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A prospective case-control study of ankle fracture in postmenopausal women

對停經女性踝骨骨折的前瞻性病例對照研究

Objectives. To compare bone mineral density of women with postmenopausal ankle fractures with controls and review patient characteristics, injury mechanisms, and outcomes.

Design. Prospective case-control study.

Setting. University teaching hospital, Hong Kong.

Participants. Women older than 60 years, admitted with ankle fractures between 2002 and 2003 and controls (age-matched women with femoral neck fractures).

Main outcome measures. Demographic data, bone mineral density, mechanism of injury, fracture pattern, treatment, and the functional outcome.

Results. The mean age of the study group (18 ankle fracture patients) was 74 years. The fractures usually resulted from a low-energy trauma; isolated lateral malleolar fracture was the most common (8/18), whilst six had bimalleolar fractures. Their mean T-score bone mineral density values at the spine and hip were -1.67 and -1.70, respectively; corresponding Z-scores were +0.73 and +0.99. The bone mineral density of the study group was significantly higher than in patients with fractured neck of femur (controls) and the general population ($P<0.05$). Nine of the study group had diabetes and one had impaired glucose tolerance. Treatment comprised casting in 10 patients and operative fixation in seven. Good functional recovery was achieved; most patients were able to resume their premorbid level of independent daily activities with a good motor functional independence score (85.18/91) 1 year post-injury.

Conclusion. In this case-control study, postmenopausal ankle fractures were not associated with osteoporosis. Diabetic neuropathy may have been a risk factor for such injury. The functional outcome of such patients was generally satisfactory, provided appropriate treatment was given.

Key words:
Ankle injuries;
Bone density;
Fractures, bone;
Osteoporosis, postmenopausal

關鍵詞：
足踝受傷；
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目的：比較停經女性及其對照組的骨質密度；並評估停經女性踝骨骨折的特點、受傷情況和結果。

設計：前瞻性病例對照研究。

安排：大學教學醫院，香港。

參與者：2002和2003年內60歲以上因踝骨骨折入院的病人，及相同年齡組別的股骨頸折斷病人。

主要結果測量：人口學數據、骨質密度、受傷情況、骨折模式、治療和活動能力結果。

結果：參與研究的踝骨骨折病人有18人，平均年齡為74歲。踝骨骨折主要因低能量創傷引起，最常見的骨折模式為單純側面踝骨折（8/18）和雙踝性骨折（6）。在脊椎和臀部量度的骨質密度T值分別為-1.67和-1.70，Z值分別為+0.73和+0.99。研究組別的骨質密度明顯高於股骨頸折斷病人和一般人口（$P<0.05$）。9位病人同時患有糖尿病，另1位有葡萄糖耐受性障礙。有10位病人以石膏模固定方式治療，亦有7位病人以手術固定骨折患處。大部分病人活動機能復原良好，能回復受傷前的獨立日常活動能力。受傷後一年的肌肉活動量度值達到良好的85.18/91的水平。

結論：這個前瞻性病例對照研究顯示骨質疏鬆症和停經女性踝骨骨折無關。糖尿性神經系統病可能是風險因素。若有適當治療，活動能力的恢復通常令人滿意。

Introduction

Ankle fracture is one of the most commonly encountered non-spinal fractures

in the elderly population and its incidence has increased over the last few decades.[1] The age-adjusted incidence of ankle fractures in elderly Finns increased from 66 per 100 000 in 1970 to 162 per 100 000 in 1994.[2] These fractures may require surgical treatment. In addition, the injury can carry significant morbidity and mortality. While hip fractures, distal radius fracture, and vertebral collapse have been well studied in the elderly population and established as a consequence of osteoporosis with a high female-to-male ratio,[1,3,4] very little is known about ankle fractures.

