size is approximately 2.2 million as of October 1st in 2010.
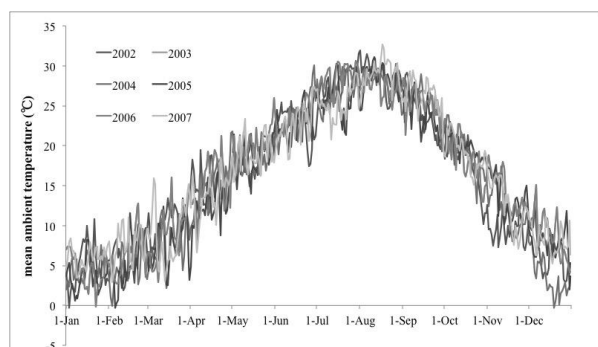

Figure 1. The daily mean ambient temperature by month in Nagoya, 2002-2007

Nagoya is located in the central part of the Japanese Archipelago and faces onto the Pacific Ocean. In terms of the climate of Nagoya, most days in winter are cold, dry and clear, while it is steamy in summer.

Meteorological data: The daily meteorological data from 2002 to 2007 were obtained from the Japan Meteorological Agency. At present, the data during 1872-2014 can be freely downloaded as a CSV-formatted file from the website of the Japan Meteorological Agency. Our study simply used the following meteorological variables for investigating the relationship between IHD and meteorological factors; mean barometric pressure (hPa), ambient temperature (℃) (mean, highest and lowest), intraday temperature difference (℃), mean vapor pressure (hPa), mean relative humidity (%), lowest relative humidity (%), mean wind speed (m/s), mean cloud cover, sunlight duration (hrs), global solar radiation (MJ), precipitation (mm).

Ambulance transports data: The information of emergency transports to the hospital, over the years 2002-2007, was provided by the Nagoya public ambulance emergency service. This data set includes 20 variables for each emergency transport; patients' demographic data (e.g. age, gender and residential area) and the date and time of emergency call and information of illness (e.g. presence of patient's consciousness, degree of the injury and coded name of illness). The name of disease was coded according to the diagnosis by the physician who first examined tha patient. If the name of disease was unidentified at the initial visit, it was coded later. In this study, we regarded angina and myocardial infarction (MI) as "ischemic heart disease (IHD)". The total number of transferred for IHD, angina and MI during the period of 6 years was 9,253, 5,279 and 3,974, respectively.

Statistical analysis: The data of meteorogical variables were shown as mean ± standard deviation. We regarded March, April and May as "Spring", June, and July and August as "Summer", September, Octorber and November as "Autumn", and December, January and Febrary as "Winter". One-way analysis of variance (ANOVA) was used to confirm the differences of emergency transports for IHD between every season, month and day of the week. After ANOVA, Tukey's multiple comparison test was performed to examine all pairwise differences of means. Backward stepwise Poisson regression analysis by Akaike's information criterion was carried out to select meaningful meteorological parameters and determine how much weather factors were related to IHD transports. A p-value of less than 0.05 was considered as statistically significant. R-3.2.2 was used for all statistical analysis in this study.

Results

The summary of meteorological data from 2002 to 2007 is shown in Table 1. Average ambient temperature for 2,191days

was 16.2 ± 8.5 (℃). The fluctuation of daily average air temperature by every years is plotted in Fig. 1.

Table 1. Meteorological parameters during the period of 2002-2007 in Nagoya, Japan

		mean ± S.D.	min.	max.
Total months (days)		72 (2191)		
Mean barometric pressure	hPa	1007.8 ± 6.4	982.5	1026.5
Mean ambient temperature	°C	16.2 ± 8.5	-0.3	32.7
Highest air tmperature	°C	21.0 ± 8.7	1.7	39.4
Lowest air temperature	°C	12.3 ± 8.7	-4.4	28.5
Intraday temperature difference	°C	8.7 ± 2.9	1.2	18.3
Mean vapor pressure	hPa	13.6 ± 7.7	2.9	31.0
Mean relative humidity	%	65.1 ± 12.2	28.0	97.0
Lowest relative humidity	%	44.0 ± 15.1	8.0	94.0
Mean wind speed	mm	3.0 ± 1.2	1.0	8.5
Mean cloud cover	-	6.5 ± 3.0	0.0	10.0
Sunlight duration	hrs	5.6 ± 4.0	0.0	13.6
Global solar radiation	MJ	13.9 ± 7.0	0.3	30.3
Precipitation	mm	4.0 ± 11.3	0.0	136.0

In comparisons of IHD emergency transports by every season, month and day of the week, there were significant seasonal and monthly differences (both $p < 0.01$), while no variability was observed among 7days of the week ($p = 0.71$) (data not shown). The number of IHD ambulance transports in winter was significantly higher than that of spring and summer (both $p < 0.01$). More emergency IHD visits were observed in December than in May and June (both $p < 0.05$).

The result of Poisson regression analysis with the backward stepwise method is shown in Table 2. Daily mean humidity, actual sunlight duration and precipitation were significantly related to IHD emergency transports. Furthermore, intraday temperature difference and global solar radiation showed marginal association with the IHD occurrence, whereas daily mean ambient temperature had no significant influence on IHD.

Table 2. Effects of meteorological parameters on emergency transports for IHD in Nagoya, Japan, 2002-2007, by backward Poisson regression analysis

	Coefficients	Standardized coefficients	p
Mean ambient temperature	-0.003	-0.049	0.14
Intraday temperature difference	0.010	0.061	0.08
Mean relative humidity	0.004	0.104	<0.01
Sunlight duration	0.013	0.108	0.03
Global solar radiation	-0.008	-0.107	0.07
Precipitation	-0.002	-0.050	0.04

Discussion

In this study, we firstly examined the number of emergency transports for IHD by season, month and day of the week. As some researchers reported, we also observed a surge in the number of ambulance IHD visits in winter and a second peak in summer. The between-month comparison showed that December had the highest IHD transports, whereas May and June had a lower number. This result fell in line with previous studies concerning seasonal difference of IHD [6-9]. Kinoshita N also reported that AMI onset significantly increased in winter compared with summer [10]. One of the conceivable reasons for seasonal and monthly difference is that colder weather induced an increased blood pressure, which is a well-known risk factor of IHD [11,12]. Additionally, some researchers have argued that clotting is likely to occur in cold weather due to the increase in fibrinogen, platelet count and plasma viscosity [13]. We found no significant relationship between the day of the week and IHD emergency transports. A previous study that focused on the incidence pattern of AMI showed no significant relationship during the week, while only women had a higher incidence rate in Saturday [14]. Therefore, we need to further investigate the association of IHD incidents with the weekly pattern by stratification.

As a main part of this study, we explored which meteorological factor was related to the number of ambulance IHD transports. We observed mean relative humidity had a positive relationship with IHD occurrence. The results regarding the association of daily humidity and AMI admissions were controversial. Some studies showed a significant relationship between the number of AMI admissions and either maximal ambient humidity [15] or low humidity [16], although another found no such associations [17]. A possible hypothesis for our consequence could be that lack of sweating function hindered by high humidity may be lead to the defects in the automatic system of internal temperature control, thus increasing burden for heart. Our study indicated that the longer sunlight duration and small amount of rain were significantly related to the higher number of IHD. Further research should be needed to elucidate the influence of precipitation and sunshine duration on IHD because our evidence is inconsistent with previous findings in terms of precipitation and sunlight hours. In this study, a marginal significant relationship between IHD and intraday temperature difference was observed. A Japanese researcher demonstrated that intraday temperature change is a predictive factor for AMI [18]. However, the mechanisms have not been elucidated. One reason could be that a rapid change in air temperature is associated with an increased risk for cardiovascular spasm.

There are some limitations should be discussed. Firstly, the name of disease might be different from the final diagnosis because it was coded according to the first diagnosis. Secondly, there is some possibility of over-counting the number of IHD patients for angina and MI because we could not exclude recurrent cases in this dataset.

Conclusions

We confirmed the seasonal and monthly variability of the number of ambulance transports for IHD. Daily mean humidity, actual sunlight duration and precipitation were significantly associated with IHD emergency visits in Nagoya.

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Trends of Antibiotic Resistance Rate of *Helicobacter pylori* Isolates from 2009-2010, 2011-2012, and 2014-2015 in a Single Center in Korea

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Introduction

Helicobacter pylori has been well known as one of the most important human pathogens, infecting more than half of the mankind. As *H. pylori* is parasitic on human gastric mucous membrane for many years, it causes various gastrointestinal diseases; slight asymptomatic gastritis, chronic gastritis, peptic ulcer, mucosa associated lymphoid tissue (MALT) lymphoma, and gastric cancer. *H. pylori* colonization should be eradicated in patients with peptic ulceration because eradication helps ulcer healing and prevents ulcer relapse. For eradication of *H. pylori* infection*,* standard triple therapy with a proton-pump inhibitor, amoxicillin, and clarithromycin remains the drugs of choice. When treatment failure occured, remedy is substituted for tetracycline, metronidazole, and levofloxacin. However, recently, antibiotic resistance is one of the main factors affecting *H. pylori* eradication. Also, it has been reported quite widely dependent on the geographic locations. In order to examine the changing trends of antibiotic resistance, we compared 5 antibiotics resistance rate from 2014-2015 with 2009-2010 and 2011-2012 in a single center in Korea.

Materials and Methods

Patients and collection of clinical specimens

Specimen collection was conducted at Yong-In Severance Hospital attached to Yonsei University College of Medicine, from May 2014 to June 2015. *H. pylori* strains, isolated from 61 patients conducted gastroscopic examination to confirm the infection of *H. pylori*, were evaluated.

H. pylori isolation and culture

The gastric biopsy specimens were completely homogenized and directly inoculated onto Brucella agar culture plates (10% bovine serum supplemented with 10 μg/mL vancomycin, 25 μg/mL nalidixic acid, 1 μg/mL amphotericin B and 8 IU/mL polymyxin B). Plates were incubated under microaerophilic and 100 percent humidity conditions at 37℃ and inspected after three to five days. Strains were identified as *H. pylori* by colony morphology analysis and urease test. The *H. pylori* ATCC 43504 strain was cultured as a reference using the same methods described above for quality control.

Susceptibility tests

The minimal inhibitory concentrations (MICs) for clarithromycin, amoxicillin, tetracycline, metronidazole, and levofloxacin were determined using a slightly modified agar dilution method (Mueller-Hinton agar base containing 10% bovine serum). Cut-off values of resistance were defined as ≥ 1 μg/mL for clarithromycin, ≥ 1 μg/mL for amoxicillin, ≥ 4 μg/mL for tetracycline, ≥ 8 μg/mL for metronidazole, and ≥ 1 μg/mL for levofloxacin.

Statistical analysis

Data of antibiotic resistance was analyzed using the Chi-square test. *P<0.05* was considered statistically significant.

Results

Table 1. Clinical characteristics of patients

		Patients (N=61)
Sex	Male	28
	Female	33
Age (mean±SD)	Male	53.7±12
	Female	53.6±12
Endoscopic diagnosis	PUD	44
	NUD	17

Values are presented as number or mean±SD.
Abbreviations : PUD, peptic ulcer disease; NUD, non-ulcer disease.

Table 2. Distribution of MICs of *H. pylori* clinical isolates

MICs (µg/mL)	Number of strains (%)				
	TET	MET	LVX	AMO	CLA
<0.016	27 (44.3)	4 (6.6)	3 (4.9)	6 (9.8)	21 (34.4)
0.016	4 (6.6)	1 (1.6)			6 (9.8)
0.03125	6 (9.8)	3 (4.9)	1 (1.6)	2 (3.3)	15 (24.6)
0.0625	13 (21.3)	1 (1.6)	13 (21.3)	7 (11.5)	6 (9.8)
0.125	11 (18.0)	1 (1.6)	20 (32.8)	6 (9.8)	1 (1.6)
0.25			5 (8.2)	11 (18.0)	
0.5		3 (4.9)	1 (1.6)	6 (9.8)	
1		7 (11.5)		7 (11.5)	
2		16 (26.2)	5 (8.2)	6 (9.8)	1 (1.6)
4		5 (8.2)	6 (9.8)	6 (9.8)	1 (1.6)
8		1 (1.6)	5 (8.2)		
16		8 (13.1)	1 (1.6)	4 (6.6)	4 (6.6)
32		8 (13.1)	1 (1.6)		4 (6.6)
64		2 (3.3)			
128		1 (1.6)			1 (1.6)
>128					1 (1.6)

Abbreviations : TET, tetracycline; MET, metronidazole; LVX, levofloxacin; AMO, amoxicillin; CLA, clarithromycin. Cut-off values of resistance were defined as ≥ 4 µg/mL for TET, ≥ 8 µg/mL for MET, ≥ 1 µg/mL for LVX, ≥ 1 µg/mL for AMO and ≥ 1 µg/mL for CLA.
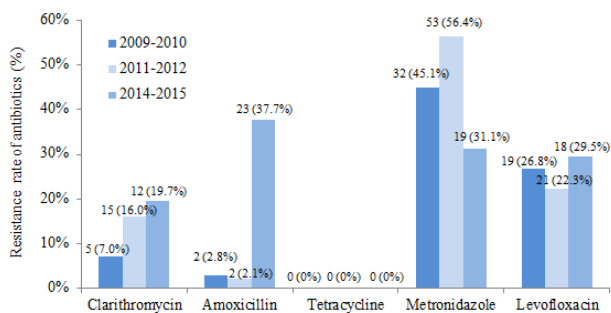
Figure 1. Resistance rate of antibiotics in *H. pylori* isolated from patients with gastrointestinal diseases during 2009-2010, 2011-2012, and 2014-2015. Increased antibiotic resistance was notable in amoxicillin, but metronidazole resistance was decreased.

Table 3. Comparison of multi-drug resistance over 3 time periods*

Types of multi-drug resistance	N of strains (%)		
	2009-2010	2011-2012	2014-2015
CLA+AMX			2 (3.3)
CLA+MET		3 (3.2)	2 (3.3)
CLA+LEV	2 (2.8)	3 (3.2)	1 (1.6)
AMX+MET		2 (2.1)	4 (6.6)
AMX+LEV			2 (3.3)
MET+LEV	8 (11.3)	8 (8.5)	1 (1.6)
CLA+AMX+LEV			5 (8.2)
CLA+MET+LEV		6 (6.4)	1 (1.6)
AMX+MET+LEV	1 (1.4)		1 (1.6)
CLA+AMX+MET+LEV	1 (1.4)		1 (1.6)

*Isolates were defined as resistant to clarithromycin (CLA), amoxicillin (AMX), metronidazole (MET), and levofloxacin (LEV), when the MICs were ≥ 1, ≥ 1, ≥ 8, and ≥ 1 µg/mL, respectively.

Discussion

In this study, the antimicrobial susceptibility test was conducted for *H. pylori* strains isolated from a single center over 3 periods. Among the *H. pylori* clinical isolates from 2009 to 2015, antibiotic resistance of *H. pylori* against amoxicillin has been increased from 2.8% to 37.7% ($p<0.001$). The rate of clarithromycin resistance tended to continuously increase from 7.0% to 19.7% although there was no statistical significance ($p<0.1$). The rate of metronidazole resistance was decreased from 45.1% to 31.1% ($p<0.01$) although it had been slightly increased from 2011-2012. Multi-drug resistance for 2 or more antibiotics was more frequent in the isolates from 2014-2015 (32.7%) than in the isolates from 2009-2010 (16.9%) and 2011-2012 (23.4%), but there was no statistical significance ($P<0.102$).

Conclusions

This result suggested that periodic monitoring of antimicrobial susceptibility is necessary for selection of an appropriate antibiotic regimen.

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Byoungrak An, Byung Soo Moon, Heejung Kim, Hyun Chul Lim, Yong Chan Lee, et al. Antibiotic Resistance in *Helicobacter pylori* Strains and its Effect on *H. pylori* Eradication Rates in a Single Center in Korea. Ann Lab Med 2013;33:415-419.

