Abstracts

Physical Therapy

ACUTE BUT NOT DELAYED ONSET OF FORCED IMPAIRED FOREPAW USE PROMOTES PLASTICITY AND FUNCTIONAL RECOVERY IN RATS AFTER CAPSULAR HEMORRHAGE

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Introduction

Upper limb hemiparesis often occurs after stroke, and it disturbs patients' ability to complete activities of daily living [1]. Forced impaired limb use (FLU), which is known as constraint-induced movement therapy, is promising method to promote functional recovery after stroke. However, little is known about the detailed changes in the brain caused by FLU. The present investigation is aimed at (1) examining behavioral and histological changes caused by FLU after internal capsule hemorrhage (ICH) and (2) comparing the effect of early- (1-8 days after ICH) and late- (17-24 days) FLU in ICH model rats.

Materials and Methods

Experimental setup: Adult male Wistar rats (250-300g) were housed at a 12 h light/dark cycle with food and water ad libitum. Rats were divided into the following experimental groups: animals receiving a sham operation (sham; n=6), sham operation with forced-use of dominant forelimb (Sham-FLU; n=6), ICH with no treatment (ICH; n=9), and animals with early and late onset of FLU after ICH (ICH-E-FLU; n=6, ICH-L-FLU; n=6). All experimental procedures were performed in accordance with the animal care guidelines of the Nagoya University. Figure 1 shows a timeline of the performed experiments.

Intracerebral hemorrhage: In the present study, we used internal capsule hemorrhage model [2]. Under deep anesthesia by sodium pentobarbital (45 mg/Kg, intraperitoneally), rats were injected collagenase (15 Units/ml, 1.4 μl, Type IV; Sigma-Aldrich, St. Louis, MO, USA) or sterile saline into the internal capsule contralateral to the dominant forepaw. Figure 2 shows a typical histological appearance of hemorrhage.

Forced-impaired limb use: FLU-treated rats were fitted with a 1-sleeve plaster cast at 24 hrs after ICH surgery. The upper torso and the unimpaired/unpreferred forelimb were wrapped in soft felt and Plaster of Paris strips. Rats were forced to completely rely on either their impaired/preferred forelimb for one week beginning 1 or 17 days after surgery.

Behavioral assessments: Behavioral recovery was tested in single pellet reaching test (for skilled reaching function) and horizontal ladder test (for forelimb stepping function) on 10-12 and 26-28 days post ICH. Figure 3 shows the appearances of these tests.

ΔFosB Immunohistochemistry: Immediately after the FLU period of each group, the rats were deeply anesthetized and perfused transcardially with 0.9% saline followed by 4% phosphate-buffered paraformaldehyde (pH 7.4). The brains were removed and postfixed, and then 40 μm thick coronal sections were obtained using a cryostat. Sections collected form sensorimotor cortex (SMC) forelimb area were processed with ΔFosB immunostaining. The primary antibody was rabbit polyclonal anti-FosB/ΔFosB sc-48 (1:400, Santa Cruz Biotechnology, Santa Cruz, CA, USA), and the secondary antibody was goat anti-rabbit IgG (1:200, Sigma). The number of ΔFosB-positive cells located in the SMC of the injured and intact hemisphere was counted from six sections per animal.

Real-time PCR assay: Separate cohorts of animals exposed to the same FLU treatment were used for quantitative transcription polymerase reaction (PCR) analysis. SMC forelimb region harvested at the end of the FLU period was analyzed by real-time PCR of brain-derived neurotrophic factor (BDNF) and growth-associated protein 43 (GAP43).

Golgi-COX staining: To investigate anatomical changes of SMC neurons, Golgi-COX staining was conducted. Rats were perfused with 0.9% saline and extracted their brains on 14 and 30 days after ICH. Collected brains were stored in Golgi-Cox solution for 14 days in the dark and then immersed in 30% sucrose solution for another 2 days before sectioning. Coronal brain sections were cut using a vibratome at 200 μm and developed as previously described [3]. Six pyramidal neurons located to layer V in the contralateral and ipsilateral SMC were selected per animal. Dendritic branching was analyzed by Sholl analysis, which examines the number of intersections of dendritic branches and rings, at 20 μm intervals from the cell body [4].

Statistical analyses: All data were analyzed using parametric ANOVA of the appropriate design, followed by Tukey-Kramer post hoc comparisons whenever a main effect or interaction attained statistical significance. All statistical analyses were conducted using the statistical software SPSS (release 12.0). Data are presented as means ±SEM.

Results

Behavioral assessment: After FLU treatment, improvement of the skilled reaching task in single pellet reaching test was found in the ICH-E-FLU group in comparison with ICH untreated. Better performance of skilled forelimb stepping in ladder test was also shown in the ICH-E-FLU group than ICH group. Although ICH-L-FLU rats also showed a slight recovery in ladder stepping task, they could not show functional recovery in the pellet reaching task.

ΔFosB Immunohistochemistry: ΔFosB, which is cumulatively and persistently expressed in response to repeated neuronal activation [5], is suitable molecular marker for investigations of practice-dependent plasticity. Abundant ΔFosB-positive cells were found in SMC forelimb region of lesioned hemisphere after early-FLU. In contrast, no significant changes of the number of $\Delta FosB^+$ cells among groups were found after late-FLU. In the intact SMC, all groups showed similar $\Delta FosB^+$ cells number.

Real-time PCR assay: BDNF and GAP43 are known as growth-related factors and involved in synaptic plasticity and axonal expansion. As the results of ΔFosB assay, BDNF and GAP43 mRNA expressions were significantly increased in the

affected side of SMC in ICH-E-FLU group compared with sham and control group, but were not in ICH-L-FLU group.

Golgi-COX staining: Golgi-Cox staining revealed that the increase of dendritic arborization was occurred in affected SMC of ICH-E-FLU group compared to ICH only group, whereas significant changes were not seen between ICH-L-FLU group and ICH group.

Discussion

These data demonstrated that forced-use of impaired forelimb after internal capsule hemorrhage induces repetitive neuronal activation and upregulation of trophic factor expression in the forelimb sensorimotor cortex of affected side of brain. Additionally, plastic change of dendrites was enhanced by FLU in the same area in parallel with behavioral recovery. These data suggest that FLU after brain injury could cause functional and anatomical plastic changes in the SMC. Additionally, in the case of small ICH, SMC in the affected hemisphere may be a key region for functional recovery. The plastic changes caused by FLU were not seen in the rats treated delayed onset of FLU after ICH. These results raise the possibility that FLU may involve the acute event of brain injury (e.g. temporal increase of neuronal excitability).

