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Compared to Bone Mineral Density between Dominant Side and Recessive Side in Normal Elderly and Stroke Patients

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ABSTRACT

Purpose : The purpose of this study of normal elderly and stroke patients by comparing the dominant side and recessive side was to evaluate the differents between each

Methods : Thirty-two elderly participated in this study. They were classified two groups: stroke patients group and the normal elderly group. Outcome measures were: general characteristics and BMD. General characteristics included age, height, weight and body mass index. BMD was represented in the osteoporosis index, T-score and Z-score. The measurements of bone mineral density were evaluated on the calcaneus region of the dominant and recessive side, using OsteoPro. The data analyzed using SPSS 17.0 software and the Paired-sample T-test and the Independent-sample T-test

Results : OI, T-score, Z-score showed no significant differences between dominant side and recessive side in normal elderly group. But stroke patients group showed OI, T-score, Z-score significant differences between paretic side and nonparetic side. Change score subtracted recessive side from dominant side was significant differences between stroke patients group and normal elderly group.

Conclusion : There is positive relationship between physical activity and BMD in stroke patients. Therefore, improved physical activity can have a beneficial effect by reducing osteoporosis in stroke patients, considering a positive relationship between physical activity and BMD.

Key Words : Bone mineral density, Osteoporosis, Stroke

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I. Introduction

Stroke refers to a neurologic dysfunction caused by a local brian tissue abnormality as the oxygen and glucose supply to the brain tissues through bloodstream becomes continuously deficient due to a cerebrovascular abnormality. Muscle weakening caused by the disorder in the ability to generate force is often observed in stroke patients.

The muscle weakening is generally found at the upper limb and the lower limb of one side as a hemiparesis on the side opposite to the affected side. As the limitation in movement due to the paralysis decreases muscular strength, and reduces physical activity by diminishing body weight load to the morbid side, osteoporosis easily occurs in stroke patients. Osteoporosis, the most common bone metabolism disease, is one of the major causes of geriatric chronic disorders.

Osteoporosis may be defined clinically by an existence of fracture, histomor phologically by decreased bone matrix per unit volume, and dynamically by a state of elevated fracture risk. Relatively many studies have been conducted on the causes and the characteristics of osteoporosis occurring after stroke. Sato et al. reported that bone decrease was started due to the increased bone absorption during the early stage of stroke, mainly by the effect of immobilization(Sato et al, 2000). As time elapses after an onset of stroke, the incidence rate of osteoporosis and the risk of fracture increase(Ramnemark et al, 2000; Ramnemark et al, 1999).

The related factors include paralysis period, paralysis degree, age, blood calcium level, 25 - hydroxy vitamin D concentration, diabetes, menopause, hyperthyroidism, and Cushing's syndrome.

Osteoporosis easily occurs in stroke patient, increasing the risk of fracture(Satto, 2000). Fracture by osteoporosis is difficult to treat, leads to complications by fracture, and causes heavy socioeconomic load including increased mortality, increased distress in the patient and the family, increased period of hospitalization, and increased medical cost(Ramnemark et al, 1998) Because osteoporosis in stroke patients is such an important factor to the result of the rehabilitation treatment, the treatment procedure is very significannt. Many studies have provided evidence of the usefulness of increased physical exercise in stroke patients, but the correlation between the normal elderly and stroke hemiplegic patients with respect to bone density has not been conducted sufficiently.

In this study, bone density was measured in the normal elderly and the stroke hemiplegic patients at the age of 60 or higher to investigate the bone density difference between the dominant side and the non-dominant side in the normal elderly, and between the dominant side and the non-dominant side in the stroke hemiplegic patients.

II. Subject and Methods

The subjects of this study were 12 elderly persons at the age of 60 or higher who had been an elderly nursing home located in D city for more than six months and had the history of stroke, and 20 other persons having no history of stroke in the control group.

The patient group included nine males and three females, and the control group included four males and 16 females. The subjects were those who were able to follow the directions of a doctor and to give an answer to a question, those who were able to carry out verbal communication, those had not taken any drugs affecting bone density including alcohol and cigarette, and those who had given consent to the participation in the study. All of them understood the purpose of this study and gave their written informed consent before experimental involvement.

The study was performed according to the orinciples of the Declaration of Helsinki, and ethical approval was granted by the local committee of the Institution Review Board of Keimyoung university hospital. The mean age of the subjects was 73.15 ± 8.53, the mean height 1.57 ± 0.09 m, the mean weight 56.15 ± 10.54 kg, and the mean body mass index 22.52 ± 3.71 kg/m²(Table 1).