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Human Exposure to Neonicotinoid Pesticides Has Increased During the Last Two Decades

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Introduction

Pesticides have had a broad spectrum of use in agricultural settings, and in areas such as public health, commerce, and individual households throughout the world for pest control (1), and have been a ubiquitous component of daily life (2). Of the pesticide classes, neonicotinoid (NEO) insecticides are now playing a key role in controlling agricultural pests which developed tolerance to traditional insecticide pyrethroids and organophosphates (OPs). Seven NEOs - acetamiprid (ACE), clothianidin (CLO), dinotefuran (DIN), imidacloprid (IMI), nitenpyram (NIT), thiacloprid (THD), and thiamethoxam (THM) – have so far been introduced to the market and have reduced labor-intensive pesticide spraying and risk of chemical exposure due to their low volatility, high permeability and highly selective insecticidal properties (3). These advantages have resulted in a pronounced increase in NEO application in the world, especially in developed countries (4-6). In general, NEOs are considered good candidates for replacing OPs.

Recently, some concerns about the effect of NEOs on the ecosystem and mammals have been reported. The most representative ones associate NEO use with the deterioration of bee colony growth and the decline of insectivorous birds (7, 8). In vivo studies to identify the possible hazards of NEOs have proven that THM and CLO may induce dopamine release in rat striatum, as detected by a brain microdialysis study (9), and that THD increases thyroid hormone levels in rat plasma after a high-dose administration (10). However, health risks of NEO exposure in daily life have rarely been investigated in human studies except for case reports focused on suicide attempts or occupational settings (11, 12). First of all, epidemiological evidence available about the level of environmental NEO exposure encountered by the human body in daily life is scarce, although it is absolutely required for making a risk assessment of NEO.

Here we show that the NEO exposure level in the human body rose steadily in Japan from the mid-1990s when farmers started to use it in their fields.

Methods

Study subjects. All participants who attended healthcare checkup programs conducted in 1994, 2000, 2003, 2009 and 2011 were asked to donate a spot urine specimen to be stored at -80°C until analysis in the Kyoto University Human Specimen Bank (13). Random sampling from the stored specimen taken from female residents aged over 45 in Kyoto and the surrounding areas was conducted using statistic software JMP Pro 11. The Ethics Committees of the Nagoya University Graduate School of Medicine, Kyoto University Graduate School of Medicine and Nagoya City University Graduate School of Medical Sciences approved the study protocol.

Urinary NEOs and DAPs analyses. The concentrations of NEOs and DAPs in urine were measured according to the methods reported previously (14, 15). Two ''quality control'' urine samples were used in the urinary NEO and DAP assay. Urine samples were collected from three healthy volunteers who had neither received medication nor had been occupationally exposed to OP or NEO beforehand, and pooled for quality control urine; then, a standard NEO and DAP solution dissolved in acetonitrile was added. NEOs in urine are stable at -80°C at least 1 year.

Determination of creatinine in urine. Urinary creatinine concentrations were measured by high-performance liquid chromatography equipped with a UV detector according to a reference method established by the Japanese Committee for Clinical Laboratory Standards (16). Ten microliters of urine samples was diluted with 990 μL H_2O in a HPLC vial, and standard creatinine solutions were prepared at 2, 4, 6 mg/dL with H_2O in HPLC vials. Analysis was performed using the LaChrom Elute System from Hitachi (Tokyo, Japan). The apparatus used for HPLC consisted of the following: pump, L-2130; auto sampler, L-2200; column oven, L-2300, diode array detector, L-2455. The HPLC operating conditions were as follows: HPLC column, CAPCELL PAK SCX (Shiseido, Tokyo, Japan), 35 mm $\times$ 4.6 mm i.d., 5 μm; mobile phase, 10 mmol/L phosphate buffer (pH 5.75) containing 100 mmol/L sodium sulfate; flow rate, 0.7 mL/min; oven temperature, 40°C; photo diode array, 234 nm; injection volume, 10 μL. Within- and between-day precisions were 0.24% and 1.27%, respectively.

Data analysis. All statistical analyses were conducted using the JMP Pro Statistical Software, Version 11 (SAS Institute Inc., Cary, NC), and 2-sided P values of <0.05 were considered statistically significant. Undetectable urinary DAP concentrations were estimated as the value of the LOD divided by the square root of 2 (17), when geometric means (GM) were calculated.

Results

Indisputably, the detection rates of NEOs generally increased over the period while each NEO was not detected before it came into the market. Of the 7 NEOs, higher detection rates were found for THM and DIN in 2011, while the rates of CLO and NIT were relatively low compared to the other NEOs. The rates of THM and DIN were positively correlated to the sampling years. Along with the increase in the rates, individual total concentrations of urinary NEOs (Σ NEO, nmol/g creatinine) also clearly increased, suggesting that the levels of NEO

exposure in the Japanese increased over the period as well. Moreover, significantly positive correlations between the amount of domestic shipments of DIN and THM in Japan and detection rates of urinary DIN and THM were found. By contrast, there was an inverse relationship between the geometric mean of urinary dimethylphosphate (DMP) concentration and the sampling years. However, concentrations of other minor OP metabolites: diethylphosphate (DEP), dimethylthiophosphate (DMTP) and diethylthiophosphate (DETP), remained stable during the period.

Discussion

We recently reported that NEO could be detected in urine of Japanese adults, suggesting that they are likely exposed to several NEOs in their daily lives (14, 15). This finding is not surprising because NEOs are widely used today. However, the time when NEO started to be detected in human urine and how much people were exposed to it in their daily lives have remained unclear. The shipment of NEO ingredients has progressively increased over the past 20 years, except for that of IMI, ACE and NIT (4). In contrast, roughly 6 thousand tonnes of OP used in Japan have been consistently reduced to around 2 thousand tonnes for ten years since 2000. Thus, the trends of urinary NEO and OP metabolite levels during about 15 years starting from 1994 in Japan could reflect the amounts released into the environment in Japan. Unfortunately, well-designed surveys for detecting change over time of NEOs in the environment are limited. Thus, it is difficult to discuss the relationship between environmental NEO contamination, such as pesticide residue in water and food, and human exposure to NEO from a historical angle. However, a survey performed by the Japanese Ministry of Agriculture, Forestry and Fisheries showed that DIN was the most frequently-detected NEO in fruits and vegetables in 2011 (18). Yamamoto and colleagues (6) have reported that the highest geometric mean was found in DIN in water collected from rivers in Osaka City, which is southwest of Kyoto. Given that the median concentration level and detection rates of DIN in human urine in 2011 were higher than those of other NEOs, it might be concluded that human exposure levels to NEOs reflect their environmental contamination levels, even though the main exposure pathway into the human body is still unclear.

Conclusions

Our results show that detection rates of urinary NEOs in Japanese women increased significantly between 1994 and 2011, suggesting that intakes of NEOs into the human body rose during that period. In contrast, exposure to OP pesticides decreased steadily according to a finding that geometric means of urinary dimethylphosphate concentrations kept diminishing considerably. These changes may well reflect amounts of NEOs and OPs released into the environment in Japan.

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Use of hTERT and HPV E6/E7 mRNA RT-qPCR TaqMan Assays in Combination for Diagnosing High-Grade Cervical Lesions and Malignant Tumors

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Introduction

Human Papillomavirus (HPV) is a major causative factor of cervical cancer, the third of the most common cancer in women. About 16 HPVs (HPV16, 18, 31, 33, 35, 39, 45, 51, 52, 53, 56, 58, 59, 66, 68 and 69) are known to be main causes of cervical cancer, so for clinical settings in Korea, DNA chips for HPV genotyping are being used. However, even though the HPV DNA genotyping has 20%-50% higher sensitivity than Pap cytological diagnosis for cervical cancer, the specificity is 50% - 85% in the cells with normal cytology results, indicating limited usefulness of viral DNA marker. Therefore, in previous study we developed RT-qPCR E6/E7 of high risk HPV subtypes. Nevertheless, the positivity rate for the assay to diagnose high grade cervical lesions was 91%, implying the need for additional biomarker. Since E6 of HPV activates telomerase which induces immortalization and progression of cervical carcinogenesis, we developed an RT-qPCR targeting human telomerase reverse transcriptase (hTERT) mRNA, and evaluated the performance of the assay using with 545 ThinPrep® Pap samples. Subsequently, the combination of RT-qPCRs targeting hTERT mRNA and high risk group HPV E6/E7 were applied to the same 545 clinical samples, and the usefulness of combinational assay for diagnosis of high grade cervical lesion was evaluated.

Materials and Methods

Clinical sample: A total of 545 Liquid-based cytology samples were collected with ThinPrep PAP test (Hologic, MA, USA) (January 2010 and December 2011 from Yonsei University Wonju Severance Christian Hospital).

Total RNA isolation and cDNA synthesis: Total cellular RNA was isolated with the Isol-RNA Lysis Reagent (5 Prime, TEX, USA) according to the manufacturers' instructions. Complementary DNA (cDNA) was synthesized by M-MLV Reverse Transcriptase kit (Invitrogen, CA, USA) and random hexamers (Invitrogen, CA, USA) according with manufacturer's recommendations.

HPV E6/E7 and hTERT mRNA RT-qPCR assay: HPV E6/E7 mRNA RT-qPCR assay are able to detect 16 high risk HPV groups (HPV 16, 18, 31, 33, 35, 39, 45, 51, 52, 53, 56, 58, 59, 66, 68 and 69), with multiplex RT-qPCR. Cut off value of HPV E6/E7

mRNA RT-qPCR was Ct 40. hTERT mRNA expression levels relative to reference gene GAPDH were automatically calculated using the comparative Ct method by CFX Manager Software v1.6 (Bio-rad). Cut-off value for distinguishing between positive and negative results was the relative hTERT mRNA expression level 10. hTERT mRNA expression levels relative to reference gene GAPDH were automatically calculated using the comparative Ct method by CFX Manager Software v1.6 (Bio-rad). Cut-off value for distinguishing between positive and negative results was the relative hTERT mRNA expression level 10.

Results

The positivity for the HPV E6/E7 messenger RNA (mRNA) assay was 94.4%, 95.2%, 82.4%, 46.5%, 25.0%, and 1.1% in squamous cell carcinomas (SCC), high-grade squamous intraepithelial lesions (HSILs), atypical squamous cells— cannot exclude HSIL (ASC-H), low-grade squamous intraepithelial lesions (LSIL), atypical squamous cells of undetermined significance (ASC-US), and normal cytology samples, respectively. Five cervical intraepithelial neoplasia grade 2+ samples were not detected by the HPV E6/E7 mRNA assay, but they exhibited positive signals in the hTERT mRNA assay (Table 1). Notably, the hTERT mRNA expression level was increased in high-grade cervical lesions but was very low in all 288 normal samples.

Table 1. Comparison of HPV E6/E7 and hTERT m RNA RT-qPCR in cytological diagnosis

Cytology	hTERT positive cases		hTERT negative cases	
	HPV E6/E7 positive cases (%)	HPV E6/E7 negative cases (%)	HPV E6/E7 positive cases (%)	HPV E6/E7 negative cases (%)
SCC	15/18 (83.3)	1/18* (5.6)	2/18 (11.1)	0/18 (0)
HSIL	20/21 (95.2)	1/21* (4.8)	0/21 (0)	0/21 (0)
ASC-H	14/17 (82.4)	3/17 (17.6)	0/17 (0)	0/17 (0)
LSIL	17/101 (16.8)	21/101 (20.8)	30/101 (29.7)	33/101 (32.7)
ASC-US	9/100 (9)	31/100 (31)	16/100 (16)	44/100 (44)
Normal (HR-HPV+)	0/90 (0)	0/90 (0)	3/90 (3.3)	87/90 (96.7)
Normal (HR-HPV-)	0/198 (0)	0/198 (0)	0/198 (0)	198/198 (100)

Abbreviations; SCC: squamous cell carcinoma, ADC: adenocarcinoma, HSIL: high grade squamous intraepithelial lesion, ASC-H: atypical squamous cells-cannot exclude HSIL, LSIL: low grade squamous intraepithelial lesion, ASC-US:

atypical squamous cells of undetermined significance. HR DNA+: high risk DNA genotypes positive, HR DNA- : high risk DNA genotype negative

Conclusions

The sensitivity and specificity of HPV E6/E7 mRNA RT-qPCR were 91% and 96.7% when we compared with the cytological diagnoses. HPV E6/E7 mRNA RT-qPCR assay had advantage that all of 16 high risk HPVs, which are associated to cervical cancer. Combined application of HPV E6/E7 and hTERT mRNA RT-qPCR assay showed 100% sensitivity. Among 56 high grade cervical lesions, which include SCC, HSIL, and ASC-H samples, 49 (87.5%) were HPV E6/E7 and hTERT mRNA positive, 2 (3.6%) were HPV E6/E7 mRNA positive only, and 5 (8.9%) were hTERT mRNA positive only.

These data suggest that the combination of HPV E6/E7 and hTERT mRNA expression levels could be used in a complementary manner in diagnosing high-grade cervical lesions and malignant tumors and might be useful as a predictive marker in monitoring low-grade cervical lesions.

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Abstracts

Radiological Technology

2015 Yonsei-Nagoya University Joint Symposium on Radiological Technology

11:00~12:20	Session I	Chair: Prof. Akiko Ihori

11:00~11:20	Monte Carlo Modeling of The LEKCELL GAMMA Knife PERFECTION^{TM} for Small Field Dose Validation using Geant4
	Hyun Joon Choi (Yonsei Univ.)

11:20~11:40	A Study on the Analysis of Cortical Thickness in Adolescents with Internet Addiction
	A Reum Min (Yonsei Univ.)

11:40~12:00	Differences of Structural Brain Network Properties Between Patients with Obstructive Sleep Apnea and Healthy Subject
	Min-Hee Lee (Yonsei Univ.)

12:00~12:20	Development of Radiation Portal System based on Energy Weighted Algoritm
	Hyun Cheol Lee (Yonsei Univ.)

12:20~14:00	Lunch

14:00~15:20	Session II	Chair: Prof. Kuniharu Imai

14:00~14:20	Characteristics of Liquid Crystal Display
	Akiko Ihori (Nagoya Univ.)

14:20~14:40	Study of Physical Image Properties on a Direct-type CMOS Imager with Conventional Mammography Devices
	Chizuru Okamoto (Nagoya Univ.)

14:40~15:00	Verification of Multi-point Source Method to Assess Annual Effective Dose by Usage of NORM Added Consumer Products
	Do Hyeon Yoo (Yonsei Univ.)

15:00~15:20	Development of a Patient Dose Calculation Algorithm Using TOPAS Monte Carlo Toolkit for Passive Scattering Proton Therapy
	Wook-Geun Shin (Yonsei Univ.)

15:20~15:40	20 Minute Coffee Break

15:40~17:00	Session III	*Chair: Prof. Chul Hee Min*

15:40~16:00	Adaptation of Effective Atomic Number for Proton Therapy
	Ryota Shimokomaki (Nagoya Univ.)

16:00~16:20	Appearance of Stochastic Resonance on Computed Tomography and its Application
	Yuki Yamamoto (Nagoya Univ.)

16:20~16:40	Gate Monte Carlo Simulation Study on 6 MV Photon Beam Characteristics for Dual Head LINAC Modeling
	Han Kyeol Song (Yonsei Univ.)

16:40~17:00	Feasibility Study for Spectral Unfolding of Clinical Megavoltage Phton Beams with Transmission Method
	Hyo Jun Park (Yonsei Univ.)