Conclusions

Forced-use of impaired forelimb after capsular hemorrhage induced better recovery of skilled reaching and stepping of the impaired limb. This functional recovery might be related plastic changes of neuronal activity, growth-related factors expression, and dendritic branching in the affected sensorimotor cortex. These plastic changes caused by FLU were more apparent in the rats treated early onset of FLU than in the rats of delayed after subcortical small hemorrhage.

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Figure 1. Timeline of the experiments

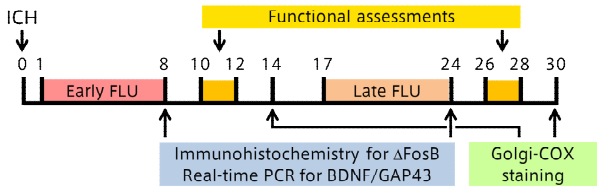


Figure 2. Typical photograph of internal capsule hemorrhage

Hematoxylin and eosin staining 30 days after ICH shows small hemorrhage localized the internal capsule.

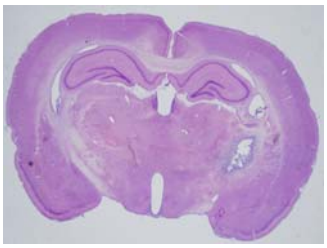
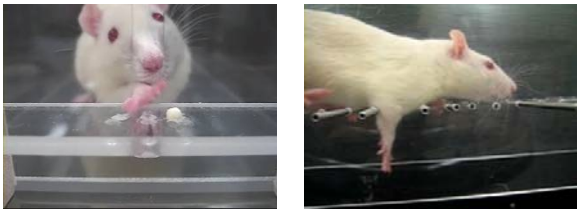


Figure 3. Behavioral tests

(A) Single pellet reaching test: Reaching to retrieve pellets through a narrow slit by their impaired forelimb was analyzed. (B) Ladder test: Crossing the 1-m long ladder was videotaped and assessed the rate of fall step.



THE EFFECT OF PASSIVE MOVEMENT ON HETEROTOPIC OSSIFICATION IN EXPERIMENTAL MODEL MICE OF SPINAL CORD INJURY

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Introduction

Heterotopic ossification (HO) is a pathological bone formation which is induced in normal soft tissue around a bone and/or a joint. It is known as a sequela of spinal cord injury, a cerebrovascular accident, a trauma in four extremities and a postarthroplastic surgery. It often occurs around large joints and causes meticulous pain and a limitation of range of motion in pathological joints. Consequently, it could be a great obstacle in rehabilitation process.

However, the reason for the development of HO is still unclear. Clinically, some written articles report that high incidence of HO can be seen in paralytic patients due to damage of central nervous system, for example in spinal cord injury [1]. It is still disputable whether passive movement for paralytic extremities enhances or inhibits the development of HO [2][3].

In this study, we made experimental model mice of HO under spinal cord injury, and investigated the effects of enforced passive movement on the new bone formation in the paralytic limbs of these animals.

Materials and Methods

Eleven ddY-line male mice, 6-weeks-old, underwent laminectomy at the level of 8th thoracic vertebra while under anesthesia of pentobarbital. A weight of 3 grams was dropped directly onto the exposed spinal cord of each mouse from a height of 3 centimeters to make the experimental model mouse of spinal cord injury [4][5]. After a week of evaluation of the grade of paralysis, all the animals were recognized to be completely paralytic.

Three milligrams of powdered bone morphogenetic protein (BMP) was stuffed into the gelatin capsule and implanted in the muscle pouch of their hamstrings. BMP is a non-collagenous protein which is usually extracted from the matrix of the cortical bone, enamel bone or osteosarcoma, and has biological ability to differentiate the mesenchymal cells into bone and/or cartilage tissue. Therefore, it is an expected material to use when making an experimental animal model of HO [6][7]. This time, we prepared the BMP, which had been crudely extracted from a porcine long bone cortex and had been verified to have the appropriate activity to make HO.

From the day after implantation, passive flexion-extension movement was applied to the left side of the knee joints of 11 mice (CPM group) with a continuous passive movement (CPM) machine. This involved passive movement 60 times per minute, 20 minutes per day, 6 days a week, with 60 degrees of knee flexion-extension, for 3 weeks. The contralateral side of the knee joint of each mouse were assigned to the non-CPM group.

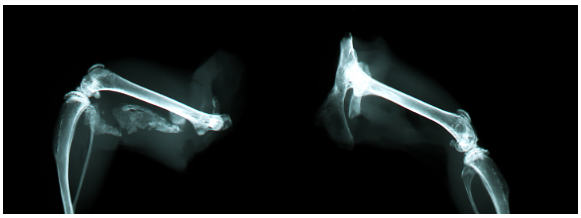
After 3 weeks of passive movement, the new bone formation was identified through soft X-ray film. According to the film image, the new bone tissue was excised out from the sample, and sintered at 1,000 ℃ for 60 minutes to obtain the ash weight of the sample. The ash weight was calculated per gram body weight of each animal. A statistical difference between two groups was studied by unpaired *t* analysis. The significance was set at $P<0.05$.

Results

Figure 1 shows new bone formation images through a soft X-ray film. The CPM group (fig.1, left) shows more extensive new bone formation compared with the non-CPM group (fig.1, right).

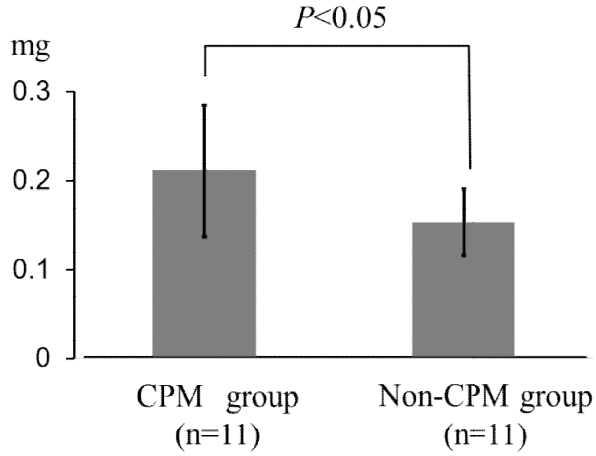
The volume of newly formed bone (ash weight per gram body weight of each mouse, mean ± SD) was 0.21 ± 0.07 mg / gram body weight (n=11) in the CPM group and 0.15 ± 0.04 mg / gram body weight (n=11) in the non-CPM group (Figure 2). A Statistical difference was recognized between the two groups ($P<0.05$).

