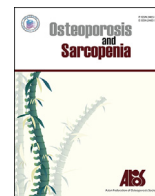




Contents lists available at ScienceDirect

Osteoporosis and Sarcopenia

journal homepage: <http://www.elsevier.com/locate/afos>

Original article

Is osteoporosis a risk factor for ankle fracture?: Comparison of bone mineral density between ankle fracture and control groups



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ARTICLE INFO

Article history:

Received 26 September 2017

Received in revised form

27 November 2017

Accepted 29 November 2017

Available online 7 December 2017

Keywords:

Ankle fractures

Bone density

Osteoporosis

Body mass index

ABSTRACT

Objectives: There remains controversy over osteoporotic feature of the ankle. Therefore, we investigated the possibility of the existence of a relationship between axial bone mineral density (BMD) in patients with ankle fracture group with that of the normal population in Korea under control of other confounding factors such as body mass index (BMI).

Methods: This study retrospectively reviewed medical records of patients who were treated in our institution from 2005 to 2015. A comparative analysis was carried out between 116 patients with ankle fracture (ankle fracture group) and 113 patients admitted with other orthopedic reasons (control group). Sex, age, energy level of trauma, and BMI were analyzed as variables affecting axial BMD.

Results: Age and sex of ankle fracture group were not different from them of control group ($P = 0.968$ and $P = 0.870$, respectively). BMI of ankle fracture group was higher than that of control ($P = 0.029$). The other variables showed no differences between the 2 groups. The energy level of trauma in ankle fracture group was related to only BMI ($P = 0.013$).

Conclusions: Axial BMD of ankle fracture patients showed no difference from that of a control group in Korean population. The occurrence of ankle fracture is affected by only BMI rather than axial BMD. Evaluation of osteoporosis for patients with ankle fracture should be considered separately.

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1. Introduction

Ankle fracture had been reported to be different from typical osteoporotic fracture, which involves hip, spine, and wrist fractures [1]. Traditional literature had reported the occurrence of ankle fractures in the elderly by the biomechanical factors is associated with more heavy weight or a trend for falls rather than osteoporotic bone quality [2,3]. However, recent studies suggested that ankle fractures in the elderly have the feature of osteoporotic fracture [4]. Additionally, several studies suggested that ankle fractures in postmenopausal women also have the features of osteoporotic fracture [5,6].

However, previous studies lacked consideration for body mass index (BMI), nevertheless BMI is reported to be related to bone mineral density (BMD) [7]. And it is important to investigate whether axial BMD is associated with the occurrence of ankle

fracture as it can provide a valuable prospective for prevention of osteoporosis as well as its treatment; furthermore, it might be manifested that ankle fracture should be within the range of osteoporotic fracture like wrist fracture [4,8]. These give a rise to review of the relationship between ankle fracture and osteoporosis with perspective of BMI and BMD. Moreover, this concern has not been studied in Korea, to our best of knowledge.

Therefore, the aim of this study was to (1) compare axial BMD between patients with ankle fracture and normal population in Korea and (2) analyze the effect of BMI, which is considered as confounding factors. We hypothesized that axial BMD of ankle fracture patients would be significantly lower than that of the normal population.

2. Methods

This retrospective comparative study was initiated based on medical records of 433 patients who were treated in our hospital from 2006 to 2015. Inclusion criteria for the ankle fracture group were (1) patients aged above 50 years and (2) the presence of a medial malleolar fracture, lateral malleolar fracture, bimalleolar

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Peer review under responsibility of The Korean Society of Osteoporosis.

fracture, or trimalleolar fracture. Exclusion criteria included avulsion fracture, previous history of fracture or ankle surgery, and case with concomitant other fractures. As a result, 116 patients with ankle fracture (ankle fracture group) were included in our study. One hundred thirteen patients were selected as a control group who visited the orthopedic department for medical health checkup. This study was approved by the Institutional Review Board of Myongji Hospital and informed consent was waived because of retrospective design.

The level of trauma in patients with ankle fracture was classified as spontaneous fracture (level 0), minor trauma (a fall from standing height or less, level 1), and major trauma (a fall from greater than standing height or other high-energy injuries such as traffic accident, level 2) [3].

BMD at the lumbar spine and proximal femur in the noninjured leg (femoral neck, Ward triangle, and trochanteric area) was measured by dual-energy x-ray absorptiometry (DEXA) as g/cm² using Discovery W (Hologic Inc., Bedford, MA, USA) following standard protocols [9]. We routinely performed DEXA in patients who were admitted to the orthopedic department of the hospital. DEXA results were selected only when the test was done within 6 months after admission to hospital. Height and body weight of the patients were also routinely measured at the time of admission to the hospital. Height was measured to the nearest millimeter and weight was measured to the nearest 0.1 kg. Subsequently, BMI was calculated as body weight (kg)/height (m)².

The proportion of male to female was compared between the 2 groups using chi-square test. All variables were evaluated for normal distribution; as a result, 2-sample t-test was performed when comparing ankle fracture group with the control group.

The relationship between BMD and trauma level in ankle fracture group was also analyzed by 2-sample t-test because there was no level 0 injury in ankle fracture group.

Logistic regression analysis was done to identify the correlation among axial BMD variables and BMI of each group and other predictors from both the sets of variables. A P-value less than 0.05 indicated statistical significance. All analyses were performed using IBM SPSS Statistics ver. 22.0 (IBM Co., Armonk, NY, USA).