※ 15 minutes presentation and 5 minutes Q&A

Monte Carlo Modeling of the Leksell GammaKnife Perfexion™ for Small Field Dose Validation using Geant4

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Introduction

Radiation therapy using small-filed photon-beam such as stereotactic radiosurgery have the advantage of imparting radiological damage to the target while minimizing dose to adjacent healthy tissue. The Leksell Gamma Knife Perfexion™ (LGK-PFX) is a stereotactic radiosurgery device that is used for the treatment of tumors or malfunctioning nerves or blood vessel defects, especially small targets in the brain. However small photon beams have increased the uncertainties in clinical dosimetry because of steep dose gradients and very small dose distribution leading to the loss of lateral electronic equilibrium and the various perturbations in detector. Monte Carlo (MC) method is a promising alternative option for small field dosimetry because it allows a detector size of zero, eliminating spatial effects, and it is possible to eliminate the perturbing effects of dose measurement. The aim of this study is to develop the LGK-PFX radiosurgery system using Monte Carlo method to accurately assess the dose distribution in the small field..

Materials and Methods

The Elekta LGK-PFX radiosurgery system was modeled in Geant4 toolkit by simulating the collimation system and 192 Cobalt-60 sources.
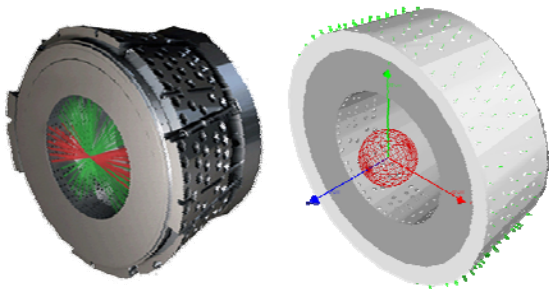
Figure 1. The LGK-PFX radiation unit (left) and modeled Gamma Knife in Geant4 (right).

The Elekta LGK-PFX contains 192 Cobalt-60 sources distributed in eight sectors. Each sector composed of 24 sources can be moved independently and each source placed over narrow collimator of three different sizes (e.g. 4mm, 8mm, 16mm). The holes and sources are targeted at one point, the isocentre, forming a ellipsoidal dose distribution with a narrow penumbra. All sources are modeled as a cylinder 17 mm long, 1mm in diameter and 1.17, 1.33 MeV radiation emitted in the uniform cylindrical distribution randomly. We assumed that each cobalt pellets are of the same dimensions and activity. The axis of source is perfectly aligned only with 4 mm hole collimation; sources slightly rotate and shift from the axis of 8, 16 mm hole collimation. The collimators are composed of multiple sections with cylindrical shape. We modeled 72 pipes composed of 5 different cylinder with holes of different size to describe

elements of this geometry and used a boolean volume (G4SubtractionSolid) to put the pipes in a complex shape of the whole collimation system. The spherical polystylene water phantom with a diameter of 16 cm used for LGK-PFX dosimetry. For the measurement of dose distribution, two radiochromic films were used and two planes (coronal, sagittal) of dose distribution in the water phantom were measured.

In this study, we used the Geant4 toolkit (ver. 4.10.00.p02) developed with the C++ programming language with object-oriented techniques. Geant4 have great advantage of adding our own descriptions of processes freely. Therefore LGK-PFX radiosurgery system was designed calculating dose distribution by one sector changing each sector settings eight times automatically according to the initial settings. Because the photons emitted isotropically from cobalt sources reach the narrow holes in collimator with only a negligible fraction of them, we employed some direction biasing as a variance reduction technique. For the time-effective simulation, photons are targeted into a 5 degree cone shape. The phase-space file was recorded on the spherical plane of 0.1 mm thickness in inner cavity of LGK-PFX system. Total 4.8×10^9 primary gammas were used for calculation of each dose distribution in 4, 8, 16 mm settings and it took almost 300 CPU-hours for the simulation of each collimator. For three-dimensional dose distribution, 4.5 cm x 4.5 cm x 4.5 cm box with 100 x 100 x 100 grid was placed at the center of the phantom and scoring mesh which is the standard command-based scoring of Geant4 was used.
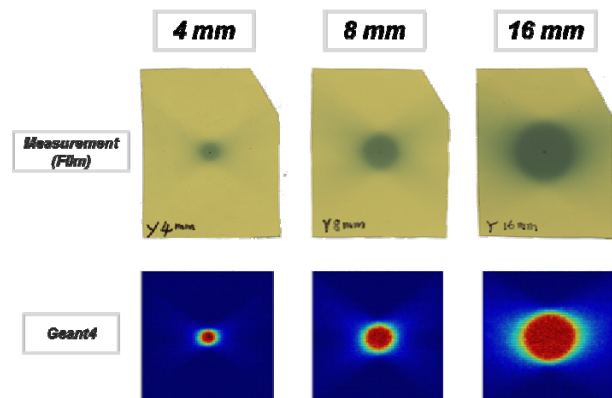
Results and Discussion

Figure 2. Three radiochromic film images used in measurement (top row) and calculated dose distribution planes from each collimator (bottom row).

The calculated three-dimensional dose distributions in 4.5 cm x 4.5 cm x 4.5 cm scoring box show that collimation system is at least roughly aimed properly. We obtained relative dose profiles along x, y, z axis for all collimator size and those are compared to measurement data. Usually LGK-PFX dosimetry uses the film because it is well-suited for dosimetry of the 4 mm collimator if it is positioned properly. For the appropriate dose

evaluation, the resolution of the scanner should be good to describe sharp gradient of profile. The resolution of the film scanner was 0.0847 mm . Three radiochromic films show the measured dose distribution. The films are punched at the center for accurate positioning and the sharp peaks of the relative dose profiles are caused by the hole at the center of the film. For the comparison between calculate and measured dose profile, calculated profile was normalized to the average value in the plateau region of the measured relative dose profile except sharp peaks. The full widths at half maximum (FWHM) of each profiles were evaluated by the reference values provided by Elekta. The reference FWHMs for 4, 8 and 16 mm collimators are 6, 10.8 and 21.3 mm, respectively. FWHMs of calculated and measured dose profiles agreed well within 0.7 mm in all cases.

According to the different combination of beam size, the dose distribution calculated by in-house developed Gamma Knife radiosurgery system in Geant4 was compared to that calculated by commercial TPS. As a result of comparison, we found that overall tendency of dose distribution was almost same.
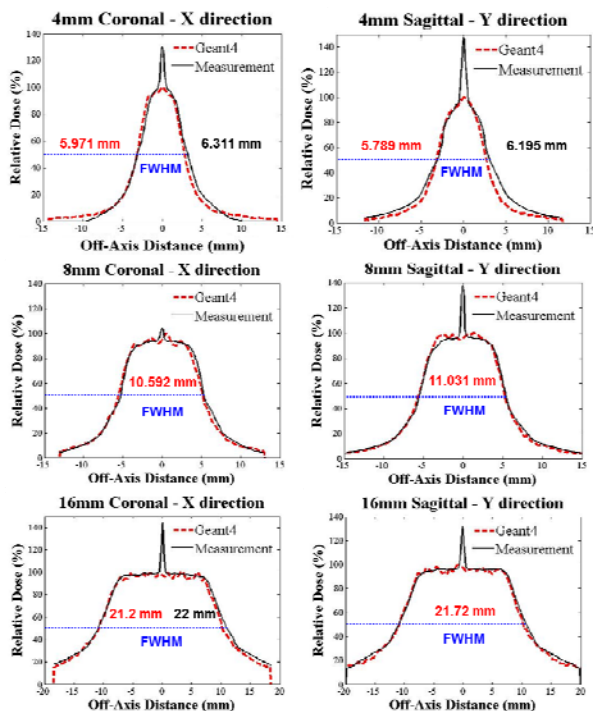
Figure 3. Relative dose profile comparisons between measurement and calculation in Geant4 for each collimator along the x, y axes.

Conclusions

The Elekta LGK-PFX was modeled and radiosurgery system was developed using Geant4. As a result of evaluation of MC calculated dose and measured dose, FWHMs of dose profiles agreed well with reference value within 0.42, 0.7 mm, respectively. Therefore, our MC simulation study showed potential to accurately determine the dose distribution in Gamma Knife radiosurgery. In the future, we will focus on absolute dose in small field and dose distribution in diverse MR-based phantoms through measurement and commercial TPS.

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A Study on the Analysis of Cortical Thickness in Adolescents with Internet Addiction

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Introduction

Adolescence is very important period. That is encompassed by alterations in psychological and social development [1]. The relatively immature cognitive control ability makes this period a time of vulnerability and adjustment and may lead to a higher incidence of affective disorders and addiction among adolescents[2,3]. As on of the common mental health issue is internet addiction (IA). IA called pathological or problematic internet use. This phenomenon may eventually result in marked distress and functional impairments of general life such as social interaction, academic performance and behavior problems[4]. Unfortunaty, there is currently no standardized diagnosis and treatment for IA due to the lack of a clear understanding of the mechnism underlying this disease[5]. To date, few neuroimaging studies had been founded brain structural and functional alteration associated with IA[6]. Therefore, we compared differences in IA group and healthy control group by measuring the cortical thickness.

Materials and Methods

Subjects: We compared 15 subjects (7 female) with IA and 15 healthy control subjects (7 female). Age range of all subjects is 11-18 years old. Each subject was matched for age and handedness. In this study, we employed Internet Addiction Test to classify the subjects into IA or control group.

Data acquisition: Magnetic resonance imaging was performed on a 3 Tesla scanner (Simens, Erlangen, Germany). T1-weighted images were obtained by a magnetization prepared rapid acquisition gradient echo (MPRAGE) sequence for cortical thickness measurements with the following parameters: TR =2000 ms, TE = 3.55, flip angle = 8°, slice thickness = 1mm, acquisition matrix = 256 x 256.

Image processing: The Freesurfer 5.3.0 package was used to make a cortical surface of 3D model for measuring cortical thickness. This package that provides a semi-automated method to investigate brain morphometry. The surface based stream involves (1) nomalization of brain signal intensity, (2) skull-stripping, (3) delineation of the gray-white interface (inner surface) and (4) tracing of the pial(outer surface)[7,8]. The distance between equivalent vertices in these two surfaces represents the cortical thickness. We investigated differences in cortical thickness between IA and control group. For the statistical analysis, we used one-way ANOVA.

Results

The results presented more reduction cortical thickness of both hemispheres in patient with IA group than healthy control group. In both hemispheres, significant cortical thickening was found lateral orbito frontal, rostral middle frontal, superior frontal, precuneus, lingual, and superior parietal regions. In left hemisphere, significant cortical thickening was found inferior parietal, precuneus, superior temporal and cuneus regions. In right hemisphere, significant cortical thickening was found precentral, superior parietal, insula, caudal anterior cingulate and entorhinal regions (Figure.1 and Table.1).
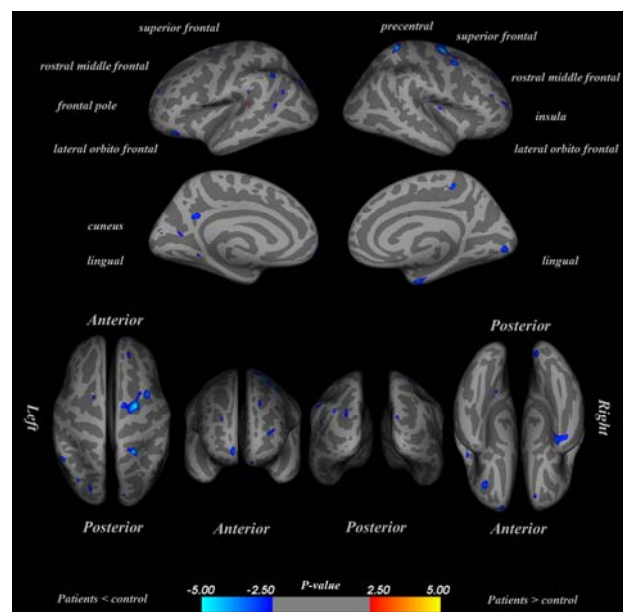
Figure 1. Significant differences between patient with IA and healthy control group (p<0.05)

Discussion

Our results showed reduced cortical thickness in the both hemispheres orbito frontal cortex (OFC). The OFC is related in decision making and reward function[9]. This result demonstrated that the abnormal structure of the OFC was associated with impaired executive function among adolescents with internet addiction[4]. Also, IA decreased visual cortex(lingual and cuneus regions) and motor cortex(superior frontal and precentral regions). This result may be associated

with the excessive exposure to excessive visual stimulation and repetitive mouse click during the internet online game play[10].

Conclusions

In this study, we found differences between patient with IA group and healthy control group in OFC, motor and visual cortex of the reduced cortical thickness. Our findings suggested that the cortical thickness abnormalities of these regions may be affected in the compulsive internet use.

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Differences of Structural Brain Network Properties Between Patients with Obstructive Sleep Apena and Healthy Subjects

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Introduction

Obstructive sleep apnea (OSA) is a common clinical sleep disorder. Patients with OSA are characterized by exposing intermittent hypoxia which causes injuries in some regions of the brain tissues and show the deficits of autonomic, cognitive and mood functions [1]. It is understood that the structural connectivity of the brain underlies the brain functions may be affected from the regional abnormalities of the brain [2]. Injuries of brain tissue are not clearly identified by T1-, T2-weighted images [3].

Diffusion tensor imaging (DTI) facilitates modeling the human brain as a network of brain regions connected by anatomical tracts defined by tractography. Network analysis can help to investigate assumed abnormalities of connectivity in neurological and psychiatric disorders and allows the quantitative analysis of network organization, describing the connections of the brain as a collection of nodes (brain regions) that communicate by connecting edges (white matter tracts) [4]. This analysis has been used beneficially for neurological and psychiatric disorders.

In this study, we examined the regional abnormalities in white matter of patiient with OSA using fractional anisotropy (FA) and revealed the regional alterations of the brain connectivity in patients with OSA.

Materials and Methods

Data acquisition and pre-processing: DTI data were collected using 1.5 Tesla MRI scanner (General Electric) with the following acquisition parameters: TR = 15000 ms, TE = 93.8 ms, diffusion gradients along 15 non-collinear directions with b = 1000 s/mm^2 after the acquisition of b = 0 s/mm^2 image. We analyzed DTI data from a total of 32 subjects, including 16 healthy subjects and 16 patients with OSA, matched for age, sex, education, apoE genotype. Each diffusion image was corrected for some distortion using FSL. We used nonlinear tensor image registration algorithms for spatial normalization, and performed tractography using the Fiber Assignment Continuous Tracking algorithm.

Network Construction: To observe the regional characteristic, we constructed the brain network using dataset derived from tractography. For this, we used the automated anatomical labeling template which was parcellated into 90 regions of cerebrum, each representing a node of the brain network [4]. Two nodes (i.e., brain regions) were connected by an edge (i.e., tracts) if any endpoints of fiber exist in both regions. Constructed brain network is shown in Fig. 1.
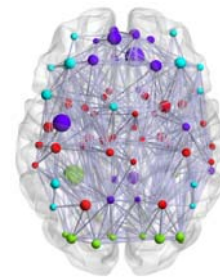
Figure 1. Visualization of structural brain network

Fractional anisotropy: The FA indicates the microstructural integrity of the white matter. We firstly calculate the FA for each voxel and then the FA maps were smoothed (full width half maximum = 8 mm). To analyze FA in white matter, we used a white matter mask segmented from standard space and FA values greater than 0.2. We then compared FA values at each voxel between healthy subjects and patients with OSA. In this comparison, the statistical threshold for significance was p < 0.001 and the minimum cluster size was set at 15 contiguous voxels.

Regional efficiency: The regional efficiency of any node i defined as inverse of the harmonic mean of the minimum path length between an node i and all other nodes in the network. The regional efficiency measures the average path length between any node and the remainder nodes in the network and reflects the integration of each node. We compared regional efficiency for each brain region to determine the abnormal regions in subjects with OSA.