Figure 1: Soft X-ray image of the new bone formation



An extensive new bone formation was recognized in CPM group (left), but was not in the non-CPM group (right).

Figure 2: Ash weight (mg) per gram body weight



The ash weight in the CPM group showed more new bone formation than that of the non-CPM group. It was statistically significant (*P*<0.05)

Discussion

In this study, the more extensive new bone formation was recognized in the experimental spinal cord model mouse. Furthermore, the enforcement of passive movement on the murine knee joints with a CPM machine enhanced a new bone formation compared with the non-CPM group. It means that HO in mice under the condition of spinal cord injury will be enhanced by enforced passive joint movement.

It is considered that not only paralytic state or enforced passive movement, but also local edema, poor circulation, local infection and metabolic dysfunction, might be pathogenetic factors of HO. It is also considered that the combination of these factors might enhance the incidence of the growth of HO[8]. Especially, in the state of spinal cord injury, we often observe some of these factors in which HO occurs much more easily. In this study, we further added the enforced passive joint movement to the state of spinal cord injury, and consequently the growth of HO might be enhanced.

The results of this study show that enforced passive movement enhances HO. On the other hand, a report has been written that passive movement inhibits HO. The extent of passive joint movement might have an effect on the growth of HO. Therefore, further investigation under the various condition of enforced passive movement, especially under the lower extent of enforcement, will be needed.

Conclusion

The extensive volume of new bone formation was recognized in the experimental model mouse of spinal cord injury. Enforced passive joint movement also enhanced the new bone formation in the same model. The process of the growth of HO which was seen in this study, resembled the clinical case of HO in the human body. Consequently, this kind of study could be a clue to clarify the pathogenesis of HO and developing the preventive modality for HO.

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Association between intensity of physical activity and arterial stiffness in older adults.

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Introduction

Arterial stiffness, one of the indices of arteriosclerosis, has been established as a predictor of coronary heart disease and stroke [1]. Aging is associated with structural and functional changes of the vessel wall, and resulted in worsening of arterial stiffness. Previous studies reported that amount of physical activity associated with improved arterial stiffness [2,3]. However, the relationship between intensity of physical activity and arterial stiffness were unclear. This, this study aimed to examine the relationship between intensity of physical activity and arterial stiffness.

Materials and Methods

Subjects: Study subjects were comprised of 147 community-dwelling elderly people over 60 years old (73.5 ± 5.7 yo, 39 males and 108 females). People who had smoking habit, abnormal ankle-brachial pressure index (ABI) and any orthopedic disorders were excluded.

Study Protocol: We assessed cardio ankle vascular index (CAVI), physical activity, body mass index (BMI), home blood pressure, lipid profile(HDL, LDL-cholesterol), HbA1c. Written informed consents were obtained from all participants, and this study protocol was approved by the Ethics Committee of the school of Health Sciences, Nagoya University.

Assessment of arterial stiffness: We assessed CAVI as a parameter of arterial stiffness. Measurements were carried out after a 5-min rest in the supine position with the upper body as flat as possible. CAVI was mesured from pulse wave velocity and blood pressure by using a Vasera VS-1000 vascular screening system (Fukuda Denshi). CAVI has characteristics of less influenced by blood pressure.

Assessment of physical activity: We assessed physical activity by using an electrical accelerometer (Kenz Lifecorder, Suzuken). The device mesures the number of steps and intensity of physical activity. The intensity was classified ranged 0-9 based on Lifecorder intensity. All participants were instructed to put on the accelerometer themselves and were instructed to use the pedometer 24 h/day for 1 week, except while bathing and sleeping.

Data analysis: Continuous variables are expressed as mean ± standard deviation (SD). The association between PMADL-8 and clinical variables were analyzed by Pearson□s or Spearman correlation coefficients. For investigating differences affected by aging, subjects divided into two groups (60-74 years old or over 75 years old). All statistical analyses were performed by SPSS 16.0 software package (SPSS Japan, Tokyo, Japan), and a $P<0.05$ was considered statistically significance.

Results

Subject characteristics are showed in Table 1. The correlations between CAVI and other parameters are presented in Table 2. Intensity of physical activity indicated weak but significant negative correlation with arterial stiffness.
(Figure 1). On the other hand, daily step count did not indicated significant correlations.

Age was most related to CAVI. To examine the influence of age-related increases in arterial stiffness on association between CAVI and physical activity, we divided subjects into two groups(60-74years old or over 75years old). In 60 - 74 years old group, duration of physical activity over Lifecorder intensity 6 and intensity 7 were significant negative correlations. Meanwhile, in over 75 years old group, intensity of physical activity tended to relate to CAVI, but there was no significance.

In other factors, home systolic blood pressure and HbA1c showed significant but weakly correlation. BMI, home DBP, LDL cholesterol, HDL choresterol did not indicate any correlation.

Table1 Subject characteristics

	Mean ± SD
Age	73.5 ± 5.7
BMI (kg/m^2)	21.8 ± 2.8
CAVI	9.1 ± 0.9
Home SBP (mmHg)	135.5 ± 19.6
Home DBP (mmHg)	78.7 ± 11.1
LDL cholesterol (mg/dL)	115.8 ± 25.4
HDL cholesterol (mg/dL)	61.3 ± 13
HbA1c (%)	5.5 ± 0.58
Daily step count	7908.2 ± 3521.6
Duration of physical activity	
in mild intensity (Lifecordere intensity 1-3)	55.2 ± 19.7
in moderate intensity (Lifecordere intensity 4-6)	24.2 ± 19.4
> Lifecorder intensity 4	25.2 ± 20.4
> Lifecorder intensity 5	11.7 ± 13.2
> Lifecorder intensity 6	7.0 ± 9.4
> Lifecorder intensity 7	1.3 ± 2.6