Aquantitative ultra sonographic system, Osteo-Pro (BM Tech, Korea), was employed to measure bone density. Bone density was decided with reference to the osteoporosis index (OI), T-score, and Z-score. OI is an index where all the factors influencing bone density are optimally combined (LaFleur et al, 2008). Z-scroe is the value obtained by dividing the difference between a certain subject's result and the normal mean value of the same age and sex group by the standard deviation of the normal values. T-score is the value obtained by dividing the difference between the result of a certain subject's result and the maximum bone density value by the standard deviation of the normal values.

World Health Organization has decided the clinical reference of bone density by applying the T-score to adult women: normal, BMD (bone matrix density) = -1 SD; osteopenia, -1 SD>BMD=-2.5 SD; and osteoporosis BMD=-2.5 SD. The difference in the bone density was calculated between the paretic side and the non-paretic side in the stroke group, and between the dominant side and the non-dominant side in the normal elderly group(Sosa et al, 2009).

The subjects were divided in to the stroke group and the elderly group. The bone density parameters, OI, t-score, and z-score, were compared and analyzed by performing a paired-sample t-test with respect to the paretic side and the non-paretic side in the stroke group, and with respect to the dominant side and the non-dominant side in the elderly group. An independent-sample t-test was performed to investigate the difference between the stroke group and the elderly group, comparing the change values between the two groups.

All the data were presented as "mean± standard deviation," and the significance was determined with reference to the p value of 0.05. A commercial statistics software SPSS ver. 17.0 for Windows was used for the statistical processing of the data.

III. Result

1. Comparison of bone density between the dominant side and the non-dominant side in the elderly group.

None of OI, T-score, and Z-score showed a significant difference between the dominant side and the non-dominant side in the elderly group(Table 2).

2. Comparison of bone density between the paretic side and the non-paretic side in the stroke group.

All of OI, T-score, and Z-score were significantly higher in the non-paretic side than in the paretic side in the stroke group(Table 2).

3. Comparison of bone density between the elderly group and the stroke group.

OI, T-score, and Z-score of each of the elderly group and the stroke group were compared, and the change in the two groups were also compared(Table 2).

The change in all of OI, T-score, and Z-score was significantly different between the two groups. The non-paretic side of the stroke group showed the highest values in each of OI, T-score, and Z-score(Table 2).

IV. Discussion

In this study, bone density was measured by using quantitative ultra sonography which has the advantages that it is harmless to human body, economical, and partially reflects the qualitative aspects of bone. Quantitative ultrasonography is used for diagnosis of osteoporosis as a part of various tests, being useful in evaluating bone quality(Maatta et al, 2009). The heel bone is used in the measurement, and more than 90% of the heel bone is composed of cartilage. The heel bone is highly correlated with the lumbar vertebra or the femur where fracture takes place often. It was reported that the heel bone density measured by broadband ultrasound attenuation is significantly correlated with spinal and femoral bone density measured by dual energy X-ray absorptiometry (Brooke et al, 2008). In quantitative ultra sonography, two parameters of speed of sound (SOS) and BUA are used to measure the speed and the attenuation of ultrasound penetrating bone matrix on the basis of the principle that the propagation speed and the degree of attenuation of ultrasound are increased as the density of a medium is increased. The measured bone density values are generally interpreted by comparing them with the

Table 1. General characte study participants

Characteristics	Mean±SD	Range
Age(year)	73.15±8.53	64.62~81.68
Height(meter)	1.57±0.09	1.48~1.66
Weight(kg)	56.15±10.54	45.61~66.69
BMI(kg/m^2)	22.52±3.71	18.81~26.23

Table 2. Comparison of OI, T-score, Z-score between Elderly and Stroke

BMD	Elderly				Stroke				Between group
	R foot	L foot	change	p-value*	nonparetic	paretic	change	P-value	P-value**
OI	36.30 ±5.26	35.71 ±5.74	0.59 ±3.60	0.50	41.43 ±5.14	38.06 ±4.82	3.37 ±3.74	0	0.03
T-score	-2.86 ±0.98	-2.98 ±1.01	0.12 ±0.71	0.49	-2.3 ±1.04	-2.97 ±0.96	0.67 ±0.74	0	0.03
Z-score	-0.14 ±-0.98	-0.33 ±0.92	0.20 ±0.94	0.38	-0.61 ±1.16	-1.28 ±1.18	0.67 ±0.74	0	0.1

