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An Analysis of the Changes in Bone Mineral Density in Long-Stay Patients of a Geriatric Hospital in Relation to Physical Therapy

The purpose of this study is to examine the changes in bone mineral density in long-stay patients of a geriatric hospital in relation to physical therapy, thereby providing basic data for preventing the onset or deterioration of osteoporosis in inpatients of geriatric hospitals or relevant facilities. The subjects of this study were 133 elderly patients who had been in H geriatric hospital in Yongin-si for more than four years. Their bone mineral density T-scores at admission and those after four years were measured to compare and analyze the changes in bone mineral density in relation to physical therapy. According to the results, the decrease in T-score for the group without physical therapy was greater by .40 than that for the group with physical therapy, indicating a statistically significant difference between the two groups($p<.01$). Accordingly, physical therapy proved to be effective in preventing bone mineral density loss and maintaining the current density.

Key words: *Bone Mineral Density; T-score; Physical Therapy; Geriatric Hospital*

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INTRODUCTION

Osteoporosis, one of the metabolic diseases accompanying aging, is defined by the WHO as a generalized skeletal disorder of low bone mass and deterioration in its architecture(1), causing susceptibility to fracture.

In the human skeleton, bones are composed of two-thirds mineral matter, such as calcium and phosphate, and one-third organic matter, which is mainly collagen. They support and protect the body and store a variety of minerals that contribute to the metabolic process(2).

Bones are repeatedly produced and destroyed all one's life long. Bone mineral density increases during the growth phase, while it gradually decreases as osteoclast activity becomes greater with aging. Osteoporosis caused by such bone loss leads to a skeletal imbalance and a decrease in the biomechanical function of the skeleton. However, exercise helps to increase bone mass by applying gravity and decrease bone loss, thereby preventing and treating osteoporosis(3, 4). Regular participation in physical activities has been emphasized as the most important factor in healthy elderly life and functional independence(5). An increase in physical activities and mechanical loading exercise prevents mineral loss and maintain appropriate levels of bone mineral density in the elderly, reducing the risk of fracture that accompanies aging(6). In addition, bone mineralization tends to occur more actively in osteoporosis patients due to exercise than in normal people(7). Moreover, as such exercise influences bones by not only loading bones but also enabling muscles to work, strengthening muscles can be one of the ways to increase bone mineral density(8).

Considering the percentage of elderly population over 65, Korea has already entered an aging society and is expected to enter a super-aging society with over 20% of elderly population in 2027, and there are currently 833 geriatric hospitals and relevant facilities in Korea(9, 10). Among elderly patients using these

hospitals and facilities, patients with osteoporosis have a high level of dependence on medications, and studies of the effects of collateral diet and exercise therapy are relatively scarce, which is why more studies of exercise therapy need to be conducted (11). Moreover, studies of the clinical effects of physical therapy through rehabilitation exercise on bone mineral density in elderly patients are currently insufficient. Thus, this researcher intends to examine the changes in bone mineral density in long-stay elderly patients over 60 of a geriatric hospital in relation to physical therapy, thereby providing basic data for clinical studies focused on prevention of the onset or deterioration of osteoporosis in patients of geriatric hospitals or relevant facilities.

METHODS

Subjects

This study examined 133 elderly patients, aged 60 or older, who were hospitalized in H geriatric hospital in Yongin-si, Gyeonggi-do for more than four years between 2002 and 2011.

The general characteristics of the subjects were as follows. In terms of gender, 105(78.9%) were females, while 28(21.1%) were males. In terms of age group, 12(9%) were in their 60's, 28(21.1%) in their 70's, 50(37.6%) in their 80's, the highest percentage, and 43(32.3%) in their 90's. Moreover, 54 patients(40.6%) received physical therapy, while 79(59.4%) did not.

The results of statistical analysis of the general characteristics of the subjects are summarized in Table 1.

Table 1. General characteristics of the subjects

Classification		Group with physical therapy(%)	Group without physical therapy(%)	Total(%)
Age	60's	4(3)	8(6)	12(9)
	70's	7(5.3)	21(15.8)	28(21.1)
	80's	29(21.8)	21(15.8)	50(37.6)
	90's	14(10.5)	29(21.8)	43(32.3)
	Total	54(40.6)	79(59.4)	133(100)
Gender	Male	11(8.3)	17(12.8)	28(21.1)
	Female	43(32.3)	62(46.6)	105(78.9)
	Total	54(40.6)	79(59.4)	133(100)

Group with physical therapy

For the group with physical therapy, 54 patients who participated in one or more physical therapy programs of gait training, mat exercise, complex exercise, and NDT(neuro-development treatment) for more than 30 minutes, three to five times a week, and for four years after the hospitalization at the geriatric hospital were selected.