Table 2 Relationships between CAVI and other parameters

	r	*P*
Age	0.504	<0.001
BMI	-0.076	0.359
Home SBP	0.194	0.018
Home DBP	-0.126	0.127
LDL cholesterol	0.003	0.697
HDL cholesterol	-0.129	0.122
HbA1c	0.187	0.024
Daily step count	-0.105	0.204
Duration of physical activity		
in mild intensity (Lifecordere intensity 1-3)	-0.087	0.293
in moderate intensity (Lifecordere intensity 4-6)	-0.083	0.310
> Lifecorder intensity 4	-0.097	0.241
> Lifecorder intensity 5	-0.192	0.012
> Lifecorder intensity 6	-0.221	0.007
> Lifecorder intensity 7	-0.310	<0.001

BMI: Body mass index,
SBP: Systolic blood pressure
DBP Diastolic blood pressure
LDL: Low-density lipoprotein
HDL: High-density lipoprotein

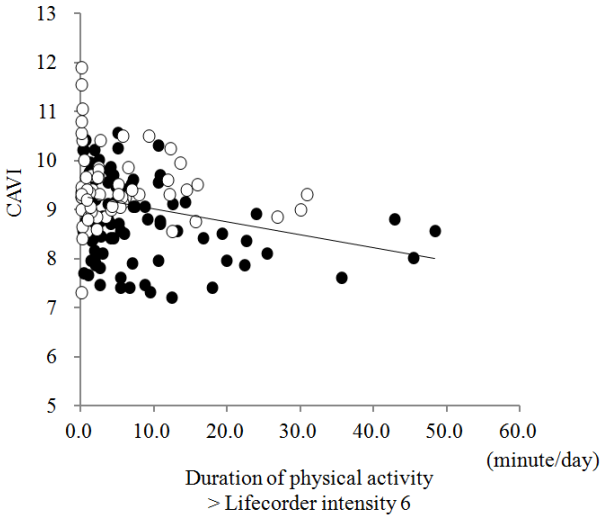

Figure 1
Relationship between CAVI and duration of physical activity more than Lifecorder intensity 6

Discussion

The results of present study suggest that duration of high intensity physical activity, rather than total amount of daily steps, associates arterial stiffness in community-dwelling elderly people.

Previous studies reported that habitual exercise associated with improved arterial stiffness. Tanaka et al [4] reported that the relationship between daily exercise and the arterial stiffness by comparing among three different intensity exercise. There was no significant difference between sedentary group and recreationally active group (mild intensity). However, Arterial stiffness in endurance trained group was lower than the other two groups. This result suggested that not only amount of physical activity but also intensity of physical activity related to arterial stiffness. Our findings support the previous study and suggest that intensity of physical activity is important for preventing age-related increases in arterial stiffness.

It is considered that exercise affects arterial function and structures. In the present study, a certain intensity level of physical activity may have these effects. Matsuda et al evaluated effects of exercise training on aortic wall elasticity and elastic components in rat [5]. Exercise rats had more distensible and higher elastin content in aorta than sedentary rats. But this study was conducted on younger rats. It was unclear that whether exercise affect on arterial structure in elderly adults or human. However, it is possible that pulse pressures and mechanical distensions during the exercise stretch collagen fibers and modify cross-linkings. Therefore increasing arterial extensibility could be expected in human. There is endothelium-depended vasodilation which is arterial function related to arterial stiffness. Desouza et al examined the influence of habitual aerobic exercise on the age-depended reduction in endothelium-depended vasodilatation [6]. The result showed that they did not find any relationship between age and endothelium-dependent vasodilatation in endurance-trained men.Therefore these results indicate that regular aerobic exercise can prevent the age-depended worsening in endothelium-dependent vasodilatation.

We must describe that our recruitment policy tended to favour healthy members of the community. Thus, the sample could have been more active than population of Japan in the same age group, we couldn't find out the threshold of physical activity which has effect of preventing age-depended increases in arterial stiffness.

Conclusions

The findings of the present study suggest that intensity of physical activity associates with arterial stiffness in community-dwelling elderly population. This result suggests that intensity of physical activity is required to countermeasure age-depended increases in arterial stiffness.

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EFFECTS OF BIOFEEDBACK USING A HOME TRAINING DEVICE FOR STRESS URINARY INCONTINENCE : A RANDOMIZED CONTROLLED TRIAL

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Introduction

Stress urinary incontinence (SUI) is defined as the complaint of any involuntary leakage on effort or exertion, or on sneezing or coughing[1)]. SUI is a common and distressing condition among parous women that can considerably impact quality of life. Although surgery is widely accepted as the treatment of choice for SUI, conservative management of this condition has received little focus in Japan. In the previous study, pelvic floor muscle training (PFMT) has been recommended as the first option for the treatment of SUI[2)]. On the other hand, the additive effect of biofeedback training is still controversial[3, 4)].

The present study compares the effects of PFMT with or without biofeedback to treat SUI at home.

Materials and Methods

Subjects: The subjects were recruited consecutively from the female urologic outpatients during October 2008 to April 2011. Inclusion criteria were history of stress urinary incontinence diagnosed by an urologist and leakage more than once a week. Exclusion criteria were genital protrusion beyond the vagina hymen, pregnancy, previous surgery for urology or gynecology at least within one year, use of medicine to counteract functional disabilities of the lower urinary tract, use of concomitant treatment during trial period, neurologic or psychiatric disease, urinary tract infection, any severe disease such as malignancy, and inability to understand instructions. 37 women were randomized to PFMT groups with (BF) or without (PFMT) biofeedback. The Research Ethics Committee of Nagoya University School of Medicine approved the study, and all of the study participants provided written informed consent.

Intervention: All the women visited the same physical therapist five times (0, 2, 4, 8, 12weeks). At the first visit, all the women individually received verbal information about pelvic floor anatomy, muscle localization, and function with the use of anatomical models and illustration. After that they learned a correct pelvic floor muscles (PFM) contraction without contracting adjacent muscles, such as the abdominal, gluteal, and hip adductor muscles with verbal instruction and palpation of perineal body. The women in the BF group learned correct contraction using biofeedback device (FemiScan clinic system, MegaElectronics, Kuopio, Finland, figure 1).