Traditionally, ankle fracture in the elderly was thought to be related to osteoporosis.[5] However, there is little evidence to support or refute this view. Although low bone mineral density (BMD) was observed in the distal radius and neck of femur in a large study of women aged over 65 years,[6] a more recent study revealed that the BMD of elderly women with a fractured ankle was no different to that of women with no fracture.[7] Jensen et al[8] reported that ankle fractures were mainly caused by substantial trauma sustained during physical activity and the presence of osteoporosis seemed to be of little relevance.

As the population of the aged continues to grow in number, the incidence of geriatric fractures will very likely continue to increase. It is therefore important to understand the characteristics of ankle fracture and the corresponding behaviour of affected persons so as to provide the best preventive and therapeutic advice.

Methods

In this prospective case-control study, postmenopausal female patients older than 60 years with an ankle fracture admitted to the Prince of Wales Hospital between 2002 and 2003 were identified. During the admission of each index patient, corresponding demographic data, concomitant medical problems, mechanism of injury, fracture pattern, treatment given, and complications were recorded. Measurement of BMD at the lumbar vertebrae and neck of femur was performed within 3 months of the initial injury, using the Norland XR 36 model (Norland Medical System Incorporation, Wisconsin, US) and the standard protocol.

Patients were discharged upon completion of treatment and commenced an individualised rehabilitation programme based on their premorbid ambulatory status. This took the form of partial weight bearing with crutches, followed by a gradual increase in weight bearing. Patients were reassessed 26 weeks and 52 weeks after the injury; residual pain was assessed using a visual analogue scale (VAS) and by recording analgesic requirement. Ambulatory capacity was noted and functional recovery assessed using a functional independence measure (FIM).

During the same period, an age-matched group of patients admitted with femoral neck fracture was identified as the control group and their BMD at the neck of femur was measured according to the same protocol. Bone mineral density findings from the two groups were compared by Student's *t* test. The T-score of BMD in the range of -1.5 to -2.5 was considered osteopenic and a score of less than -2.5 was considered osteoporotic.

Table 1. Bone mineral density of hip and lumbar vertebrae in study patients and age- and sex-matched controls

	Ankle-fracture group	Hip-fracture (control) group	General population*
Hip			
T-score	-1.70	-2.57†	-2.28†
Z-score	+0.99	-0.08†	+0.13†
Lumbar vertebrae			
T-score	-1.67	N/A‡	N/A
Z-score	+0.73	N/A	N/A

* Departmental data
† P<0.05 when compared with the ankle-fracture group
‡ N/A denotes not available

Results

During the study period, 22 patients fulfilled the study criteria, of whom 18 (mean age, 74; range, 60-86 years) were successfully analysed. Among the four patients who were not recruited, two preferred treatment from 'bone-setters', one defaulted, and one did not complete BMD measurements.

Seventeen of the ankle fractures followed low-energy trauma (falling on stairs or twisting the ankle) and one was an isolated fibular fracture sustained during a traffic accident.

There were eight isolated lateral malleolar fractures and only one isolated medial malleolar fracture. Six and three patients sustained bimalleolar and trimalleolar fractures, respectively. Weber type B fracture pattern occurred in 12 patients, and types A and C in 5 and 1, respectively. No patient in this study sustained a pylon fracture.

Casting formed the primary treatment in 10 patients, seven underwent open reduction and internal fixation and one had an open reduction and internal fixation augmented by postoperative casting for 6 weeks.

Comparison of BMD in age-matched patients with ankle fracture and fractured neck of femur revealed a significantly higher mean T-score and Z-score in the former. The scores were also higher than those of the age- and sex-matched general population (Table 1).

There were four patients with a T-score of less than -2.5 in the spine and hip, and three with both T-score and Z-score of less than -2.5 in both the spine and hip.

Mild residual pain was reported by seven patients (VAS: 1-3). No patient reported moderate-to-severe pain requiring regular analgesia and 11 required no analgesia.