Group without physical therapy

For the group without physical therapy, 79 patients who maintained their usual lives instead of receiving physical therapy for four years after the hospitalization at the geriatric hospital were selected.

Measurement

Bone mineral density T-scores at admission and those after four years for elderly patients who had been hospitalized at H geriatric hospital in Yongin-si, Gyeonggi-do, were measured in order to compare and analyze the changes in bone mineral density in relation to physical therapy.

Method for measuring bone mineral density

AOS 100 Acoustic Osteo Screener that uses quantitative ultrasonography was used to measure bone mineral density in the subjects of this study. Among various methods for measuring bone mineral density, quantitative ultrasonography has the merit of being relatively inexpensive having a low risk of radioactivity and is considered as a accurate method for distinguishing between normal bone tissues and osteoporosis. The measurement was taken by a medical technologist at the calcaneus of the patient.

Bone mineral density(T-score)

According to the WHO, a bone mineral density(T-score) over -1.0 is considered normal, and a T-score between -1.0 and -2.5 is defined as osteopenia. Osteoporosis is defined as a bone mineral density T-score below -2.5, while severe osteoporosis is defined as a T-score below 2.5 and fracture experience.

Data Analysis

The data collected in this study was analyzed as follows by using SPSS ver. 18.0, a statistical treatment program, at the significance level($p<.05$).

1) A paired t-test was conducted at the significance level of $p<.05$ to examine the changes in bone mineral density T-score for the group with physical therapy and group without physical therapy.

2) An independent t-test was conducted at the significance level of $p<.05$ to examine the difference in bone mineral density T-score changes from the initial measurement to the remeasurement between the two groups.

3) A Mann-Whitney test was conducted at the significance level of $p<.05$ to examine changes in bone mineral density T-score by gender for the two groups.

4) A Kruskal-Wallis test was conducted at the significance level of $p<.05$ to examine the difference in bone mineral density T-score change by age group for the two groups.

RESULTS

In this study, in order to conduct a comparative analysis of the effects of physical therapy on bone mineral density in long-stay elderly patients over 60 of a geriatric hospital, their bone mineral density T-scores were measured at admission and after four years. The results are as follows.

Changes in Bone Mineral Density T-score for the Subject Groups

In order to determine the changes in bone mineral density T-score for each of the two groups, the changes were calculated and analyzed through a paired t-test at the significance level of $p<.05$. The results are as seen in Table 2.

The T-score for the group with physical therapy from the initial measurement was -2.25±.90, while that from the remeasurement was -2.83±.91, indicating a decrease by .58, and it significantly decreased by lapse of time($p<.001$).

The T-score for the group without physical therapy from the initial measurement was -2.61±.95, while that from the remeasurement was -3.58±.44, indicating a decrease by .97, and it significantly decreased by lapse of time($p<.001$).

In short, T-scores for both groups significantly decreased from the initial measurement to the remeasurement.

Table 2. Changes in bone mineral density by group (Mean±SD)

Classification	T-score		t	p
	Initial measurement	Remeasurement		
Group with physical therapy(N=54)	-2.25±.90	-2.83±.91	5.775	.000***
Group without physical therapy(N=79)	-2.61±.95	-3.58±.44	10.618	.000***

***p<.001

The Difference in Bone Mineral Density T-score Change between the Subject Groups

In order to analyze the difference in bone mineral density T-score change from the initial measurement to the remeasurement between the two groups, the changes in T-score were calculated and examined through an independent t-test at the significance level of $p<.05$. The results are as seen in Table 3.

According to the results, the change in T-score for the group with physical therapy was -.58±.74, while that for the group without physical therapy was -.98±.82. Although both groups showed a decreased T-score, the decrease for the group without physical therapy was greater by .40 than that for the group with physical therapy, indicating a statistically significant difference between the two groups($p<.01$).

Table 3. Analysis of the changes in T-score between initial measurement and remeasurement for each group (Mean±SD)

Classification	T-score			t	p
	Initial measurement	Remeasurement	Change		
Group with physical therapy(N=54)	-2.25±.90	-2.83±.91	-.58±.74		
Group without physical therapy(N=79)	-2.61±.95	-3.58±.44	-.98±.82	-2.876	.005**
Total (N=133)	-2.46±.95	-3.28±.77	-.82±.81		

**p<.01

Changes in Bone Mineral Density T-score by Gender

In order to examine the changes in bone mineral density T-score by gender for the two groups, the changes in T-score were calculated and analyzed through Mann-Whitney test at the significance level of p<.05. The results are as seen in Table 5.