Home Program: All women were given verbal and written instructions for home practice and advised to practice for 10 minutes, twice per day, everyday in principle. The exercise session was designed to include short and long duration exercises, as both type Ⅰ and type Ⅱ muscle fibers need to be exercised. Additionally, all women were advised to pre-contract and hold a contraction before and during coughing, sneezing, and lifting.

EMG-assisted home training device: Each woman in the BF group received an individual EMG-assisted home training device (FemiScan home trainer, MegaElectronics, Kuopio, Finland, Figure 2) at the first visit and returned the device at the last visit. The device was consists of a vaginal probe and connected headphones, and is based on surface EMG for home use. While practicing the home program, the device emits a voice signals if the contraction is too weak or enough. The device can modify the exercise program according to change of PFM strength, and record PFM activities.

Outcome measure: The PFM strength was measured by perineometry. Perineometry was performed by use of air-filled silicone sensor connected portable perineometer with a pressure transducer (Peritron 9300V, Cardio-Design Pty Ltd, Australia, Figure 3). All women were encouraged to contract the PFM, and maximum contraction pressure was recorded. A three-day voiding dairy was completed to assess the numbers of incontinence episodes and of pads used, and voiding frequency. 1-hour pad test was performed to quantitatively evaluate the results. The King's health questionnaire (KHQ) was applied to assess a women's quality of life[5)]. The instrument yields score for nine domains: general health perceptions, incontinence impact, role limitations, physical limitations, social limitations, personal relationships, emotions, sleep/energy, incontinence severity measures. Each KHQ domain obtains a score and therefore there is no general score. The scores range from 0 to 100 and the higher the score, the poorer the quality of life. The International Consultation on Incontinence questionnaire-short form (ICIQ-SF) is a disease-specific questionnaire that assesses the symptoms and the quality of life of patients with urinary incontinence[6)]. The questionnaire consists of four questions pertaining to the frequency of leakage, amount of leakage, interference with everyday life, and the perceived cause of leakage. The scores for the first three questions were added to obtain the total score. The total score ranges from 0 to 21, and higher score indicates a more severe condition.

Analysis: As several variables were not normally distributed, pair-wise comparisons were made with the Mann-Whitney U test for between-group comparisons, and the Wilcoxon signed rank test compared changes within groups. All data were statistically analyzed using the SPSS 12.0J program, and p-values < .05 were considered significant, and were adjusted for multiple testing using Bonferroni correction.

Results

Maximum vaginal squeeze pressure significantly increased after exercise in both groups (both $p < 0.01$). At the point of 2, 8w, maximum vaginal squeeze pressure was higher in the BF group than the PFMT group ($p < 0.005$).

The number of incontinence episodes significantly decreased after exercise in both groups (both $p < 0.05$). The number of pads used per day and voiding frequency decreased in both groups, but the differences between before and after exercise in each did not reach significance.

The leakage of 1-h pad test decreased in both groups, and the difference between before and after exercise reached significance in the PFMT group ($p < 0.05$).

The total score for ICIQ-SF significantly decreased in both groups after exercise (both $p < 0.05$).

Scores for most domains of KHQ significantly decreased in both groups after exercise (both $p < 0.05$).

However, no differences in any assessed parameters between the groups were significant after exercise.

Discussion

The results of the present study showed that PFMT with or without biofeedback increased the strength of the PFM, decreased the number of incontinence episodes, and improved the quality of life of women with SUI. However, no statistically significance between the two groups was shown in any of the outcome variables after exercise. The results of the present study correspond with the largest randomized controlled trial of Mørkved et al[4].

In our study, PFMT with biofeedback promoted early progress in the PFM strength. On the other hand, no difference between the groups reach significant in the total score for ICIQ-SF. In previous study, Berghmans et al. demonstrated quicker reduction of leakage in the BF group[7]. The results of the present study contradicted the data from previous study.

The benefit of using biofeedback is that a small amplitude contraction with low force can be visualized. Using a device during training may motivate many women, thus this should be one of the options in the clinical practice.

Conclusions

The present study showed that PFMT with or without biofeedback increased the strength of the PFM, decreased the number of incontinence episodes, and improved the quality of life of women with SUI. However, the additive effects of biofeedback training were not discernable.

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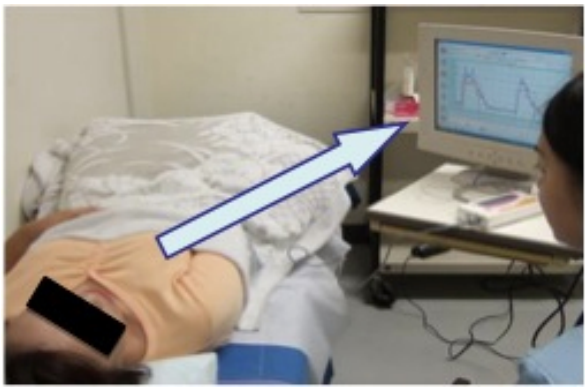

Figure 1. PFMT using biofeedback device

Muscle activity signals were visible on the computer screen.

Figure 2. Home training device (FemiScan)

The device was consists of a vaginal probe and connected headphones, and is based on surface EMG for home use.

Figure 3. Perineometer (Peritron 9300V)

Perineometry was performed by use of air-filled silicone sensor connected portable perineometer with a pressure transducer.

Relationship between Coronary Risk Factor and Endothelial Function in Community - Dwelling Elderly Female.

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Introduction

Endothelial dysfunction is independent risk factor of cardiovascular events and affected by coronary risk factors such as hypertension (1). Previous study demonstrated that lower physical activity level was associated with endothelial dysfunction suggesting that lower physical activity might affect on vascular endothelial dysfunction (2).

Endothelial function is maintained until 40 years old in male and 50 years old in female, after that it decreases with aging (3). However, there are few reports of the factors which affect vascular endothelial function in community-dwelling elderly population, especially Japanese over 60 years old (4).

Therefore, this study aimed to investigate the association between vascular endothelial function and coronary risk factors including physical inactivity in community-dwelling elderly population.

Materials and Methods

Subjects: We enrolled 71 subjects in this research. Inclusion criteria were 60-74 years old in community-dwelling elderly female.