Results

Patients with OSA showed lower FA compared with healthy subjects in some brain regions, including right inferior frontal gyrus (Fig. 2(b)), bilateral thalamoparietal fibers passing through parietal white matter (Fig. 2(a),(c)). On the other hands, right capsula interna (Fig. 2(d)) are showed higher FA in patients with OSA.

In the comparisons of regional efficiency, we found that patients with OSA showed significant lower regional efficiency in right precentral gyrus, left insula, posterior cingulate, inferior occipital gyrus, and bilateral supplement motor area, and higher in right orbitofrontal, superior frontal gyrus, precuneus, left thalamus and bilateral temporal gyrus than healthy subjects (p < 0.05; Fig. 3).
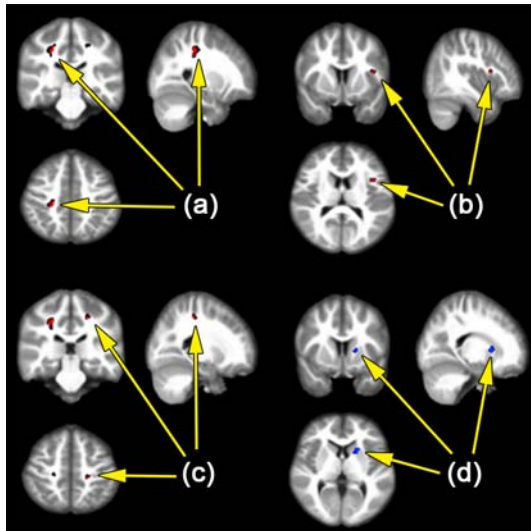
Figure 2. **The comparison results of FA. Regions with reduced FA in OSA involved bilateral thalamoparietal fiber (a) (c), right inferior frontal lobe (b). Right capsula interna (d) with increased FA in OSA.**
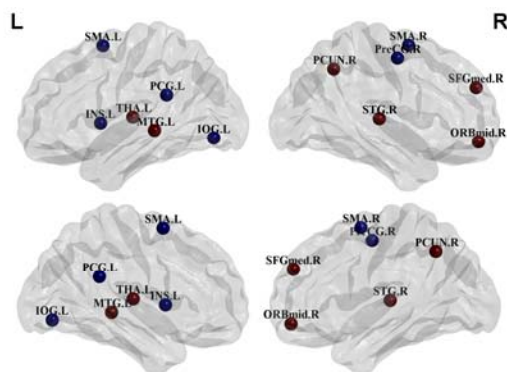

Figure 3. Alteration of regional property in OSA. Blue circles present reduced regional properties in OSA and red circles present increased regional properties in OSA.

Discussion

From VBA of FA, we found the abnormalities in right inferior frontal gyrus and bilateral thalamoparietal fibers pathway between parietal lobe and thalamus. Decrease of FA means that brain tissues were injured and it is considered to be related to alterations of pathway passing through injured brain regions. Additionally, increment of FA was observed in right capsular interna. It is considered to be related to the higher myelination and less branching in neural level and the fibers from thalamus to the frontal lobe pass through the right capsular interna.

In the network analysis for the regional property, we found increase and decrease of regional efficiency in patients with OSA. This result denotes that the structural brain networks undergo rewiring during the course of the illness. Our results provided the evidence for the altered structural connection of the brain which may affect the cognitive, emotional functions and autonomic regulations explained in the following paragraphs.

Patients with OSA frequently show mild cognitive impairment and high incidence of dementia [5]. The cognitive impairment associated with OSA may result from abnormality of brain regions in cingulate, prefrontal, temporal [3]. Patients with OSA also showed emotional

problems due to the disturbance in the limbic system, including cingulate gyrus and insula [3]. Insula is related to breathlessness and plays an important role on the regulation of emotions including anger, sadness, and fear [6].

Sleep-disordered breathing is high risk factor of cardiovascular disease [7]. Cardiovascular regulations are related to cingulate, prefrontal cortex [3]. Additionally, the important role of thalamus is regulation of the sleep-wake cycle and alterations of these cycle may induce irregular blood pressure rhythms or increase of the cardiovascular mobidity. Motor cortices have functional connections with the brainstem and ventrolateral medulla which control heart, blood pressure and breathing [8]. Moreover, the structural alterations in precentral gyrus and supplementary motor area result in increasing the load of upper airway and respiratory muscles, which appears to be related to the repetitive pauses of breathing during sleep and OSA may, therefore, become more serious.

Conclusions

We studied the regional neural damages in the OSA patients' brain using VBA of FA and changes of the structural connection using network analysis. OSA patients showed the injuries of white matter in four regions and increase or decrease of regional network properties in various brain areas. Since our findings provide the relation between the regional properties and typical OSA symptoms, brain network analysis can be used to disclose potential functional deficits in OSA patients.

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Development of Radiation Portal Monitoring System based on Energy Weighted Algorithm

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Introduction

To prevent and restrain nuclear terrorism, many radiation portal monitoring (RPM) system have been installed and operated on main ports of South Korea such as port of Incheon, Busan, and Pyeong-taek [1]. In RPM system, plastic scintillation detectors are usually included, because of their easy figuration and low cost for large detection area, but there is limit on radionuclide analysis by its poor energy resolution [2].

In previous study, energy weighting algorithm was developed using the Monte Carlo method and small plastic scintillation detector to discriminate natural isotopes and artificial isotopes [3]. In measured energy spectrum through the plastic scintillation detector, counts on each bin were multiplied with its energy of bin and the method was able to discrimination of radionuclide by changing the Compton edge of isotope to clear peak in re-calculated spectrum (energy weighted spectrum).

But small plastic scintillation detector showed limitation of detection efficiency, so we constructed test RPM system based on large sized plastic scintillation detector and evaluated the energy weighted algorithm in this study.

Material and Methods

For the verification of the energy weighted algorithm, polyvinyl toluene (PVT) (BC-408, Saint-Gobain Ind.), plastic scintillation detector, of $50 \times 100 \times 5$ cm^3, light guide (BC-802, Saint-Gobain Ind.), photo-multiplier tube (9266B, ET enterprises Ltd.), pre-amplifier (Ortec 113, Ametek Inc.), amplifier (Ortec 575A, Ametek Inc.), and digitizer (PXI-5105, National Instrument Inc.) were connected for construction of test RPM system. And using LabVIEW (Ver. 2014, National Instrument Inc.), user interface which can realize signal processing and presenting energy spectrum was developed (Fig. 1).

In measurement, ^{133}Ba, ^{137}Cs, and ^{60}Co (> 80 μCi) were used and source to detector distance was 100 cm with 2 minute of measurement time.
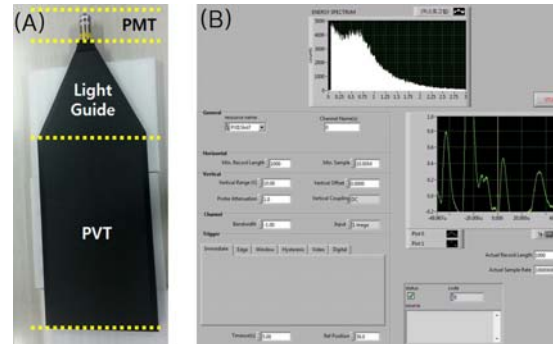
Fig. 1. (A): PVT plastic scintillator combined with light guide and PMT (B): Graphic user interface.

For the energy calibration, the Monte Carlo method and Gaussian broadening method was applied [4, 5].

The measured energy spectrum was converted to the energy weighted spectrum through the following equation:

$$C_{EW,i} = C_i \times E_i, \tag{1}$$

where $C_{EW,i}$ is the energy-weighted count of the ith bin of the optical photon distribution, and the original optical photon count and the energy in the ith bin are C_i and E_i, respectively.

And peak location in energy weighted spectrum was compared with theoretical Compton edge of each radionuclide to evaluate the energy weighted algorithm.

Results and Discussions

In this study, module test of RPM system was

performed about PMT, pre-amplifier, amplifier, and digitizer for appropriate signal processing. By comparing with energy spectrum measured from commercial used multi-channel analyzer (Ortec digiBASE, Ametek Inc.), the optimal parameter of each module was decided as 1.0 kV of high voltage, 100 pF input capacitance of pre-amplifier, 0.5 μsec shaping time and 160 gain of amplifier.
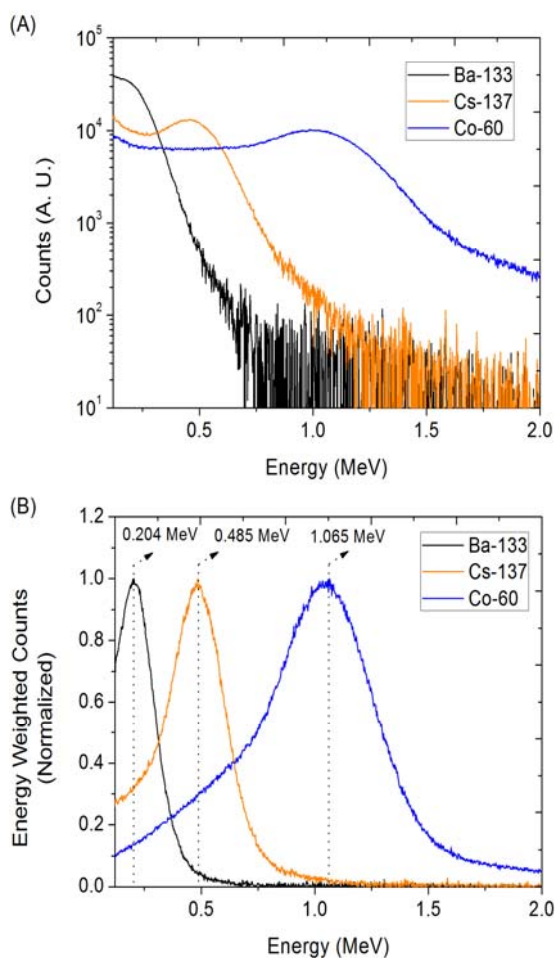

Fig. 2. (A) Measured energy spectra of ^{133}Ba, ^{137}Cs and ^{60}Co, and (B) its energy weighted spectra.

Figure 2-(A) is showing energy spectra of ^{133}Ba, ^{137}Cs, and ^{60}Co, and the spectra have low statistical fluctuation because of high radioactivity of 80 μCi and large detection area. Also, in the energy weighted spectra converted from energy spectra, the peak location of ^{133}Ba, ^{137}Cs, and ^{60}Co were 0.204, 0.485, 1.065 MeV, respectively, those have error of 0.48%, 0.42%, and 0.29% with theoretical Compton edge location.

Conclusions

In this study, test RPM system consist of plastic scintillation detector, signal processing device, and user interface based on LabVIEW for checking energy spectrum was constructed. Through energy spectrum measurement of ^{133}Ba, ^{137}Cs, and ^{60}Co, the energy weighted algorithm showed good discriminating performance of radioisotopes by comparing the peak location error of energy weighted spectrum with the Compton edge energy in energy spectrum.

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Characteristics of liquid crystal displays

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Introduction

Medical image diagnostic systems are shifting from hard copy to soft copy. Especially because of the very small size of detected calcifications in mammography diagnosis, digital images require a fine pitch and a large matrix size. Therefore, liquid crystal displays (LCDs) with 5 million (5M) pixels are recommended for the interpretation of a mammogram. In clinical practice, however, it is not uncommon for radiologists to observe mammography images using LCDs with 2 million (2M) or 3 million (3M) pixels for multi-modality workstations.

It is important to evaluate the characteristics of displays and to carry out maintenance management in medical facilities that use LCDs. Therefore, as one factor of the image quality of a display, a modulation transfer function (MTF) was measured to evaluate the sharpness of the image.

We also visually evaluated mammography images displayed on LCDs with different numbers of pixels, which are commonly used in hospitals. The purpose of our study is to determine whether the detection rate of images using a reduced pixel size of 2M and 3M is decreased compared to that of the recommended 5M-pixel LCD. In addition, a variety of interpolation methods can be used to reduce image sizes but the method currently used in the medical field is generally the bilinear method. In this study, images were reduced using bilinear interpolation and other methods of interpolation to determine a method that does not reduce the signal detectability even for a high reduction ratio.

Ⅰ. Physical evaluation
Materials and Methods

The method used here is based on "a periodic rectangle wave composition of a fundamental frequency and harmonics, which are sine waves" [1] as shown in Fig. 1.
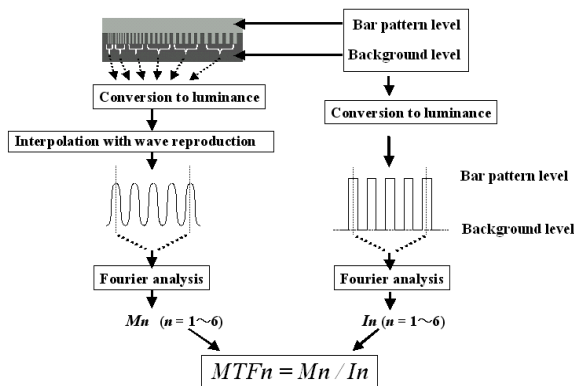
Fig. 1. Outline of the MTF measurement method using frequency analysis of a bar pattern image.

The bar pattern was displayed at the center of the display, and a photograph was taken with a digital camera equipped with a macro lens. We took pictures of the bar pattern in horizontal (portrait) and vertical (landscape) directions.

The data for exact integer cycles of the bar patterns were extracted from an output waveform. The amplitude value of a fundamental frequency of the bar pattern was calculated and the MTF was computed. We used monochrome LCDs with 1M, 2M, 3M, and 5M pixels. The displays with 2M pixels used two different systems, an in-plane switching (IPS) system and a vertical alignment (VA) system [2], for which the liquid crystal operation mode differs. The monochrome LCDs with 3M and 5M pixels were examined with and without a protective filter. Two or three displays are used for each system. Table 1 shows specifications of the monochrome LCDs.

Table 1 Specifications of monochrome LCDs.

LCDs	Number of pixels of LCDs	Pixel pitch [mm]	Liquid crystal operation mode	Filter	Number
1M	1280×1024	0.2805	IPS	−	2
2M	1600×1200	0.255	VA	○	3
		0.270	IPS	○	3
3M	2048×1536	0.207	IPS	−	3
				○	3
5M	2560×2048	0.165	IPS	−	3
				○	3

Results & Discussion

For the horizontal direction of the monochrome LCDs, the MTF of the 5M-pixel display is the highest, decreasing proportionally for the lower-resolution displays. No difference was seen when using a protective filter. For the monochrome LCDs, the MTF in a horizontal direction was higher than the MTF in a vertical direction. Figure 2 shows the enlargement of the pixel when displaying a bar with one pixel on the monochrome 3M LCD. The yellow squares indicates one pixel. An individual display pixel consists of six sub-pixel regions.
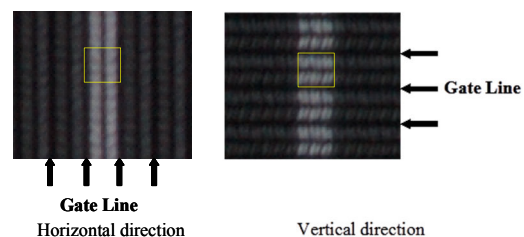

Fig. 2. Enlargement of the pixel when displaying a bar with one pixel on the monochrome 3M LCD.

For the horizontal direction, a bar with one pixel and gate line become parallel but for the vertical direction, they become perpendicular. Therefore, the width of a bar with one pixel in the horizontal direction was effectively narrower than the width of a bar in the vertical direction.

Conclusions

We measured the MTFs of monochrome displays. The MTFs of the LCDs were affected by the difference in pixel size and shape, the structure and operation mode of the liquid crystal, and the number of pixels.