For the group with physical therapy group, the T-score change from the initial measurement to the remeasurement for males was -.83±1.15, while that for females was -.51±.59, indicating that males showed more significantly decreased T-scores than females did(p<.05).

For the group without physical therapy, the change in T-score from the initial measurement to the remeasurement for males was -1.41±1.14 and -.86 ±.67 for females, revealing a significant decrease in T-score in both males and females.

In short, the T-score change was significantly greater for males than for females in both groups (p<.05).

Table 4. Changes in T-score by gender in each group (Mean±SD)

Classification	Change in T-score (Remeasurement-Initial measurement)		Z	p
	Male	Female		
Group with physical therapy(N=54)	-.83±1.15	-.51±.59	-2.256	.024*
Group without physical therapy(N=79)	-1.41±1.14	-.86±.67	-2.022	.043*

*p<.05

The Difference in Bone Mineral Density T-score Change by Age Group

In order to examine the difference in bone mineral density T-score change from the initial measurement to the remeasurement by age group in the two groups, a Kruskal-Wallis test was conducted at the significance level of p<.05. The results are as seen in Table 5.

For the group with physical therapy, the change in T-score from the initial measurement to the remeasurement was .45±1.17 for those in their 60's, -.69 ±.69 for those in their 70's, -.60±.65 for those in their 80's, and -.78±.62 for those in their 90's. Bone mineral density increased only in those in their 60's, while it increased in the other age groups. However, there was no statistically significant difference.

Table 5. Change in bone mineral density of each group by age group (Mean±SD)

Classification	Change in T-score(Remeasurement-Initial measurement)				x^2	p
	60's	70's	80's	90's		
Group with physical therapy(N=54)	.45±1.17	-.69±.69	-.60±.65	-.78±.62	4.995	.172
Group without physical therapy(N=79)	-1.26±.96	-.98±.68	-1.03±.74	-.86±.93	2.964	.397

*p<.05

For the group without physical therapy, the change in T-score from the initial measurement to the remeasurement was −1.26±.96 for those in their 60's, −.98±.68 for those in their 70's, −1.03±.74 for those in their 80's, and −.86±.93 for those in their 90's. Bone mineral density decreased in all of the age group, indicating no statistically significant difference.

DISCUSSION

With the recent increase in the elderly population, the importance of elderly healthcare through exercise therapy is emerging, and exercise therapy is regarded effective in maintaining physical health and bone metabolism. Osteoporosis and a decrease in bone mineral density reduce the quality of life in the elderly(12). Decreased activities caused by muscle weakness decrease bone mineral density, and longer duration of disease and a higher degree of paralysis accelerate the decrease in bone mineral density(13). Physical activities are one of the important stimuli for bone remodeling in the elderly, and the risk of femoral fracture in elderly people who actively participate in physical activities is lower by 20 to 40% than that in those who are sedentary(14). In addition, considering that exercise has great preventive effects on bone loss in the elderly, it is advisable to maintain or increase the strength, structure, and mass of bones through active physical activities and mechanical loading exercise(15).

A long period of a bedridden state or immobilization leads to a decrease in bone mass in the elderly, so physical therapy along with strengthening, stretching, weight bearing exercise, balance training, and neuro-developmental treatment should be provided based on the health of each patient as soon as possible.

Fujino et al. reported the effects of exercise on an increase in bone mineral density(16). They compared bone mineral density of an exercise group of patients who received gait training and that of a control group of patients who were in a bedridden state for six months, and the results revealed that the exercise group showed 1% higher bone mineral density. Yamada et al. compared bone mineral density of a control group of patients aged over 70 who were bedridden and that of an experimental group of patients who received physical therapy after femoral fracture, and the results indicated that the control group showed lower bone mineral density(17). Shin reported that participating in regular exercise including aerobic exercise and weight training for three years leads to an increase in bone mineral density of each body part and that variables for bone mineral density can be improved or maintained through exercise(18). In addition, Jeong conducted a longitudinal study of elderly exercise participants. The results revealed that there was no significant changes in bone mineral density in the subjects after two years, suggesting that exercise suppresses and prevents the progression of osteoporosis(19).