Measurements: We evaluated age, body mass index (BMI) and home blood pressure as baseline data. The number of steps, low intensity, moderate intensity, and high intensity activity time were measured by using an electrical accelerometer (Life Corder, Suzuken.Co). All participants were instructed to put on the accelerometer themselves and were instructed to use the accelerometer 24 h/day for 1 week, except while bathing and sleeping. High-density lipoprotein cholesterol (HDL-C), low density lipoprotein cholesterol (LDL-C) and HbA1c were measured by blood sample. Blood pressure was measured for consecutive three days in each subject by same type digitral sphygmomanometer and average value for three days was calculated as home blood pressure.

n this research, we defined hypertension (>135/80 mmHg and/or current use of antihypertensive agents), dyslipidemia (HDL-C＜40mg/dl, LDL-C≧140mg/dl and/or current use of lipid-lowering agents), diabetes mellitus (HbA1c ≧ 5.8% and/or current use of insulin or oral medication for diabetes), Obesity (BMI ≧ 25), and physical inactivity (＜ median number of steps per day) as coronary risk factors.

The vascular endothelial function was assessed by measuring flow-mediated dilatation (FMD) of the brachial artery by ultrasonic diagnostic equipment (UNEXEF, UNEX.Co). The participants were instructed to fast and to abstain from smoking and from ingesting alcohol, caffeine prior to testing in the morning. They took medicines as usual. The participants had a supine position after 15 minute rest in a quiet temperature-controlled (22−24℃) laboratory setting. Using a 10-MHz linear array transducer probe, the longitudinal image of the right brachial artery was continuously recorded from baseline to at 2 minute after the cuff deflation that followed super systolic compression (50mmHg above systolic blood pressure) of the right forearm for 5 minute. We use flow-mediated total dilation %FMTD as index of vascular endothelial function because of good reproducibility (5). %FMTD was calculated as the maximum percent increase in arterial diameter from the diameter immediately after cuff deflation.

Data analysis: In order to investigate the relationship between coronary risk factors and endothelial function, we divided the subjects into two groups by coronary risk factors: no or 1 risk factor group and 2 or more factors group. Then we performed Mann–Whitney U test to compare %FMTD between each group. Secondly, we divided the subjects into two groups by median value of %FMTD and Mann–Whitney U test or unpaired t-test were used to compare age, SBP, DBP, HDL-C, LDL-C, HbA1c, BMI, number of average steps per day, duration in low intensity, middle intensity, and high intensity activity time. Variables with a $p < 0.1$ from this analysis were entered into the multiple logistic regression analysis for selecting independent associate factors. All analyses were performed by the SPSS 12.0J software package (SPSS Inc, Tokyo, Japan). A p value of < 0.05 was considered statistically significance.

Results

Table 1 shows the characteristics of all participants. %FMTD was significantly higher in lower coronary risk factor group (Fig1). Table 2 shows the clinical characteristics of higher and lower %FMTD groups. HDL-C, number of steps and low intensity activity time were significantly better in higher %FMTD group. Table 3 shows the result of the multiple logistic regression analysis. HDL-C and number of step were selected as independent factors for higher %FMTD group.

Table1 Characteristics of participants

	Female n=71
Age	69.6±3.2
Hypertension	43(60.6%)
Dyslipidemia	37(52.1%)
Diabetes mellitus	10(14.1%)
Obesity	10(14.1%)
Physical inactivity	36(50.7%)
Coronary risk factor	1.96±1.0
Average number of step (step/day)	8295±3296
Low intensity activity time（min/day）	57.7±18.2
Moderate intensity activity time（min/day）	25.0±19.2
High intensity activity time（min/day）	1.8±3.3
FMTD (%)	4.84±2.3

Data are presented as means ±SD.
FMTD; flow-mediated total dilation

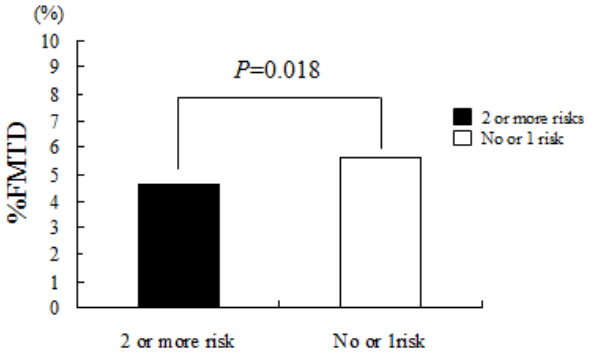

Fig1 Comparison of %FMTD in low and high coronary risk factor group.

Table2 Difference in each factors between high and low FMTD

	Low %FMTD n=35	High %FMTD n=36	*P*
Age	69.3±3.6	70.0±2.9	0.586
SBP	134.1±13.9	134.7±19.2	0.565
DBP	79.7±8.1	80.4±10.8	0.818
HDL-C	60.3±9.9	68.6±11.4	0.002
LDL-C	111.9±24.2	120.4±29.4	0.199
HbA1c	5.5±0.5	5.4±0.6	0.332
BMI	21.3±2.9	22.7±3.4	0.089
Average number of step	7076±2253	9448±3718	0.003
Low intensity activity time	53.1±13.1	62.0±21.2	0.037
Moderate intensity activity time	19.5±11.7	30.3±23.2	0.059
High intensity activity time	1.1±1.1	2.5±4.4	0.141

Data are presented as means ±SD.
%FMTD; %flow-mediated total dilation, SBP; systolic blood pressure
DBP; diastolic blood pressure, HDL-C; high-density lipoprotein cholesterol
LDL; low density lipoprotein cholesterol, HbA1c; hemoglobin A1c
BMI; body-mass index

Table3 Result of Multivariate regression analysis

	Odds ratio (95%CI)	*P*
HDL-C	1.05 (1.00 -1.11)	0.045
Average number of step	1.00 (1.00 -1.0004)	0.037

HDL-C; high-density lipoprotein cholesterol
Dependent variables: High %FMTD group
Independent variables: HDL-C, BMI, Average number of step, Low intensity, Moderate intensity, High intensity activity time

Discussion

The main finding of this study was that vascular endothelial function was associated with physical activity in community-dwelling elderly female population as well as HDL-C. To our knowledge, this is the first report to demonstrate the relationship between vascular endothelial function and coronary risk factors including physical inactivity in the community-dwelling female elderly.