3. Results

The mean ages of ankle fracture and control groups were 68.1 ± 10.7 and 68.2 ± 10.8 years, respectively. Of all population, 46 patients were male and 183 were female patients. There was no difference in the proportion of male to female in both the groups (P = 0.870) (Table 1). Comparative analysis of demographic data between the 2 groups revealed that age of ankle fracture group also showed no significant difference compared to the control group (P = 0.968) (Table 1). In addition, higher BMI was noted in the ankle fracture group (P = 0.029) (Table 1). Axial BMD variables (region of lumbar, femur neck, and trochanter with P = 0.634, P = 0.145, and P = 0.207, respectively) showed no difference between the 2 groups. By logistic regression analysis, only BMI of 2 groups showed no significant effect on ankle fracture group (odds ratio, 1.1; 95% confidence interval, 1.01–1.20; P = 0.020). The energy level of trauma in ankle fracture group was related to only BMI and not axial BMDs (Table 2).

4. Discussion

Patients with ankle fracture tended to be younger and heavier than the normal group in this study. BMD of both two groups showed no significant difference even after controlling for BMI confounder. Accordingly, these results are largely in coincidence with previous literature.

Table 1

Comparison of demography between ankle fracture group and control groups.

Variable	Ankle fracture (n = 116)	Control (n = 113)	P-value
Age, yr	68.1 ± 10.7	68.2 ± 10.8	0.968
Sex, male:female	24:92	22:91	0.870
BMI, kg/m ²	24.6 ± 3.3	23.6 ± 3.3	0.029*
Male	24.1 ± 3.1	22.8 ± 1.8	
Female	24.7 ± 3.3	23.8 ± 3.5	
P-value	0.526	0.156	
BMD			
L1–4	0.837 ± 0.157	0.847 ± 0.157	0.634
Male	0.929 ± 0.147	0.939 ± 0.185	
Female	0.813 ± 0.151	0.824 ± 0.142	
P-value	0.001	0.001	
Femur neck	0.631 ± 0.122	0.654 ± 0.116	0.145
Male	0.708 ± 0.133	0.672 ± 0.101	
Female	0.610 ± 0.111	0.649 ± 0.120	
P-value	0.002	0.348	
Trochanter	0.564 ± 0.112	0.583 ± 0.111	0.207
Male	0.643 ± 0.120	0.623 ± 0.105	
Female	0.544 ± 0.100	0.573 ± 0.111	
P-value	0.001	0.055	

Values are presented as mean ± standard deviation or number.

Ratio of sex was analyzed using chi-square test and others were analyzed by 2-sample t-test.

BMI, body mass index; BMD, bone mineral density.

*P < 0.05, statistically significant differences.

Table 2

Bone mineral density (BMD) according to trauma level in patients with ankle fracture.

Variable	Trauma level			P-value	Adjusted P-value
	0 (n = 0)	1 (n = 95)	2 (n = 18)		
BMD					
L1–4	N/A	0.837	0.835	0.919	0.637
Femur neck	N/A	0.636	0.603	0.104	0.824
Trochanter	N/A	0.565	0.568	0.663	0.547
BMI, kg/m ²	N/A	24.9	23.0	0.013*	N/A

P-value, by Mann-Whitney test, means significance of BMD difference according to trauma level. Adjusted P-value using partial correlation analysis (age, sex, and BMI controlled).

BMI, body mass index; N/A, not available.

*P < 0.05, statistically significant differences.

Ankle fracture is important because its hospitalization rate is known to be higher than wrist or vertebral fractures, which are classical osteoporotic fractures [10]. Several anatomic regions, which have been known as the source of osteoporotic fracture, are off the ground, so motivator such as slip down or sitting down can have enough influence to break bones. In contrast, the ankle joint is always attached to the ground and hardly have chances to be impacted. And ankle may not have osteoporotic feature according to previous several literature and this study. So, the effects of heavy weight and daily activity on ankle fracture are more important than on any other fractures [11].

Previous literature have already analyzed the efficacy of estrogens in preventing the hip and distal radius fractures in postmenopausal women. The reports supported the solid evidence that estrogen offers protection against postmenopausal osteoporosis [12]. Although ankle fracture has not yet been determined as typical osteoporotic fracture and there are still ongoing debates over this concern, recent studies suggested that ankle fracture have osteoporotic features. This issue is very important because it could provide crucial preventive and treatment policy for osteoporosis in cases where ankle fracture is one of the osteoporotic fractures.

Greenfield and Eastell [3] compared patients of ankle fracture with a normal population group, and found that overweight portion of a group with ankle fracture was significantly higher than

that of a normal group. The study revealed no differences in BMD between the 2 groups. However, numerous researches have investigated the relationship between BMI and BMD thereafter [7,13,14]. Thus, we studied this issue in the perspective of BMI and BMD because BMI could affect axial BMD as a confounding factor. Though our results were largely similar to the previous results, more studies such as the relationship between peripheral BMD and ankle fracture would be needed for identifying osteoporotic features of ankle fracture.

There are some limitations in our study. First, this study was performed with retrospective design and relatively small sample size, which could have masked the hidden relationship between BMI and BMD. Second, control group in this study could not be confirmed as true normal population because they might not be representative of Korean. Future studies are warranted to identify the osteoporotic features associated with ankle fracture.

5. Conclusions

Axial BMD could not be considered as a risk factor for ankle fracture, which is largely different from the typical osteoporotic fracture in Korean population. Only BMI affected the occurrence of ankle fracture in this study. Therefore, evaluation of osteoporosis for patients with ankle fracture should be considered separately.

Conflicts of interest

No potential conflict of interest relevant to this article was reported.

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