Ⅱ. Visual evaluation

Materials and Methods

We examined the influence of differences in LCD image-reduction rates on the signal-detection performance by observational experiments. Since a phase contrast mammography (PCM) image has the largest numbers of pixels among medical images, we used a PCM image as the original image in this study. The PCM images of the tissue-equivalent phantom model 011A, manufactured by Computerized Imaging Reference Systems (CIRS, Norfolk, VA, USA), were recorded using the PCM equipment at 28 kV and 50 mAs. The phantom is realistically shaped and has the tissue properties of an average, firm breast. Breast detail components closely mimic the radiographic properties and shapes of normal and pathological breast structures, as shown in Fig. 3.
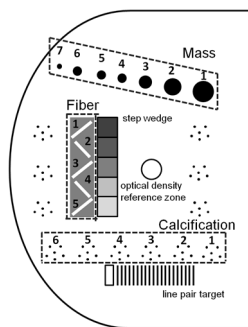
Fig. 3. Certification phantom CIRS, model 011-A used for experimental tests. We observed seven masses, five fibers, and six groups of six calcifications.

The phantom image was reduced using bilinear, bicubic, and nearest-neighbor interpolation methods, pictured in Fig. 4. The image-reduction rate, shown in Table 2, was calculated as the ratio of the number of pixels per LCD to that of the reduced image when the phantom image was displayed on LCDs of 2M, 3M, and 5M pixels. The reduced images were displayed on a 5M-pixel LCD using the ImageJ software program, and the signal-detection performance with each interpolation method was examined. The observers were ten radiological technologists with two to 10 years of experience in the mammography field. They observed

the reduced images and reported whether any signals could be detected. The observers followed the detailed procedures outlined in the ACR's Mammography Quality Control Manual[3] to score phantom images.
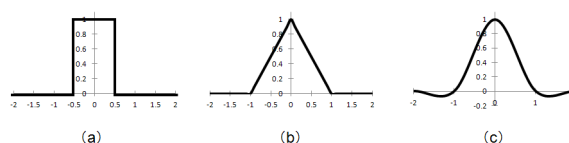
Fig. 4. Interpolation functions for (a) nearest-neighbor, (b) bilinear and (c) bicubic methods.

Table 2 Image-reduction rate

LCDs	Number of pixels of LCDs	Reduction rate	Number of pixels of reduced images
2M	1200×1600	16.87%	1194×1599
3M	1536×2048	21.60%	1529×2047
5M	2048×2560	27.00%	1911×2559
5M (split-screen display)	1024×2560	14.46%	1023×1370

Results & Discussion

The mass detection rate was the highest for the bilinear reduction of the 3M-pixel image. The signal disappeared when the image was small, and the signal to noise ratio (SNR) of the signal was low when the image was large. The detectability of calcifications decreased as the image size reduced. The difference in reduction rate had a minor impact on the detectability of fibers. For most sizes, the bilinear method increased the detection rate and the nearest-neighbor method had the lowest detection rate.

Conclusions

When displaying PCM images on LCDs that have a small number of pixels, the signals of calcification disappear. The visibility deteriorates and the display size of the mass is too small or too large. The bilinear method could be used to calculate the mean of neighboring pixels, thus providing a smoothing effect. As the noise is decreased by smoothing, the rate of detection with the bilinear method is increased.

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Study of Physical Image Properties on a Direct-type CMOS Imager with Conventional Mammography Devices

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Introduction

Cancer is one of the most prevalent killers of Japanese people and is recognized as a national disease. Breast cancer is the most common form of cancer to be diagnosed in Japanese women, and ranks fifth in the number of deaths caused by cancer that women suffer from [1]. These numbers are increasing year by year. However, if we enable early detection and treatment, we will be able to achieve a high cure rate. Breast cancer examinations and screening mammography are essential for the early detection and prevention of breast cancer.

Mammography is an effective technique in the detection of small masses and calcification. While some calcifications have nothing to do with cancer, one common early sign of cancer is microcalcification depicted lightly, and it is necessary to perform highly accurate screenings to recognize them. Therefore, the use of high quality detectors with high spatial resolution is essential. A detector with an extremely small pixel size has recently been developed and is used in clinical applications. The smallest pixel size in detectors which meet the specification standards of the Japan Radiological Society (JRS) is 50 microns [2], and is equipped in mammography devices used in clinical.

In this study, we examined the physical image properties of a detector with a pixel size of 50 microns developed for mammography. There are many high-definition mammography devices equipped with direct-type flat panel detectors (FPD). Amorphous selenium (a-Se) film is used in direct-type FPD. The a-Se film is known to be inferior in its temperature properties. However, new a-Se film was developed, which has superior heat resistance and is fit for high electric field driving. We considered the applicability of the detector using the a-Se film with complementary metal oxide semiconductor (CMOS) integrated circuit for clinical use. First, we calculated the detective quantum efficiency (DQE) with changing applied voltage to the a-Se film. Secondly, we compared the physical image properties of this detector with those of the conventional mammography systems.

Materials and Methods

Proposed mammography system: The direct-type flat panel detector (FPD) developed by the Electron Tube Division, HAMAMATSU PHOTONICS K.K was used. The CMOS integrated circuit is used (referred to as the CMOS imager). We used the X-ray unit (Mermaid, KONICA MINOLTA) and set the CMOS imager on the table of X-ray unit.

For comparison: We used the conventional systems AMULET Innovality (FUJIFILM Corporation) and MicroDose SI (Philips). The equipped detector in AMULET is a direct-type FPD of current integration mode, and is a silicon (Si) detector of photon counting type in MicroDose. Tungsten (W) is used as an anode material in both. The filter is rhodium (Rh) plate in AMULET and aluminum (Al) plate in Microdose. Both pixel sizes are 50 microns.

The geometries of the CMOS imager and the conventional imager are shown in Fig. 1.
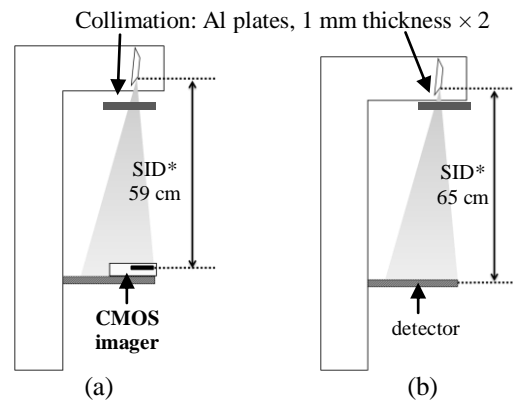

Fig. 1 Geometries of
(a) the proposed mammography system, and
(b) conventional mammography for comparison.
*SID: source-image receptor distance

Study items: 1. Physical image properties of CMOS imager with changing applied voltage: We measured about the difference of the applied voltage to the detector elements (-0.5, -0.8, -1, -2, and -3 kV). To calculate the DQE, we measured the pre-sampled modulation transfer function (MTF), Wiener spectrum (WS) and the number of incident photons per unit area.

$$DQE(u) = \frac{MTF^2(u)}{the\ number\ of\ incident\ photons \times WS(u)} \quad (1)$$

It is difficult to measure directly the number of incident photons. Therefore, we used the coefficient referring to the International Electrotechnical Commission (IEC) 62220-1-2 standard to calculate this easily. The coefficient is set in the quality of radiation, which is decided by half value layer (HVL). We measured HVL with the dosimeter (Radcal Corporation Ltd. Model: 9015 Chamber: $10 \times 5 - 6M$).
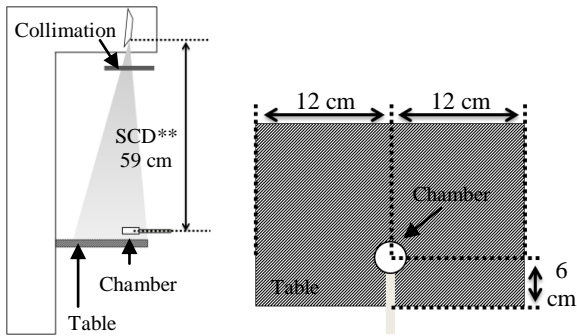
Fig. 2 Geometry for the decision of radiation quality
**SCD: source chamber distance

Next, we selected the RQA-M2 condition and used 4981 photons per $mm^2 \cdot \mu Gy$ in this study. The selected tube voltage was 30 kV. In this condition, we measured the input-output characteristic curves to calculate MTF and WS with an X-ray exposure from a pixel value. These were plotted using the time scale method. The MTF was measured using the edge method with the tungsten edge, and the WS was calculated using the two-dimensional Fourier transform method referring to the IEC 62220-1 standard. Also, we calculated the DQE from the measured MTF, the WS value, and the number of incident photons.

2. Comparison of MTF with conventional systems: We measured the input-output characteristic curves and pre-sampled MTF using the same method as that of the above CMOS study. AMULET was set to 28 kV and Microdose was set to 32 kV

Results & Discussion

1. CMOS study: The input-output characteristic curve shows a strong linearity between the incident X-ray exposure and the pixel value for each applied voltage. However, it was found that the linearity could not be maintained over a pixel value of 3500. The difference in the applied voltages in both the horizontal and vertical directions has no influence on the MTF and WS. In the low-frequency domain of Fig. 3, the DQE value is observed to be approximately 0.6. This value indicates this system has high detection efficiency.
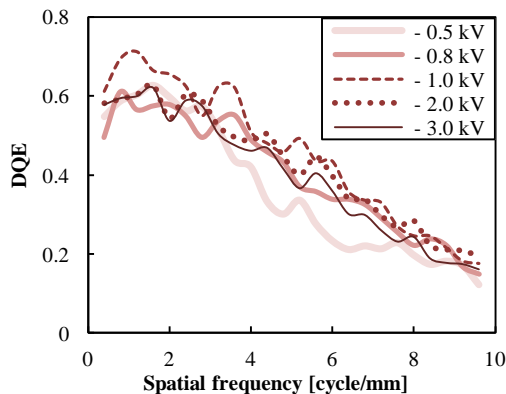
Fig. 3 DQE about the difference of applied voltage

2. Comparison of MTF with conventional systems: The input-output characteristic curve shows strong linearity between the exposure dose and the pixel value in each device. The AMULET shows strong linearity to the logarithmic exposure dose. On the other hand, the MicroDose shows strong linearity to the exposure dose. In the MTF of the Microdose, however, there is an important difference between the horizontal and vertical directions, as shown in Fig. 4. We guess that this is because the MTF in the vertical direction depends on the pixel pitch, while the MTF in the horizontal direction depends on the effect of the continuous scan movement. The MTFs of AMULET and MicroDose reported here are similar to the literature values [3] [4] of previous generation models and thereby may be taken as accurate. From the comparison, the CMOS imager shows the highest definition of the three.
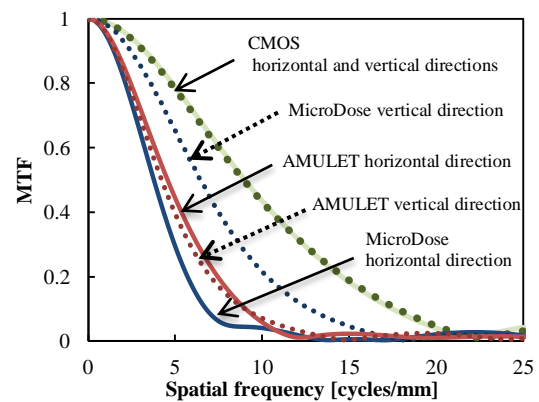

Fig. 4 MTF of three devices

Conclusions

The CMOS imager has very high definition and a high detection efficiency. Also, it seems to be independent to the voltage applied to the a-Se film. The physical image properties are superior to those of the conventional devices. In future, we wish to obtain and study breast phantom images with proper exposure doses.

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Verification of Multi-Point Source Method to Assess Annual Effective Dose by Usage of NORM Added Consumer Products

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Introduction

Naturally Occurring Radioactive Material (NORM) are commonly found in food, soil, rocks and minerals of the earth`s crust (such as ^{40}K, ^{13}C, and ^{238}U) [1]. NORM are responsible for the majority of an average person's yearly radiation dose, however the dose levels are very low and therefore they are not usually considered of any special health or safety significance [2]. When NORM are concentrated through technological activities the Technologically-Enhanced (TENORM) may be used. Uncontrolled activities associated with TENORM can contaminate the environment and pose a potential risk to human health. Typical examples are the radon concentration inside buildings that can increase by about a hundred times compared to the natural concentration or the level of the radium from an oil well that may lead to considerable build-up. In Korea, in order to regulate the exposure dose of the general public from NORM and TERNORM, a law called 'Act on safety control of radioactive rays around living environment' was passed. In this work we investigated a series of commercial products (pillows, accessory, waist supporters, and mattresses) containing NORM that are commonly found on the market. In most cases, the addition of NORM to commercial products results from the controversial theory of radiation hormesis, which predicts that a small dose of ionizing radiation can be beneficial for human health. In this study we developed a more flexible source model named "multi-point source model" in which radioactive sources are uniformly distributed directly in the phantom skin over the areas in contact or proximal to the consumer product. We benchmarked our new model against the real shape modeling by comparing the exposure dose performed due to the usage of NORM added consumer products.

Materials and Methods

Monte Carlo (MC) simulations were performed using the Geant4 code and a computational human phantom in order to evaluate the exposure dose from the usage of NORM-added consumer products. Specifically, we used the Polygon-surface reference Korean Man and Woman (PSRK-Man, PSRK-Woman) phantom [3] that is composed of high resolution polygons to accurately model 27 organs as shown in figure 1. The PSRK-Man and PSRK-Woman was developed based on the reference Korean body with height and weight of 171 cm, 68 kg, 159 cm and 54 kg, respectively. Each polygon is defined by the three coordinate of the vertexes as shown figure 2.
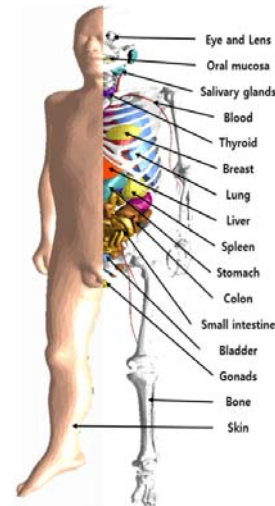

Figure 1. Graphic rendering of the PSRK-Man male phantom.

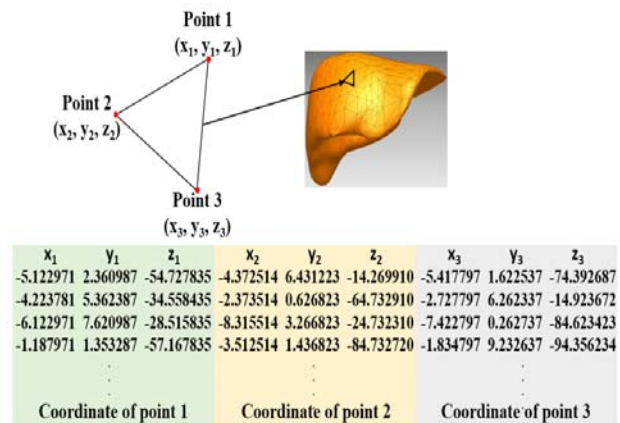| x_1	y_1	z_1	x_2	y_2	z_2	x_3	y_3	z_3
-5.122971	2.360987	-54.727835	-4.372514	6.431223	-14.269910	-5.417797	1.622537	-74.392687
-4.223781	5.362387	-34.558435	-2.373514	0.626823	-64.732910	-2.727797	6.262337	-14.923672
-6.122971	7.620987	-28.515835	-8.315514	3.266823	-24.732310	-7.422797	0.262737	-84.623423
-1.187971	1.353287	-57.167835	-3.512514	1.436823	-84.732720	-1.834797	9.232637	-94.356234
	Coordinate of point 1			Coordinate of point 2			Coordinate of point 3	

Figure 2. Enlargement of on polygon of the PSRK-Man.