Tomiyama et al. reported that coronary risk factors such as age, gender, BMI, systolic blood pressure, diastolic blood pressure, HDL-C, triglycerides, fasting glucose and smoking habit were independently associated with endothelial function in Japanese normal subjects. (4). Their study reported that subjects in low Framingham risk score group showed higher %FMD than those with high score group. The results in this study are in line with their results, adding new aspect of the effects of physical inactivity. However, they did not analyze the effects of physical activity. Our findings add the physical inactivity as well as HDL-C is also a keen factor for endothelial dysfunction even in the elderly female population. The effect of physical inactivity on endothelial function is also reported in peripheral artery disease (2). Thus, several reports including our findings suggest the physical activity level should take into account to assess endothelial function.

There are several potential limitations to the findings in the present study. A relatively small sample size might affect the results. Therefore, this study could function as a preliminary study for vascular endothelial dysfunction in community-dwelling female population. Other coronary risk factors, such as smoking, alcohol, metabolic syndrome and chronic kidney disease, potential factors to associate with endothelial dysfunction, may need to be studied to provide more details. Nevertheless, the present study is the first report of clinical associates of vascular endothelial function in the female elderly.

Conclusion

The findings of the present study suggest that endothelial function in the community-dwelling female elderly is associated with the number of coronary risk factors including physical inactivity.

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A Comparison of Pelvic and Spine Angle in Various Cross-legged Sitting Postures

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INTRODUCTION:

Orientation of pelvis during sitting influences on spine curve because the pelvis is considered as the base for the spine in the spine-pelvic complex. According to the Tully's buttom-up mechanism, in sagittal plane, increased anterior pelvic tilt leads to a larger lumbar lordosis and compensatory increases in the thoracic and cervical kyphosis. In addition, in frontal plane, postural and structural pelvic asymmetry is related to compensatory scoliosis.

Cross-legged sitting is one of the most preferred sitting postures. Because cross-legged sitting requires less effort of the internal and external oblique abdominal muscles, people feel less fatigue in this posture compared to uncrossed sitting. Also, adducted and flexed hip joints in leg crossing contribute to the stability of the sacroiliac joints. However, prolonged asymmetric use of abdominal muscles and uneven pressure distribution to the buttocks increase pelvic and lumbar rotation, and may cause lower back pain in the long run. Previous studies have primarily focused on the influence of the cross-legged sitting on the muscle activation not on the biomechanical aspects of pelvic and spine structures. Therefore, the objective of current study was to investigate possible kinetic and kinematic changes that may occur in the pelvic and spine regions during cross-legged sitting postures.

METHODS: Experiments were performed on sixteen healthy subjects. Kinetic and kinematic data were collected while the subject sat in 4 different sitting postures for 5 seconds: sitting while placing his right knee on the left knee (KK), sitting by placing right ankle on left knee (AK), sitting by placing right ankle over the left ankle (AA), and uncrossed sitting with both feet on the floor (US). The order of the sitting posture was random. The sagittal plane angles (pelvic tilt, lumbar A-P curve, thoracic A-P curve) and the frontal plane angles (pelvic height, lumber lateral curves, thoracic lateral curves) were obtained using Vicon system with 6 cameras and analyzed with Nexus software. The pressure on each buttock was measured using Tekscan. Repeated one-way analysis of variance (ANOVA) was used to compare the angle and pressure across the four postures. The Bonferroni's post hoc test was used to determine the differences between upright trunk sitting and cross-legged postures.

RESULTS: In sagittal plane, cross-legged sitting postures showed significantly greater kyphotic curves in lumbar and thoracic spine when compared uncrossed sitting posture. Also, pelvic posterior tilting was greater in cross-legged postures. In frontal plane, only pelvic height of the right leg was significantly higher in KK sitting than in US. Finally, in KK sitting, the pressure on the right buttock area was greater than US and ,in AK sitting, the pressure on the left buttock area was greater than US. However, all dependent variables in both planes did not demonstrate any significant difference among the three cross-legged postures ($p>.05$).

CONCLUSION: The findings suggest that asymmetric changes in the pelvic and spine region secondary to the prolonged cross-legged sitting postures may cause lower back pain and deformities in the spine structures.

Comparison of Abdominal Muscle Activity During a Single-Leg Hold in the Hook-Lying Position on the Floor and on a Round Foam Roll

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INTRODUCTION: To improve trunk stability or trunk muscle strength, many athletic trainers and physiotherapists use various types of unstable equipment for training. The round foam roll is one of those unstable pieces of equipment and may be useful for improving trunk stability. To assess the effect of the supporting surface (floor versus round foam roll) on the activity of abdominal muscles during a single-leg hold exercise performed in the hooklying position on the floor and on a round foam roll. We hypothesized that performing the exercise on a round foam roll would induce greater muscle activity than the same maneuver on the floor.

METHODS: Nineteen healthy volunteers (11 men, 8 women) from a university population. The participants were instructed to perform a single-leg hold exercise while in the hook-lying position on the floor (stable surface) and on a round foam roll (unstable surface). Surface electromyography (EMG) signals were recorded from the bilateral rectus abdominis, internal oblique, and external oblique muscles. Dependent variables were examined with a paired *t* test.

RESULTS: The EMG activities in all abdominal muscles were greater during the single-leg hold exercise performed on the round foam roll than on the stable surface. The percentage increment of muscle activity was 88.08% in the contralateral RA (Padj = .003), 107.81% in the ipsilateral RA (Padj < .001), 51.67% in the contralateral EO (Padj = .003), 96.59% in the ipsilateral EO (Padj < .001), 172.24% in the contralateral TrA/IO (Padj < .001), and 118.88% in the ipsilateral TrA/IO (Padj = .001).

CONCLUSION: The single-leg hold exercise in the hook-lying position on an unstable supporting surface induced greater abdominal muscle EMG amplitude than the same exercise performed on a stable supporting surface. These results suggest that performing the single-leg hold exercise while in the hooklying position on a round foam roll is useful for activating the abdominal muscles.

Relationship between electromyographic activity of the abductor hallucis and the pressure of a pinch gauge during short foot exercise

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INTRODUCTION:
The abductor hallucis (AbdH) muscle has important roles in maintaining stance, gait, and balance. Several different strengthening methods for the AbdH have been described in order to prevent overuse injuries in people with problems from excessive pronation. One of the recommended exercises is the "short foot" (SF), which is accomplished by bring the head of the first metatarsal toward the heel without toe flexion. Previous study reported that SF exercise showed great electromyographic (EMG) activity in the AbdH. However, it is difficult to keep the first metatarsal head and heel simultaneously on the ground during the SF exercise. Therefore, the aim of this study is to investigate the correlation between the EMG activity of AbdH and the amount of pressure measured by a pinch gauge (PG), and to compare the AbdH activity and the pressure measured by the PG during SF exercise between subjects with pes planus and in subjects with a neutral foot alignment.