According to the findings of this study, the bone mineral density T-score for the group of patients who received physical therapy for more than 30 minutes, three to five times a week, and for four years was −2.25±.90 from the initial measurement at admission and −2.83±.91 from the remeasurement after four years, showing change by −.58±.74. This indicates the patients' bone mineral density significantly decreased($p<.001$). On the other hand, the bone mineral density T-score for the group of patients who maintained their usual lives instead of receiving physical therapy was −2.61±.95 from the initial measurement at admission and −3.58±.44 from the remeasurement after four years, showing change by −.97. This indicates the patients' bone mineral density significantly decreased($p<.001$). Moreover, the decrease in bone mineral density in the group with physical therapy was significantly smaller than in the group without physical therapy($p<.01$). Similar to the results of other previous studies, these results suggest that regular exercise contributes to preventing osteoporosis and maintaining bone mineral density in long-stay patients of geriatric hospitals.

Bone mineral density decreases along with aging regardless of gender, and it the decrease begins at age between 35 and 50(20, 21). In Sweden, according to a measurement of bone mineral density in people aged between 50 and 84 by using dual energy x-ray absorptiometry, the osteoporosis prevalence in females was 21.2% and that in males 6.3%(22). In Korea, Shin et al. measured the prevalence of osteoporosis in residents aged over 50 in a local community by using sonography and reported the prevalence of 4.2% in males and the prevalence of 27.3% in females(23). Ha et al. measured the prevalence of osteoporosis in 735 residents aged over 50 in a local community and reported the prevalence of 28.7% in males and that of 57.4% in females(24).

In females, lack of estrogen after menopause leads to an increase in bone resorption, and decreased vitamin D causes a rapid decrease in bone mineral

density and bone strength(25). Improving muscular strength, flexibility, and coordination through exercise is effective in preventing osteoporosis in elderly females(26). Krolner et al. examined the effects of exercise on bone mineral density in females aged between 50 and 72 and reported that lumbar bone mineral density in females who participated in regular training for eight months increased by 3.5%, while that in females who did not participate in training decreased by 2.7%(27). In addition, it was reported that the risk of bone loss in menopausal females who walked below 1km a day increased by 30% compared to that in those who walked over 1km a day and that the risk of osteoporosis and bone loss in those who exercised less than an hour a week increased by 40 to 50% compared to that in those who exercised more than two hours a week(28). Improving muscular strength and bone mass through weight training is effective in preventing osteoporosis in males(29).

On the other hand, Kim et al. noted that the correlation between an increase in physical activities through a 10-week exercise program and lumbar bone mineral density in menopausal females was very low despite some effects of exercise on density(30). Park et al. also noted that there was no significant difference between before and after an exercise program although the exercise program including walking and cycling slightly increased bone mineral density in elderly females(31). As discussed thus far, many studies of exercise therapy for osteoporosis have been focused on females, and the results have been clinically applied. On the contrary, not many studies have been focused on males.

According to the results of the examination of the change in T-score from the initial measurement at admission to the remeasurement after four years, the change in bone mineral density T-score for males was −.83±1.15, while that for females was −.51 ±.59 in the group of patients who received physical therapy for four years, indicating that T-score for males significantly increased more greatly than that for females($p<.05$). In the group of patients who maintained their usual lives instead of receiving physical therapy, the change in T-score for males was −1.41±1.14, while that for females was −.86 ±.67. T-score decreased in both males and female, but that for males significantly decreased more greatly($p<.05$). These results suggest that the decrease in bone mineral density is greater in males than in females, regardless of physical therapy.

Although it was difficult to conduct a direct comparison due to lack of relevant studies, the results of this study suggest that participating in constant physical therapy is more effective than maintaining a usual life in preventing and managing osteoporosis in long-stay patients over 60 of geriatric hospitals, and this finding is worth further research.

CONCLUSION

This study examined 133 elderly patients aged over 60 who had been in H geriatric hospital in Yongin-si for more than four years between 2002 and 2011 with the purpose of determining the effects of physical therapy on bone mineral density. For statistical analysis of changes in bone mineral density in the elderly patients, their T-scores at admission and those after four years were measured, compared, and then analyzed. the results are as follows.

The T-scores for the group of patients who both received physical therapy and didn't received physical therapy significantly decreased($p<.001$).

In terms of the difference in bone mineral density T-score change from the initial measurement to the remeasurement, the decrease in T-score for the group without physical therapy was greater by .40 than that for the group with physical therapy, indicating a significant difference between the two groups($p<.01$).

In terms of the change in bone mineral density T-score by gender, the T-score for males significantly decreased more greatly than females in both groups($p<.05$).

There was no significant difference in bone mineral density T-score by age group in both groups.

The results above suggest that physical therapy is effective in reducing a decrease in bone mineral density in the elderly. Consequently, constant physical therapy such as gait training is expected to serve as an effective method for preventing a decrease in bone mineral density or maintaining the current density in the elderly.

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