In the multi-point source model particle sources were placed on the center of each polygon on the skin-area in contact or proximal to the consumer product. In this study, for evaluate the exposure dose from the usage of NORM added consumer products, the source consisted of 0.6 MeV gammas emitted isotropically on each point source. The effective dose and organ equivalent dose by each skin-point-source was compiled into database for 0-2 MeV with 0.1 MeV interval. For the various consumer products, the annual effective dose were assessed with the usage scenario for each product obtained from the Statistics Korea like table 1. To validate the skin point source method, the real shape of the product was simulated and for the same energy gammas the effective dose was compared with that by skin-point-source.

Table 1. Exposure scenario.

Consumer products	Usage location	Usage time
Pillow	Back of the head and neck	7 h 50 min
Accessory	Neck and wrist	8 h 7 min
Belt	Waist and abdomen	5 h 1 min
Sleeping mattress	Waist, abdomen, thigh and hip	7 h 50 min

Results

Multi-point sources of the pillow products were determined near the head and neck area consist of 233 weight center point on the PSRK-Man as shown in Figure 3. For the comparison purpose, the realistic pillow also modeled with a rectangular parallelepiped shape of width, length, and height of 30 cm, 50 cm, and 13 cm, respectively.

(a)   **(b)**
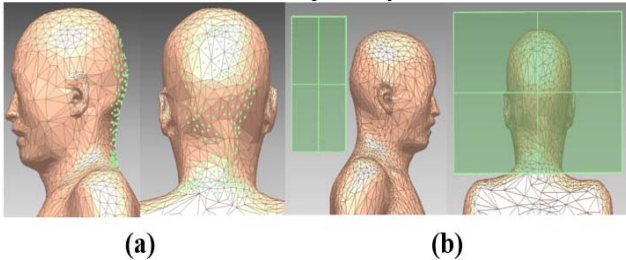
Figure 3. **Multi-point source (a) and realistic shape model (b) of the pillow.**

Figure 4. shows the organ equivalent dose with the initial gammas of 10^7 with 0.6 MeV isotropically emitted from the both sources. The organ equivalent dose of the modeling source of the bone and skin distributed to the whole body were evaluated as higher than that of the multi-point sources; that is, increasing the distance between the source and computational phantom increase the potential effective angle to the organs distributed in a whole body.
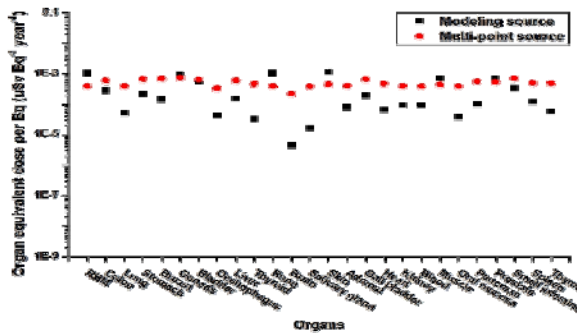
Figure 4. Organ equivalent dose with 0.6 MeV gamma energy.

Finally, the annual effective dose due to the usage of the TENORM added consumer products was evaluate based on the usage time and organ equivalent doses as shown in figure 5. The annual effective dose with the multi-point source was higher than that of modeling source. Especially, 2.5 times higher annual effective dose was assessed in mat product using multi-point source. The annual effective dose over six products was evaluated less than 1 mSv, even though the employment of conservative point source method.
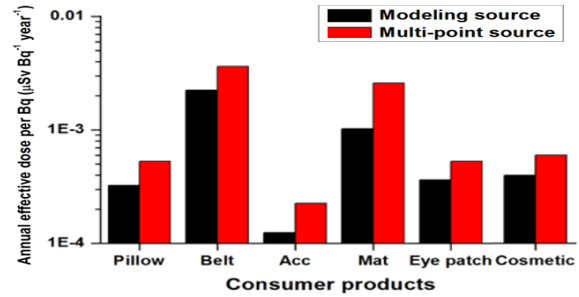
Figure 5. Annual effective dose with 0.6 MeV of gammas for the six consumer products with modeling and multi-point sources.

Discussion

Our simulation study shows that the skin-point-source shows similar organ dose compare to that by the realistic shape source of the TENORM added consumer products. For the most case, two times higher effective dose was assessed with skin-point-source, because the sources are closer to the organs than the product shape source. Finally our results demonstrate the potential that with the database obtained from skin-point-source could be used to efficiently assess the effective dose just by defining the product usage location in PSRK-Man, PSRK-Woman and its activity without additional Monte Carlo simulation.

Conclusions

The current study showed the effectiveness of the multi-point source on the computational human phantom to evaluate annual effective dose by usage of TENORM added consumer products. The point source method could also be used for the other field for radiation protection to calculate the effective dose.

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Development of a Patient Dose Calculation Algorithm Using TOPAS Monte Carlo Toolkit for Passive Scattering Proton Therapy

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Introduction

In proton therapy, accurate dose calculation is the most important for radiation treatment planning (RTP) in clinical situation. Currently, pencil beam algorithm (PBA) is employed to calculate dose because of fast calculating time, however, it is reported that PBA has many physical disagreement such as nuclear interaction and multiple Coloumb scattering in inhomogeneous material. There are many challengeable researches such as Analytical Anisotropic Alorithm (AAA), Collapse Cone Convolution algorithm (CCC), Acuros XB (AXB), Simplified Monte Carlo (SMC). However, the accuracy of the Monte Carlo (MC) is more than these algorithms. So MGH and the other hospitals employes Monte Carlo method to validate patient dose. The purpose of this study is to develop a patient dose calculation platform using tool for particle simulation (TOPAS) based on Monte Carlo method, and to validate the patient dose in internal mammary node (IMN) and abdomen (ABD) cases.

Materials and Methods

Modeling and Validation of the Proton Beam Nozzle: In previous study, we developed proton beam nozzle code for passive scattering proton therapy using Geometry and Tracking4 (Geant4) MC tool. Figure 1 is the visualized proton beam nozzle. The code was emigrated to TOPAS, and was validated by comparing axial percent depth dose (PDD) in a virtual water phantom with measured data by Markus ionization chamber. The dimension of water phantom was 30 X 30 X 30 cm^3 and the center line of the water phantom were divided into 5 X 5 X 0.1 cm^3. PDDs of 8 beam options were compared with measured data (4.73 – 24.01 cm), snout size is 250 mm (SNT-250), and source to surface distance (SSD) is 300 cm. 10^7 primary protons were employed for calculating PDD in each beam option.
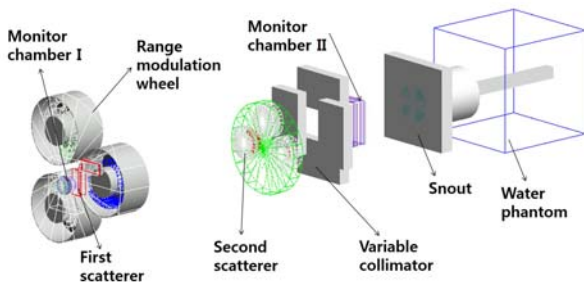

Figure 1. Schematic illustration of proton beam nozzle and a water phantom modeled by TOPAS.

Automatic Algorithm for Patient Dose Calculation: In this study, an algorithm for patient dose validation was developed with TOPAS by automatically importing the patient data such as the beam delivery conditions and patient image through DICOM file. Figure 2 shows a flowchart of automatic patient dose calculation algorithm by using TOPAS. First, nozzle parameter was determined by range and modulation width measured by quality assurance (QA) process. Second, phase-space file was generated to reduce calculation time. The information of neutrons and protons which pass through virtual plate at downstream of the compensator was recorded. At last, patient dose was calculated based on CT data and phase-space file. Schneider model was employed to convert CT data to CT phantom.
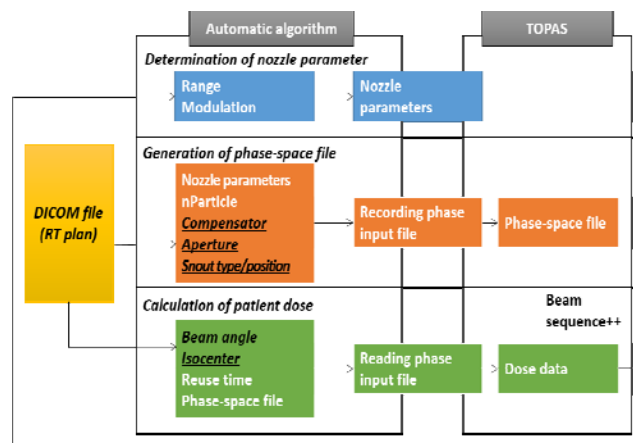

Figure 2. Flowchart for automatic dose calculation algorithm by using TOPAS.

Validation of the Patient Dose Calculation Algorithm: To validate the dose calculation algorithm, IMN case and ABD case were employed. Both patients were treated by passive scattering proton therapy at National Cancer Center (NCC), and both simulations calculated 10^9 primary protons totally. 300 CPU-hours were taken for each case and dose-to-water was calculated to compare same physical quantity with RTP dose. We employed the supercomputer called TACHYON supported by Korea Institute of Science and Technology Information (KISTI) for reduction of simulation time with parallel calculation and Matlab was employed to analyze our simulation results.

Results

For MC-commissioning, PDDs calculated by TOPAS beam nozzle code were compared with experimentally measured PDDs. Figure 3 shows an example of SOBP which has 4.73 cm range. The agreement between MC simulations and measurements show the difference of 0.1 mm range error and 0.2 mm modulation width error.
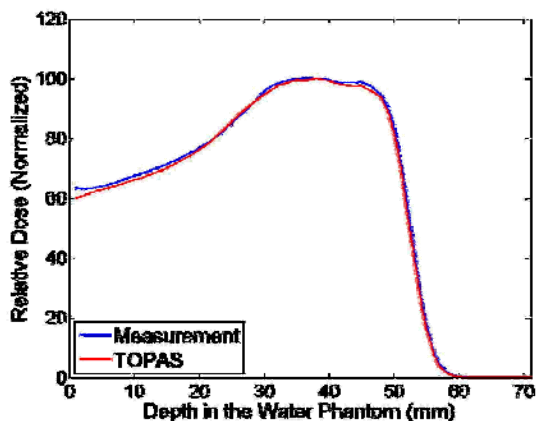

Figure 3. PDD of 4.73 cm range proton beam measured by Markus ionization chamber (blue) and calculated by TOPAS (red).

ABD case and IMN case represent homogeneous and inhomogeneous materials, respectively. The dose distribution show close relationship between RTP and MC as shown in Fig. 4. Minimum 99% of 3D gamma passing rate for most of the organs was assessed with 3 mm of distance to agreement (DTA), 3% of dose difference (DD), and 20% of threshold. However, in the IMN case, lung dose show relative high difference (96% of gamma passing rate) because of the inhomogeneity.
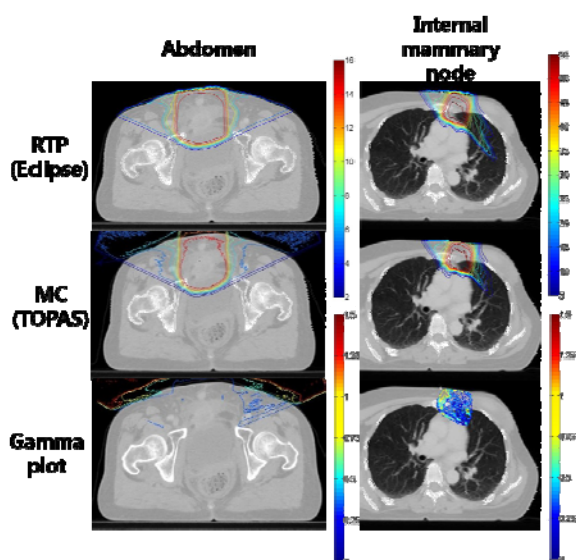
Figure 4. Dose distributions of ABD (left) and IMN (right) case calculated by Eclipse RTP (1st row) and TOPAS Monte Carlo tool (2nd row) in the isocenter plane, and gamma plot representing the difference between RTP and MC (3rd row).
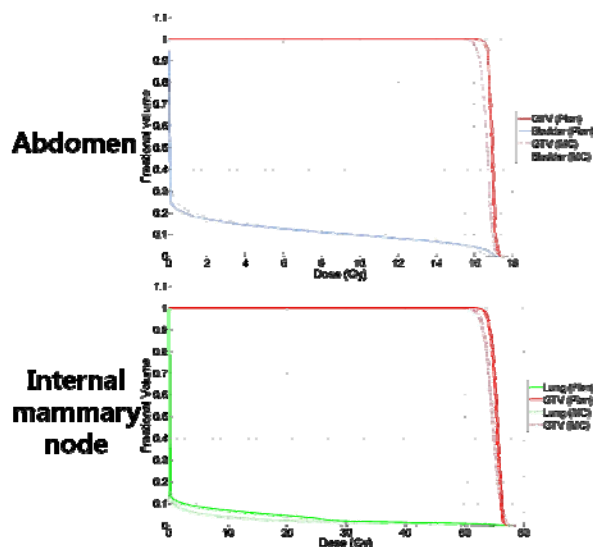
Figure 5. DVHs for ABD case (upper) and IMN case (lower). Solid line indicates dose calculated by Eclipse RTP and dashed line indicates dose calculated by TOPAS Monte Carlo tool.

Figure 5 shows difference of DVHs between RTP and MC. Because of statistical fluctuation, the MC-DVH curve for target volume is more gradual than RTP-DVH curve. And the relative high fraction of low dose in bladder can be generated by dose from secondary particles.

Discussion

The results of two patient cases show good agreement between RTP and MC. However, in the inhomogeneous case (IMN), lung dose shows relative high difference of 96% gamma passing rate. In this study, we determined 10^9 primary particles for patient dose calculation, however, still statistical fluctuation is most limitation. In further study, experimental validation of patient dose calculation algorithm will be performed in various conditions which show difference from plan such as disequilibrium inhomogeneous materials, range degradation, and small field. In addition, graphic user interface interlocked with patient management system at the NCC will be developed.

Conclusions

In this study, proton beam nozzle for passive scattering proton therapy installed at NCC was modeled by using TOPAS which employs MC method. In addition, patient dose calculation platform was constructed and validated by comparing with dose distribution assessed by RTP. This study demonstrates the reasonability of patient dose calculation using MC method.

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ADAPTATION OF EFFECTIVE ATOMIC NUMBER FOR PROTON THERAPY

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Introduction

Proton therapy can deliver a high radiation dose to target tumor without giving that to healthy organs because of the Bragg Peak. To maximize the advantage we need accurate calculation for stopping power.

To calculate dose deposition for human body, the value of electron density of each tissue is needed. Electron density can be estimated as electron density ratio (EDR) to water by using computed tomography (CT) images because the CT numbers expresses the ratio of attenuation coefficient of material to water. Therefore stopping power is always determined as stopping power ratio (SPR) to water. In a case of particle beam therapy, the differences of elemental compositions complicate the calculation of dose distribution for each tissue or organ in comparison to x-ray radiotherapy because mean excitation energy of target molecule is needed to the precise calculation of SPRs. The most popular method for calibration of CT numbers to SPRs is called "stoichiometric calibration method", Schneider *et al* [1] proposed. In this method, a calibration curve is used to determine SPR by CT number. Later, Kanematsu *et al* [2] showed a simpler method by poly-binary tissue model that have accuracy equal to Schneider's method. However, these methods are thought to have potential error because of elemental differences between patient body and reference materials which used when make a calibration curve. The differences appear as the errors of EDR and mean excitation energy.

In recent study, there are several reports using dual energy CT (DECT) for calculating SPRs. The biggest advantage of using DECT is that it can derive effective atomic number (EAN) and EDR with high accuracy by scanning at two different x-ray spectra. The accuracy of EDR greatly affects to that of SPR. Further, EAN can be adapted to calculate SPR accurately in particle therapy because it have so close relationship with mean excitation energy. From these reasons, the methods to calculate SPRs by DECT have more accuracy than Schneider's and Kanematsu's method.