METHODS: Fourteen subjects were recruited for this study (pes planus group=7; neutral foot alignment group=7). We screened the foot type of the subjects by measuring the resting calcaneal stance position (neutral alignment: between 2° of inversion and 2° of eversion) and their scores on the navicular drop test (neutral alignment: between 5 and 9 ㎜). A surface EMG was used to collect AbdH activity, and a PG was positioned under the first metatarsophalangeal joint to measure the pressure produced by the first metatarsal head during the SF exercise. The means of three trials for each exercise were used for data analysis.

RESULTS: The muscle activity of the AbdH and the pressure measured by the PG showed a high correlation ($r=.80$, $p=.001$). The EMG activity of the AbdH and the pressure measured by the PG, is significantly lower for subjects with pes planus than for those with a neutral foot alignment ($p<.05$).

CONCLUSION: Based on these findings, the PG can be recommended as an effective instrument for evaluating the performance of the AbdH. It may also be beneficial for monitoring how well the SF exercise is performed, and for providing visual feedback to patients during SF exercise in a clinical setting.

A Novel EEG-based Brain Mapping to Determine Cortical Activation Patterns in Normal and Cerebral Palsy during Motor Imagery Tasks

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INTRODUCTION: Motor imagery is a promising neurorehabilitation technique, which plays a crucial role in motor relearning and associated skill reacquisition in children with cerebral palsy (CP). Recent empirical evidence suggests that the motor impairments in children with CP are associated not only with movement execution dysfunction, but also with impaired motor planning and motor imagery, which involve an important cognitive-motor process and motor control. Nevertheless, there is a dearth of evidence highlighting neural substrates underpinning motor imagery. Hence, our study was to determine and compare cortical activation patterns using the obtained EEG topographical maps in normal and children with cerebral palsy during motor execution and motor imagery tasks.

METHODS: Four normal and four children with CP (mean 11.7 y) were recruited from a community medical center. A EEG-based brain mapping system with 30 scalp sites (extended 10-20 system) was used to determine cortical reorganization in the region of interests (ROIs) during four motor tasks; movement execution (ME), kinesthetic-motor imagery (KMI), observation of movement (OOM), and visual motor imagery (VMI). ROIs included the primary sensorimotor cortex (SMC), the premotor cortex (PMC), and the supplementary motor area (SMA).

RESULT: EEG brain mapping data showed increased activation in SMC during the ME-KMI block and in SMC and visual cortex (VC) during KMI in normal children, respectively. Children with CP showed relatively similar SMC activation along with other motor network areas (PMC, SMA and VC) activation. During the OOM-VMI block, normal children primarily activated VC or occipital area whereas children with CP activated VC and SMC and bilateral auditory areas.

CONCLUSION: This is the first study highlighting different neural substrates used for motor imagery tasks in normal and children with CP. In conclusion, given the status of the real-time EEG-based brain mapping system as a new technology, examination of its potential efficiency in rehabilitation has only just begun. However, our brain mapping system can be used as an alternative neuroimaging vehicle to probe underlying neural recovery mechanisms and as a powerful real-time neurofeedback system for individuals with stroke or CP. Further studies with a larger sample size are warranted for generalization of our EEG measurement.

Keywords: Motor imagery, EEG, Cortical activation, Topographical map

Inter-rater Reliability of Thickness Measurement of the Abdominal Muscles Using Ultrasonography According to Different Probe Location and Measurement Technique

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INTRODUCTION: The ultrasonography (US) is useful for assessing muscle thickness and guiding rehabilitation decision-making for clinicians and researchers recently. The previous studies have not reported about the inter-rater reliability of ultrasound measurements from different probe location and measurement technique. Thus, the purpose of this study was to determine the inter-rater reliability of the ultrasound measurement according to different probe location and measurement technique for thickness measurement of the abdominal muscles.

METHODS: Twenty healthy volunteers were recruited in this study. Muscle thickness of the transversus abdominis (TrA), internal oblique (IO) and external oblique (EO) were measured over the 3 times in the supine position. Prior to muscle thickness measurement, two examiners underwent 20 hours of hands-on training for the specific US protocol. The 3 different probe locations were as follows; 1) Probe location 1 (PL1) was located immediately below the rib cage in direct vertical alignment with the anterior superior iliac spine (ASIS). 2) Probe location 2 (PL2) was located halfway between the ASIS and the ribcage along the mid-axillary line. 3) Probe location 3 (PL3) was located halfway between the iliac crest and the inferior angle of the rib cage and then adjusted to ensure the medial edge of the TrA. The 2 different measurement techniques were as follows; 1) Measurement technique A (TA) was in the middle of the captured image. 2) Measurement technique B (TB) was along a horizontal reference line located 2 cm apart from the medial edge of the TrA in the captured image. All US were captured at the end of inspiration at rest (RI), the end of expiration at rest (RE) and with abdominal drawing-in maneuver at the end of inspiration (AI). Intraclass correlation coefficient (ICC) (3,1) was used to calculate the inter-rater reliability of the thickness measurement of TrA, IO and EO using the values from both the first and second examiner.

RESULTS: The ICC(3,1) value of inter-rater reliability of IO in RI, RE and AI for all different probe location and measurement technique demonstrated excellent reliability value ICC(3,1)=.92~.97. The ICC(3,1) value of inter-rater reliability of TrA and EO in RI, RE and AI for all different probe location and measurement technique demonstrated moderate to excellent reliability value ICC(3,1)=.68~.94; except ICC(3,1) of TrA in RE for PL2-TA=.19.

CONCLUSION: All the ICC(3,1) value of inter-rater reliability for three probe location and two measurement technique were moderate to excellent. Especially, The ICC(3,1) value of inter-rater reliability of IO in RI, RE and AI for three probe location and two measurement technique were excellent. In conclusion, the use of US in different probe location and measurement technique would be recommended for thickness measurement of the abdominal muscles.

Key Words: Abdominal muscles; Inter-rater reliability; Muscle thickness; Ultrasonography.