Table 2. Ambulation levels in patients with ankle fractures (n=18)

	Patient numbers pre-injury	Patient numbers post-injury
Walk unaided	12	9
Walk with 1 cane	4	7
Walk with 2 canes	1	0
Chairbound	1	2

Table 3. Prior co-morbidities in patients with ankle fractures

Co-morbidity	No. of patients, n=18
Diabetes/impaired glucose tolerance	10
Hypertension	9
Stroke	2
Malignancy	2

One year later, a high proportion of patients had regained an ambulatory level similar to their premorbid status; nine could walk unaided, three walked with one-side aid, and two were chair-bound (Table 2). The mean FIM score was 87 pre-injury and 85 a year post-injury. Sixteen patients had a high FIM score and were independent whilst two had a low score and one had a score of 48 both before and after the initial injury. In another patient, the FIM score decreased from 77 pre-injury to 53 post-injury.

No patient had a history of prior fracture; nine were diabetic and nine were hypertensive. One other patient had impaired glucose tolerance (Table 3). Two patients had recovered from a stroke and two had received treatment for a malignancy with no recurrence reported during the study period.

Discussion

The mean BMD of the study population (Table 1) was within the osteopenic range (T-score: -1.5 to -2.5), and only four were classified as having osteoporosis (T-score: <-2.5).

Local epidemiological data reveals a prevalence of osteoporosis at the spine of 45% in the 60-to-69–year age-group.[9] Though patients in this study were older, the proportion with osteoporosis was much lower (22%). The positive mean Z-score in this group of ankle fracture patients suggests that they had better age-related BMD, which was also consistent with them being more active, more outgoing, and maintaining greater mobility.

When compared to age-matched patients with fractured neck of femur and with age- and sex-matched subjects in the general population, the T- and Z-scores of patients with ankle fracture were higher. However, the controls had not been matched for premorbid ambulatory status (which may also affect BMD).

This study did not support osteoporosis as a cause of ankle fracture in these postmenopausal women, except in the patients with trimalleolar fractures. If the latter patients were excluded, most of the remaining patients were osteopenic rather than osteoporotic, consistent with their positive Z-scores and higher BMDs than in age- and sex-matched subjects in the general population.

Two patients who had trimalleolar fracture had osteoporosis with T-score of the hip being -2.91 and -2.65. One of these patients also sustained a simultaneous fracture of the proximal humerus. The latter, an 85-year-old woman was treated conservatively with casting, even though there was malunion of the ankle fracture. Nonetheless, the patient regained her premorbid mobility, could walk with a cane and continued to be independent in her daily activities. The other patient with trimalleolar fractures was treated by open reduction and internal fixation, augmented by 6 weeks' postoperative casting. Intra-operatively, the bone was discovered to be too weak for the metallic implant; her Z-scores in the spine and hip being -2.52 and -2.91 respectively.

During the study period, no patient with a pylon fracture was encountered, possibly due to the small number of patients in this study and the low incidence of such fractures. Historically, pylon fracture were considered to result from: (a) high-energy trauma (eg motor vehicle accidents or falling from height) or (b) low-energy rotational injury, such as encountered in water and whilst snow skiing. Postmenopausal Chinese women are at a relatively low risk of being exposed to such trauma.

Most patients had sustained their ankle fractures as a result of low-energy trauma, as might be anticipated in osteoporosis. However, it is evident that ankle fracture resulting from low-energy trauma (such as level-ground ankle inversion injury) can even occur in young active males.

The life expectancy for women in Hong Kong is 83.9 years.[10] Based on this figure, the patients in this study had a remaining life expectancy of greater than 10 years. Therefore, treatment for ankle fracture should be aggressive with appropriate rehabilitation and avoidance of long-term complications.

In our study there was a high proportion of patients with diabetes and hypertension. In individuals over 65 years old, the local prevalence of diabetes is approximately 25%.[11] Although no relationship could be established from these data, diabetic neuropathy and impaired proprioception may have contributed to the falls on level ground. Similar observations have been reported in the US.[12] Further study of a larger population is required with concomitant testing of proprioception.

Conclusion

This study provided no evidence to support osteoporosis as a cause of postmenopausal ankle fracture. Diabetic neuropathy may be a risk factor. Patients made a satisfactory functional recovery, provided appropriate treatment was given.

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