normal mean values between the age, sex, and racial groups. OI is an index where all the factors influencing bone density are optimally combined. Z-scroe is the value obtained by dividing the difference between a certain subject's result and the normal mean value of the same age and sex group by the standard deviation of the normal values. T-score is the value obtained by dividing the difference between the result of a certain subject's result and the maximum bone density value by the standard deviation of the normal values((LaFleur et al, 2008; Sosa et al, 2009). Z-score is often applied to patients of a high age (around 70 years of age), and T-score is applied to others. In this study, OI, T-score, and Z-score showed a significant difference in the change in the stroke group. According to the WHO T-score clinical reference, the mean T-score of the elderly group was -2.86 ± 0.98 on the dominant side, and -2.98 ± 1.01 on the non-dominant side, both of which corresponded to osteopenia. The mean T-score of the stroke group was -2.3 ± 1.04 on the non-paretic side, and -2.97 ± 0.96 on the paretic side, and thus the T-score of the non-paretic side corresponded to osteopenia, and that of the paretic side corresponded to osteoporosis. Therefore, it is presumed that the increase of the excessive physical activity on the non-paretic side in the stroke group, caused by the increase in the body weight-supporting load on the non-paretic side during daily living, might have bone density to the level higher than that of the normal subjects(Shan et al, 2009; Silva et al, 2007). According to the studies that have been conducted until now, the following two mechanisms are considered to be involved in the decrease of bone density due to the decreased physical activity by hemiplegia. The first is the increased bone absorption due to the limited physical activity by paralysis as well as the disorder in bone mineralization due to the decreased weight load. The second is the increased parathyroid hormone secretion by the decreased serum calcium concentration caused by vitamin D deficiency due to the insufficient nutrient intake and sunlight exposure(Sato et al, 1998; Sahin et al, 2001). Muscular paralysis by stroke causes decreased physical activity by weakening muscle strength and diminishing body weight load to the morbid side. Physical activity plays an important role in maintaining bone mass and bone metabolism. Limited physical activity due to muscular paralysis increases bone absorption and decreases weight load to bones, thus

causing an disorder in bone mineralizatio

n. Mechanical stress on a bone is one of the factors determining osteogenesis, bone density, and bone strength. Induction of immobilization in post-stroke hemiplegia patients increases bone absorption, decrea

ases osteogenesis, and eventually causes osteanabrosis and bone weakening, which is called osteoporosis of disuse. Osteoporo

sis of disuse is caused by long-term immobilization due to stroke, muscular paralysis by the injury in the central nervous system, spinal nerve or periphera

l nerve, muscular inactivity by a disease in the joint or muscle, and agravity. According to Wolff's law, bone morpholo

gy and bone density are dependent on the force applied to a bone. The force normally applied to a bone may not be normally applied during a long-term immobilization and weight load-free period (Krolner et al, 1983; Uhthoff & Jaworski, 1978). Weight load exercise has been reported to be more effective than non-weight load exercise in increasing bone density because weight load exercise activates osteoblasts by applying pressure to a bone through muscular contraction. Mechanical force is necessary in maintaini ng bone mass in a body, while disuse causes decrease in bone mass(Abramson & Delagi, 1961).

An increase in physical activity shows an osteoporosis preventing effect by decreasing the frequency of fracture and increasing bone density by increasing the stress on a bone, including gravity and muscular tension(Slemenda et al, 1991). In a similar study about the bone density change after stroke, Liu et al. measured the bone density in the humerus, radius, femur, heel bone, and lumbar vertebra on the paretic side and on the non-paretic side, and compared the density at the time of being hospitalized and at the time of being discharged, showing that the bone density was lower on the paretic side than on the non-paretic side(Liu et al, 1999). Many other researchers also reported that the bone density was lower on the paretic side than on the non-pareti ic side in hemiplegic patients(Hamdy et al, 1999; Jorgensen et al, 2001). There are also reports showing that body weight load exercise increased bone density. Jorgensen et al. observed the change in bone density, and showed that the bone mass loss was lower in the group where the patients had started walking within two months after stroke than in the group where the patients had been unable to do so.(Jorgensen et al, 2000). With respect to physical activity, it has been reported in most of the reports, including the reports of Kohrt et al. and Unsi et al., that appropriate physical activity reduced the risk of fracture by maintaining or increasing bone density(Ko hrt et al, 1997; Unsi et al, 1998). Howeve er, Young et al. and Bauer et al. reported differently(Young et al, 1995; Bauer et al, 1993). The result of this study showed that the bone density was higher on the non-paretic side than on the paretic side due to the limited physical activity caused by stroke. In this study, bone density on the heel bone was compared between the dominant side and the non-dominant side(Yang et al, 1997; Gumustekin et al, 2004). The result showed that there was not a significant difference in bone density between the dominant side and the non-dominant side in normal elderly group. However, the bone density was higher on the non-paretic side than on the paretic side in stroke patients. The bone density was the highest on the non-paretic side of stroke patients. According to the results of this study as well as the previous studies, it may be presumed that physical activity may prevent the decrease in bone density, and that accomplishing the maximum functional recovery in hemiplegic patients is critical to the prevention of the general bone density decrease in a body. Limitations of this study include a small sample size. Therefore, future studies need to be conducted with complements these limitations.

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