The main purpose of this study is to evaluate the extraction accuracy of EAN, EDR and SPR for a phantom by using two different x-ray tube voltage of single energy CT that used in clinical treatment planning. We simplify Landry *et al* [3] to extract EAN, and EDR is obtained by solving equation, discussed below, and finally calculate SPRs.

Materials and Methods

In this study, we scanned two different electron density phantoms; CIRS (Computerized Imaging Reference System, Norfolk, VA) phantom and Gammex RMI 467 (Gammex, Middleton, WI) phantom, which have some rod-shaped tissue substitutes made of known different elemental compositions and densities. CIRS phantom was regarded as a calibration phantom and Gammex phantom as a human body.

The ratio of linear attenuation coefficient μ of a material to water at a certain x-ray tube voltage (kVp) is expressed as

$$\left(\frac{\mu}{\mu_{water}}\right)_{kVp} = \rho_e \times \left(A_{kVp} + B_{kVp} \times Z^{1.86} + C_{kVp} \times Z^{3.62} \right). \tag{1}$$

where ρ_e and Z shows EDR and EAN respectively. A_{kVp}, B_{kVp} and C_{kVp} represent the coefficient for incoherent scattering, coherent scattering, and photoelectric effect respectively [1]. Left hand in equation (1) is obtained from CT measurements by a CT scanner (TOSHIBA Aquilion LB). Both phantoms were scanned at two different tube voltage (80 kVp and 135 kVp) at 400 mAs, 2mm thickness. Two kinds of equation (1) were obtained from the CT measurements for CIRS phantom at each tube voltage. A_{kVp}, B_{kVp} and C_{kVp} at each tube voltage were calculated by least square fit between HU_{kVp} and EAN for each rod. EAN for each rod of phantoms were calculated using information of their elemental composition.

After determining A_{kVp}, B_{kVp} and C_{kVp} in equation (1) for each tube voltage, the ratio between 80 kVp and 135 kVp of the linear attenuation coefficient ratio to water $\mu|_{135\,kVp}^{80\,kVp}$ was obtained as following equation [1]

$$\mu|_{135\,kVp}^{80\,kVp}$$
$$= \frac{A_{80\,kVp} + B_{80\,kVp} \times Z^{1.86} + C_{80\,kVp} \times Z^{3.62}}{A_{135\,kVp} + B_{135\,kVp} \times Z^{1.86} + C_{135\,kVp} \times Z^{3.62}} \tag{2}$$

Since equation (2) can be regarded as a calibration curve between EAN and $\mu|_{135\,kVp}^{80\,kVp}$, the EAN for each pixel of Gammex phantom can be determined by the calibration curve. By using the determined EAN, EDR of each pixel can be calculated by solving equation (1) for each x-ray spectrum;

$$\rho_{e,kVp} = \left(\frac{\mu}{\mu_{water}}\right)_{kVp} \times \frac{1}{\left(A_{kVp} + B_{kVp} \times Z^{1.86} + C_{kVp} \times Z^{3.62} \right)}. \tag{3}$$

We determine EDR as average of $\rho_{e,80\,kVp}$ and $\rho_{e,135\,kVp}$.

Calculated EAN was converted to mean excitation energy. Figure 1 shows the relationship between EAN (calculated by β=3.3) and natural logarithm of mean excitation energy for the reference tissues from ICRU report 44 and 46 such as adipose, liver, brain, cortical bone, etc. We approximate by 5-order equation among minimum and maximum EAN (6.23 and 13.63 respectively). In the approximation, we did not include thyroid tissue because it has specific mean excitation energy value by the content of iodine. Outside of the fitting region, the linear extrapolation of the fitted function gave the EAN.

SPR for each pixel of Gammex phantom was calculated using the following Bethe-Bloch formula [2],

$$SPR = EDR \times \frac{\ln[2m_e c^2 \beta^2 / I(1 - \beta^2)] - \beta^2}{\ln[2m_e c^2 \beta^2 / I_{water}(1 - \beta^2)] - \beta^2}, \tag{4}$$

where m_e, I, and $c\beta$ show electron mass, mean excitation energy and velocity of proton beam.

Calculated EAN, EDR, mean excitation energy and SPR were represented as images respectively. In each image, region of interests (ROI) are set at each rod and the mean values and standard deviation (SD) in each ROI are obtained. The mean value of each ROI is evaluated as relative error to their theoretical value defined by

$$\text{Relative Error}(\%) =$$
$$\frac{Obtained\ Value - True\ Value}{True\ Value} \times 100. \quad (5)$$

In addition, the SPRs from our method were compared with that from stoichiometric calibration method, performed at 120 kVp, by equation (5) and root mean square (RMS) error defined by

$$\text{RMS error}(\%) = \sqrt{\frac{\sum_{i=1}^{N}(eq.\,5)^2}{N}}, \quad (6)$$
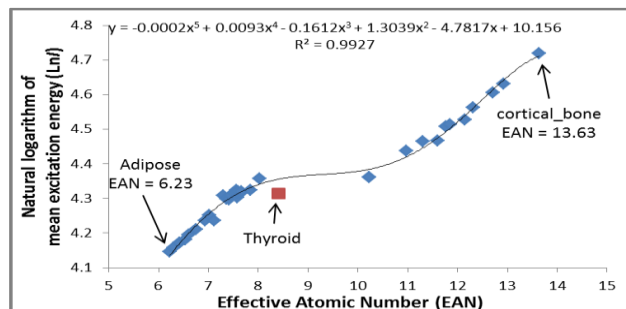
where N means the number of rods.

Figure 1. The relationship between effective atomic number (EAN) and logarithm of mean excitation energy (LnI) for reference tissues from ICRU report 44 and 46.

Results

Figure 2 shows the calibration curve from CIRS phantom and CT measurement data plot of Gammex phantom at each rod with SD. CT measurement data for Gammex phantom well agree with the calibration curve from CIRS phantom especially soft tissue substitutes, except lung substitutes (EAN are 7.60 and 7.62). Figure 3 (a), (b) and (c) show relative error between outputs and theoretical values for mean EAN, EDR and natural logarithm of mean excitation energy with SD at each rod. All outputs have critical large SD, so we focus on the mean value. The largest error of mean value among the rods is 26.11% for EAN, 9.22% for EDR, and 11.37% for mean excitation energy.

Figure 3 (d) shows relative error for SPR with SD at each rod. Red circle plots are stopping power ratio from our method and blue triangle plots are stopping power ratio from stoichiometric calibration method. The largest error is -9.51% for SPR from our method, and -6.12% for from stoichiometric calibration method. RMS error is 3.67% for from our method, and 2.12% for from stoichiometric calibration method.

Discussion

When we focus in mean value, we can find from figure 3 (d) that our method is equal to or more accurate than stoichometric calibration method at the region whose SPR is close to 1.0. However, at the lung and bony tissue regions, our method have less accuracy. The result represents that our calculation of EDR is not accurate at the regions than stoichiometric calibration method because the accuracy of SPR calculation greatly depends on the accuracy of EDR calculation, which depends on the accuracy of EAN calculation. Figure 3 (a) and (b) show that we could not calculate EAN and EDR accurately for lung tissues. This is because lung tissues are greatly deviated from the calibration curve as shown in figure 2. In addition, in figure 3, there are large errors at high EAN region, even for the rods whose EAN errors are small. This means that the approximation showed in figure 1 is incorrect especially at high EAN range and occurs the inaccuracy of SPR calculation.
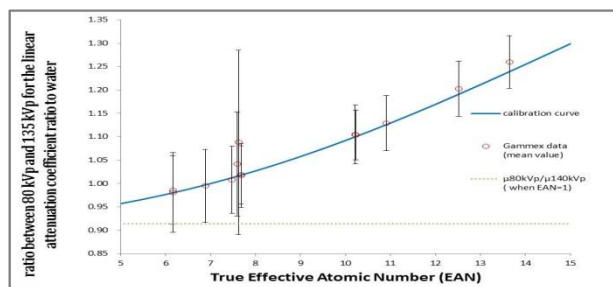

Figure 2. Calibration curve from CIRS phantom and CT measurements of Gammex phantom.
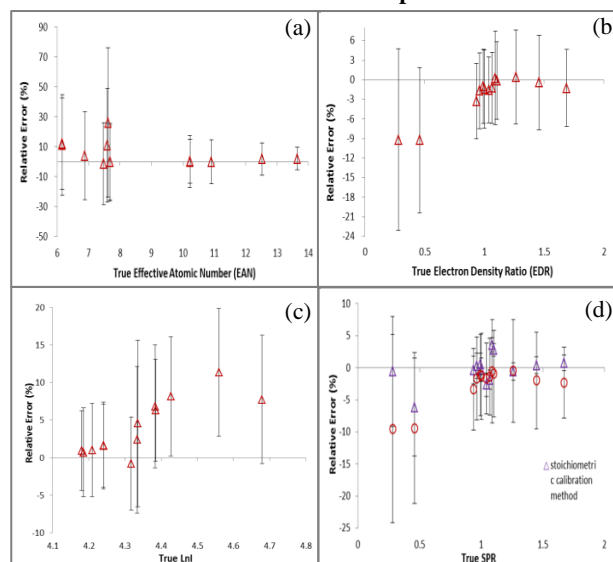

Figure 3. The results of relative error. (a): effective atomic number (EAN). (b): electrom density ratio (EDR). (c): rogarithm of mean excitation energy (LnI). (d):stopping power ratio (SPR) from stoichiometric calibration method and from EAN and EDR.

More importantly, figure 2 and 3 show that the outputs from our method have greatly large SD, which is equal to noise, then our method to calculate SPR is exceedingly less reliable than stoichiometric calibration method. We need to decrease the noise, derived from the noise of CT measurement, to perform a correct evaluation.

Conclusion

Our method could calculate SPRs equal to or more accurately than stoichiometric calibration method except lung or bony regions. It indicates the possibility that EAN and EDR can be adapted to calculate SPR accurately. However, the results have critical problem for the SD. Therefore our next step is to decrease the noise to obtain a reliable results. In addition, we have to evaluate the dose exposure by CT measurement simultaneously.

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Appearance of Stochastic Resonance on Computed Tomography and its Application

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Introduction

Image noise on Computed Tomography (CT) is one of the important factors degrading image quality, and many studies about noise reduction have been conducted. On the other hand, noise can have positive influence on some nonlinear systems. This phenomenon is called "Stochastic Resonance (SR)". This SR has been applied for various researches such as neuroscience and optical research. Gammaitoni et al. reported that SR caused by adding optimal noise provided improvement of a system response (e.g. signal-to-noise ratio) [1]. Thus, SR can be applied for improving signal detectability on X-ray digital images. However, at least to our knowledge, it has not been reported that SR has appeared on CT images. The aim of this study is to verify whether SR appears on CT images and improves signal detectability.

Materials and Methods

I.   CT image acquisition

Figure 1 illustrates target object used to measure high contrast resolution (Catphan528; The Phantom Laboratory). The phantom was scanned with a 64-row multidetector CT scanner (LightSpeed VCT; GE Healthcare). The scan parameters were as follows: tube voltage of 140 kVp, tube current of 180, 250, 320, and 400 mA. All images were reconstructed with standard kernels for brain.

II.   Verification of SR on CT images

CT images displayed on 8-bit gray scale based on process of windowing have nature of nonlinearity. In this study, white Gaussian noise of zero-mean and standard deviation (SD) denoted by σ representing noise intensity from 50 to 1000 Hounsfield Unit (HU) was added to CT images obtained with 140 kVp, 180 mA or 400 mA. For these CT images, a window width and window level were set to 40 HU and 100 HU, respectively. We have subjectively assessed the appearance of SR on these CT images.
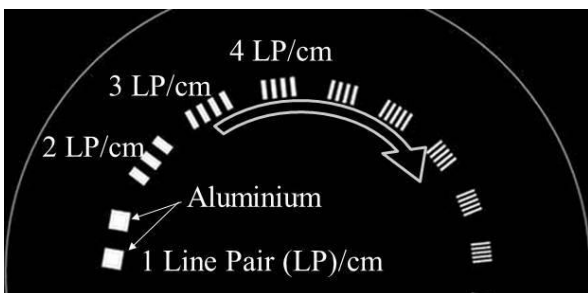
III.   Quantitative evaluation of signal detectability on SR images

Rousseau et al. reported that SR was represented by the curve with a peak SNR at the optimal noise intensity [2]. Thus, we have quantitatively evaluated the differences in the signal detectability for added noise intensity σ with the following two physical indices: i) Michelson's contrast and ii) Contrast-to-Noise Ratio (CNR). Michelson's contrast is given by,

$$Contrast = \frac{P_{signal} - P_{background}}{P_{signal} + P_{background}} \quad (1)$$

where P_{signal} and $P_{background}$ are mean pixel values of signal (bars) and background areas, respectively. Then, the contrast at each spatial frequency was normalized to 1.0 at 1 LP/cm.

CNR is defined as follows;

$$CNR = \frac{P_{signal} - P_{background}}{NoiseSD} \quad (2)$$

where $NoiseSD$ is standard deviation of background area.

Results and Discussion

I.   Verification of SR on CT images

Figure 2 (a) shows original CT image obtained with 140 kV and 400 mA and noise-added CT images When the noise intensity was 300 HU, bars on noise-added CT images appeared to be separated, indicating high-contrast resolution of 3 LP/cm. Moreover, the dark-band artifacts

Original σ=300 HU σ=1000 HU
(a) 140 kV, 400 mA
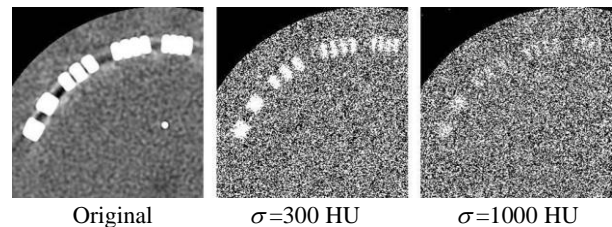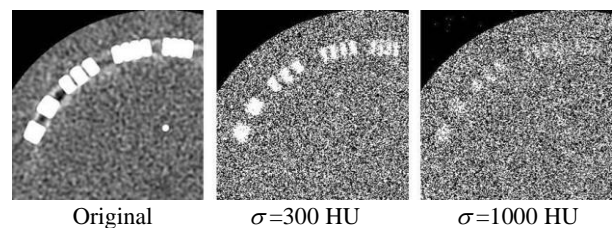
Original σ=300 HU σ=1000 HU
(b) 140 kV, 180 mA
Fig. 2 Original CT and noise-added CT images

Fig. 1 Target object (Catphan528)

on original CT image were found to be reduced by adding noise. However, when the noise intensity was 1000 HU, bars on noise-added CT images appeared to be separated, whereas bars looked buried in noise. Thus, the addition of optimal intensity of noise to CT image provided a substantial improvement of signal detectability. Thus, this result verified that SR occurs on CT images.

Figure 2 (b) shows original CT image obtained with lower tube current (180 mA) and noise-added CT images. As shown in this figure, SR also appeared on the images with lower tube current and with added white Gausian noise, and provided a substantial improvement of signal detectability. This result indicated that appearance of SR was independent on amount of noise on original CT images.

II. Quantitative evaluation of signal detectability on SR images

Figure 3 shows spatial frequency characteristics of Michelson's contrast for various noise intensities. For original CT image, the contrast decreased with the increase in spatial frequency and dropped to almost zero at 3 LP/cm. On the other hand, for noise-added CT images, the contrasts at 1-6 LP/cm were improved with the increase in noise intensity up to 300 HU, leveling off at higher noise intensity.

The results of Michelson's contrast showed the contrast at 3 LP/cm was substantially improved by adding noise to original CT image. Figure 4 shows CNR at 3 LP/cm as a function of noise intensity. CNR took the maximum value at the noise intensity of approximately 300 HU, and decreased for higher noise intensity. However, CNR did not significantly vary with tube current. This result indicated that CNR was not dependent on amount of noise on original CT images, but changed with noise intensity added to the CT images. Thus, these results showed that appearance of SR on CT images was quantitatively verified and contrast resolution and CNR of CT images were increased by adding optimal intensity of noise.
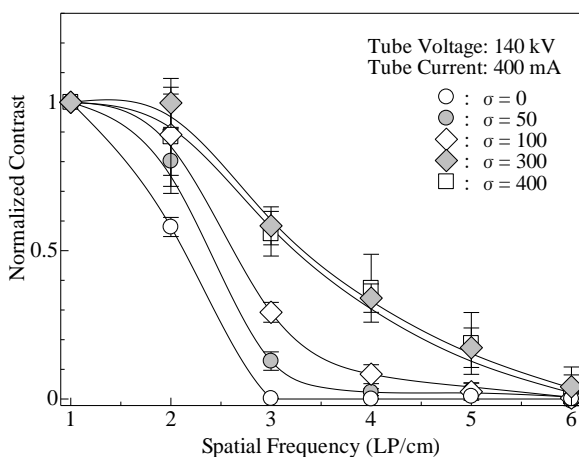

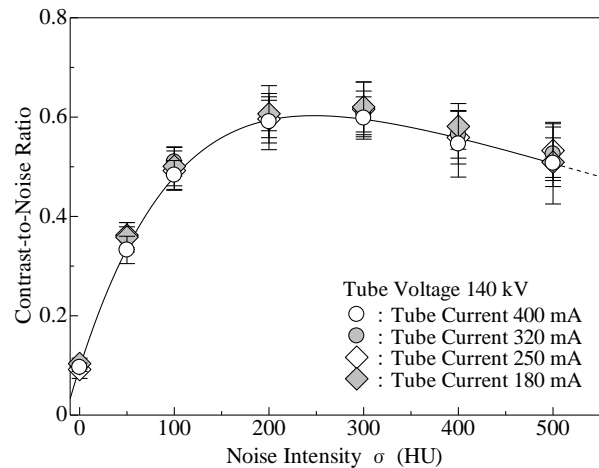Fig. 3 Spatial frequency characteristics of Michelson's contrast for each noise intensity

Fig. 4 CNR at 3 LP/cm as a function of noise intensity

Conclusion

We have verified appearance of SR on CT images by adding white Gaussian noise, and have quantitatively evaluated improvement of signal detectability on the CT images with two physical indices of Michelson's contrast and CNR. Our results suggested that application of SR on CT images can be clinically useful for detection of sulcal effacement such as acute ischemic stroke.

Acknowledgement

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GATE Monte Carlo Simulation Study on 6 MV Photon Beam Characteristics for Dual Head LINAC Modeling

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Introduction

In order to design the purposed dual head LINAC system, 6 MV photon beam was simulated and evaluated quantitatively with GATE Monte Carlo code for a preliminary study. The generated 6 MV photon beam was demonstrated from a sing head simulation in terms of the Percent Depth Dose (PDD) and cross-line profile. Then, the dual head was simulated and deposited dose was measured according to irradiation time, field size and the shpae of a phantom.

Materials and Methods

The geometrical and material properties were derived from a VARIAN's manufacturer specified layout for VARIAN 2300EX. The simulated components were primary collimator, target, mirror, ion chamber, X-Y jaws and water phantom.

The simulation was separated by two stages. The first stage was to generate 6 MV photon beam. At the first stage, a single LINAC head was modeled with GATE platform. The properties of head which were geometry, dimension, material and density were defined from the manufacturer information and described as precisely as possible. The electron source was placed within the primary collimators and it generated 6 MeV electrons. To be exact, the electron source generated 6.1 MeV electron to fit the conventional 6 MV photon spectrum with given geometry. The electrons hit the target and 6 MV photon spectrums were generated. The simulated photons were stored within a Phase Space (PhS) which saved entering particles' information in terms of position, direction, energy, etc. The PhS was attracted to predetermined volume and placed above the X jaws (Secondary collimators). The number of primary electron was 10^8.
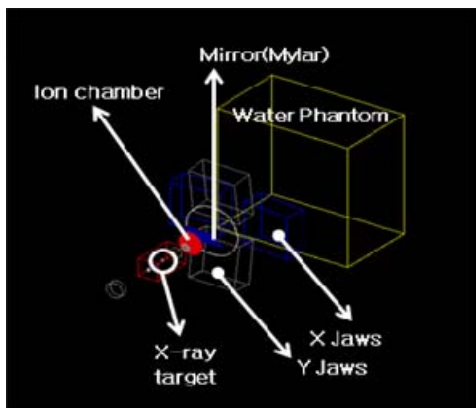

Figure 1. LINAC head geometry on the GATE simulation

In the second stage, PhS was acted as the photon source at the same location. In other words, the simulation was begun at top of the secondary collimators and the source was located at the same space with a PhS record volume. In this stage, the photon spectrum was irradiated to water phantom after passed through X-Y jaws with given field size. The field size was set by 5×5 and 10×10 cm2 depending on the jaws location and shape. The Source to Surface Distance(SSD) was 80 cm.

The simulated photon spectrum was irradiated to the water phantom below the lower jaws. The shape of the phantom was box with 50×50×30 cm3 of dimension. In the water phantom, cross-line profile and PDD were measured to verify the simulation quantitatively. The line profile was evaluated at the surface of the phantom and had 100×1×1 resolution with 5×500×500 mm3 of voxel size. After verify the single head and spectrum, the dual heads were described and both of the heads irradiated 6 MV photons with various field size. One head was stationary and the other head was rotated by 45o and 90o to describe one arbitrary treatment moment. At the center of the dual heads, water phantom was placed and various shape of the phantom was modeled. As the result, the deposited dose within the phantom was measured. We compared the deposited dose for given time which was described in terms of the number of particles on the single head case and the dual head case, respectively . In addition, the deposited dose of whole volume was also compared at both cases.

Results

The mean energy of the specturm was 1.303 MeV and 6.1 MeV of maximum energy was observed. In orter to evaluate the X-ray beam generated from the simulated head, cross-line profile and PDD were measured within the water box phantom. Figure 2 showed the measured cross-line profile on the water phantom with 10×10 cm² of field size. On the cross-line profile, field flatness and symmetry were 4.65% and 0.115%, respectively.
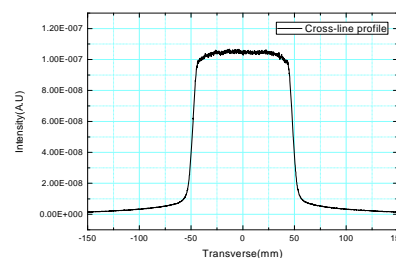

Figure 2. Cross-line profile(10×10 cm² field)

The dual head irradiation was compared to single head irradiation in terms of the deposited energy which corresponded to treatment time. Both simulations were performed with $2×10^8$ particles which were from PhS file. Figure 4 and Figure 5 showed the deposited dose at box and sphere phantom, respectively. The efficiency was calculated that deposited dose from dual heads was divided by the dose from single head.
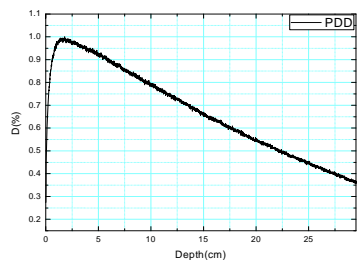
Figure 3. Percent Depth Dose curve(10×10 cm² field)

At all condition, dual head showed higher treatment efficiency. Efficiency was increased about 40 to 60%. The efficiency variation was caused by phantom geometry and photon energy which penetrated the phantom. The photons were not fully deposited within the phantom due to no compensator and actual planning.
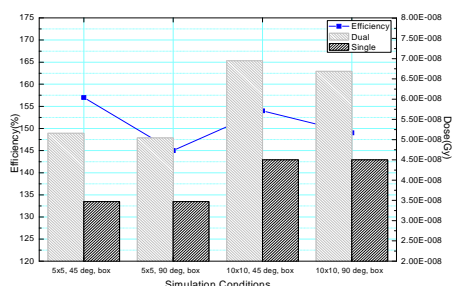

Figure 4. Comparison of the deposited dose and its efficiency at box phantom
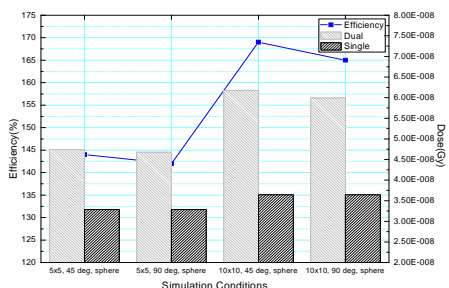

Figure 5. Comparison of the deposited dose and its efficiency at sphere phantom

Conclusion

In this study, in order to validate the feasibility of a dual heads LINAC system, GATE Monte Carlo simulation has been employed and it was estimated. LINAC head modeling was evaluated with a single head and the geometry and property were extended to the dual head system. In the dual head LINAC, it showed the improved deposited dose which could be corresponded to the faster radiotherapy and the higher degree of freedom to treatment planning than a single head LINAC system. However, this study was not concerned the actual planning and patient's information, therefore, it was required to be estimated with the practical condition in the future.

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Feasibility Study for Spectral Unfolding of Clinical Megavoltage Photon Beams with Transmission Method

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Introduction

In radiation therapy, it is required to determine beam quality such as energy spectrum to accomplish accurate treatment planning and dosimetry. For this, direct measurement of energy spectrum from the linear accelerator (Linac) is prefered. However, it is physically difficult to estimate the photon energy spectrum directly because of very high intensity of radiation from Linac. Typically, beam quality from Linac have been estimated by matching percent depth-dose (%dd) and profile data that are measured. As considering attenuation coefficients of materials that consis of human body, however, it is required to measure accurate photon energy spectrum.

Among the methods suggested to calculate photon energy spectrum from Linac, method determining energy spectrum with the transmission data, which is called as unfolding energy spectra, showed its potential with high cost efficiency and relatively easy measurements setup.

In this study, the possibility of unfolding photon spectrum was proved by using Monte Carlo (MC) simulation and a program called as HEPROW which is designed to calculate energy spectrum.

Materials and Methods

Transmission: Transmission is the ratio of charge transferred to ion chamber with and without attenuator. Theorectically, transmission with the attenuator of certain thickness is defined as a integral function of multiplications of energy transferred to ion chamber and the exponential considering attenuation expressed as below.

$$T(x) = \frac{M(x)}{M(0)} = \frac{\int F(E)R(E)e^{-\mu(E)x}dE}{\int F(E)R(E)dE}$$

In the equation above, T(x) and M(x) mean transmission and ion chamber signal with attenuator of certain thickness, x, respectively, and F(E) is the fractional signal of the photon spectrum, and R(E) means response fuction of ion chamber.

Simulation setup: To obtain transmission data, Geant4 simulation tool-kit was used. Elekta Linac and PTW farmer-type ion chamber were modeled in the simulation. In the simulation, to increase simulation efficiency, only sensitive volume of ion chamber was modeled. Also, Aluminum (Al) Alloy 1100 was selected as the attenuator material and Lead (Pb) secondary collimator was modeled to detect only straight radiation that reaches ion chamber. Figure 1 below shows overall setup of transmission measurement simulation.

In the simulation, Al attenuator and ion chamber were located at the distance of 1 m and 3 m respectively from the zero point and secondary collimator was located at 275 cm from the zero point.

With the simulation, ideal energy spectrum and transmission curve of Linac were calculated. Also, chamber response matrix which is one of important input factor of HEPROW is calculated.
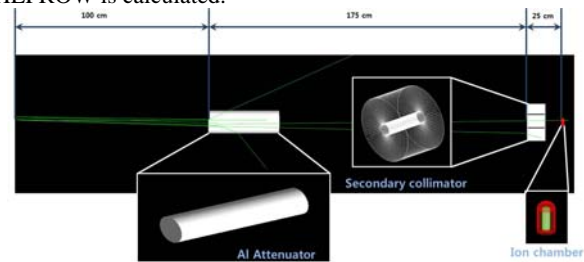

Figure 1 Simulation setup of transmission measurement

Energy spectrum calculation: In this study, HEPROW which calculate energy spectrum through series of iterations using least-square method was selected to obtain photon energy spectrum by analysing transmission curve of 6 MV photon beam from Linac. HEPROW was designed to calculate original energy spectrum from measured one based on the equation below.

$$z_{0i} = \int dE \, R_i(E) \, \Phi_E(E)$$

In the equation, z refers detected spectrum which is input values of HEPROW, R(E) is response function depends on the photon energy E, and $\Phi(E)$ is the fluence of photon of the energy E.

Results

The relative curve of transmission of photons from Linac through thicknesses of Al Alloy 1100 attenuators was measured by using farmer-type ion chamber and the energy spectrum was reconstructed by using HEPROW from the transmission curve.

Figure 2 is the plot of transmission curve obtained from the simulation. To see the curve, it has a shape of exponential curve that is mathematically reasonable because the base formual of transmission curve explained at *Maetrials and Methods*, which has variable of attenuator thickness, x, is exponential function.
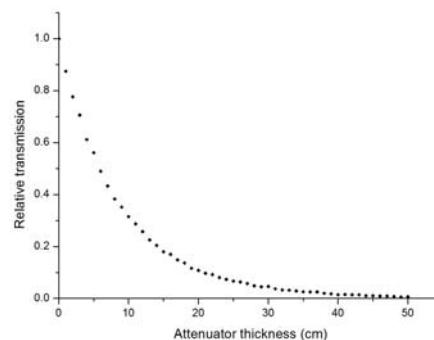
Figure 2 Transmission curve obtained from MC simulation

Figure 3 shows the comparison between the spectra obtained with HEPROW and MC simulation. In Figure 3, diamonds(◆) indicate energy spectrum obtained from MC simulation and asterisks(*) indicate energy spectrum oftained from using HEPROW. Energy spectrum obtained from HEPROW underwent 3,000 iterations using least-square method. To see the spectra, they show similar tendency, similar peak energy and spectral shape. Also, difference between mean energies of each energy spectra was calculated as 1.5% from the energies of 1.98 MeV and 1.95 MeV for HEPROW and MC simulation, respectively.
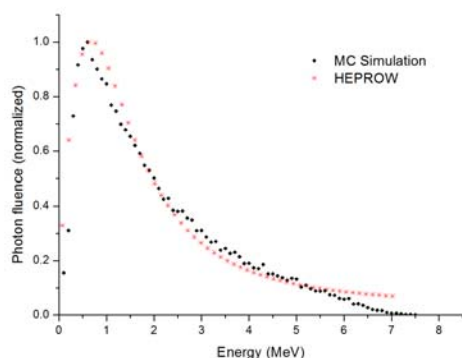

Figure 3 Comparison between energy spectra obtained from MC simulation and HEPROW

Discussion

In this study, we calculate transmission curve of 6 MV photon beam from Linac and obtain energy spectrum by using the transmission curve and HEPROW program. In the results, overall tendencies of the spectra from MC and HEPROW seem to be similar. However, there is difference between the spectra in slope of each spectra. This problem seems to be solved by increasing iteration tries of HEPROW but it didn't work because more iterations resulted more distortions of shpe of energy spectrum, especially, values of high energy region were increased. And, considering peak locations of energy spectra and mean energy, it seems that difference between the spectra is resulted from using a single attenuation material, Al. Therefore, additional researches on these problems are needed for further study.

Conclusions

We unfolded energy spectrum from Linac by MC simulation and HEPROW employed in this study and demonstrated the possibility of unfolding energy spectrum from Linac. Additional study to develop in-house unfolding code is needed based on the results of this study. For advanced research, experimental studies for validation of the results on this study and optimization of measurement setup are needed.
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