Calcaneal Densitometry as a Tool for Identifying Wrist Fractures in Older Women

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Purpose. To determine whether bone mineral density (BMD) measured by means of calcaneal densitometry is a reliable means of discriminating between women over 60 with and without a wrist fracture.

Materials and methods. This is a case-control retrospective study that established as its working hypothesis that women over 60 with a calcaneal densitometry T-score < –0.6 are at a higher risk of sustaining distal forearm fractures. Between 1 October 2003 and 31 March 2004, 66 women older than 60 presented with a distal forearm fracture; these women constituted the sample cases of our study. Sixty women with similar characteristics to the ones mentioned but who had not sustained a fracture were randomly selected to make up the control group. BMD was measured through dual-energy x-ray absortiometry (DEXA) of the calcaneus (PI-XI). A Lunar device (model 30200) was used.

Results. The average BMD as measured through calcaneal densitometry was 0.368 (0.273-0.542) for patients with a distal forearm fracture, as compared with 0.472 (0.289-0.668) for patients without a fracture, which constitutes a significant difference (p < 0.01). The odds ratio revealed that the risk of sustaining a distal forearm fracture in women over 60 with a PIXI calcaneal T-score < –0.6 is 10.67 times higher than in women in the same group but with a T-score > –0.6.

Conclusions. Calcaneal BMD measured by a DEXA scan is a reliable way to discriminate between women with and without a wrist fracture.

La densitometría de calcáneo permite discriminar fracturas de muñeca en mujeres ancianas

Objetivo. Determinar si la densidad mineral ósea (DMO) obtenida mediante densitometría de calcáneo permite discriminar mujeres mayores de 60 años con y sin fractura de muñeca.

Material y método. Estudio retrospectivo de casos-control, estableciendo como hipótesis de trabajo el mayor riesgo de fracturas distales de antebrazo, en mujeres mayores de 60 años cuya densitometría de calcáneo refleja una T-*score* < –0,6. Desde el uno de octubre de 2003 hasta el 31 de marzo de 2004 se atendió a 66 mujeres mayores de 60 años con fractura distal de antebrazo, constituyendo los casos-muestra del estudio. De forma aleatoria se escogieron 60 mujeres con características similares a los casos y que no habían padecido fractura alguna, constituyéndose de esta manera el grupo control. La DMO se midió mediante absorciometría dual de rayos X (DEXA) en calcáneo (PIXI). Se utilizó para ello el equipo LUNAR (modelo 30200).

Resultados. La media de la DMO medida obtenida mediante densitometría de calcáneo fue de 0,368 (0,273-0,542) para los pacientes con fractura distal de antebrazo, frente a 0,472 (0,289-0,668) para los pacientes sin fractura, estableciéndose diferencias significativas (p < 0,01). El cálculo de la *odds ratio* reflejó un riesgo de padecer fractura distal de antebrazo en mujeres mayores de 60 años con una T-*score* < –0,6 obtenida mediante PIXI en calcáneo de 10,67 veces superior respecto a mujeres del mismo grupo de edad con una T-*score* > –0,6.

Conclusiones. La DMO de calcáneo mediante DEXA permite discriminar mujeres con y sin fractura de muñeca.

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Distal forearm fractures (DFFs) are one of the most frequent conditions seen in casualty departments and use up considerable financial and human resources both in trauma surgery units and the health care system in general[1-6].

In our country, several retrospective studies have been published in such areas like Avilés, La Rioja and Alicante that report incidence levels ranging between 15 and 40 cases/10,000 women/year aged between 50 and 70[7,8].

According to the data published by the Spanish National Health System, 3,028 ulnar and radial distal fractures (patients older than 44) were reported in our country in 1999, which resulted in a total 12,141 days of hospitalization (mean stay: 6.02 days)[9].

Currently, several treatments are being used to reduce the risk of osteoporotic fractures. Given their high cost, these interventions are normally offered to patients with a high fracture risk. Hence the importance of identifying high risk individuals.

It is a well known fact that women with less bone stock in their distal forearm have a four-fold risk of sustaining a fracture than women with bone stock that is considered normal[10-12]. Although forearm bone density is correlated to the lumbar and femoral bone mass[13], and several authors (Bauer et al, 1997; Hans et al, 1996) have established the correlation between a central and peripheral densitometry[14,15], there is insufficient data as to the predictive value afforded by a lower amount of bone in other sites like the calcaneus, and the risk of sustaining a DFF.

The main purpose of this study is to determine whether the bone mineral density (BMD) level obtained by means of peripheral calcaneal densitometry, a more economical test performed with more easily transportable machines, makes it possible to discriminate between women older than 60 with and without a wrist fracture further to minimal energy trauma (falls from a standing position).

MATERIALS AND METHODS

We designed a case-control study and established as our working hypothesis a greater risk of DFF further to minimal energy trauma in women over 60 whose calcaneal densitometry reflects a T-score < –0.6 (osteopenic and osteoporotic range); the lower the T-score, the higher the risk.

Sixty-six women over 60 with a DFF were treated at the Virgen Macarena University Hospital of Seville between 1 October 2003 and 31 March 2004; these were the sample cases of our study. Sixty women with similar characteristics to the women in the group under study were randomly selected to be included in the control group; these women had not sustained any type of fracture. Women needing aid to ambulate were excluded, as were those women who were being treated for osteoporosis or who had a history of severe pathologies. Subjects with a history of DFF were excluded from the control group.

All the DFFs included in the 9th revision of the International Classification of Diseases (ICD-9) were recorded provided that they had occurred as a result of severe trauma.
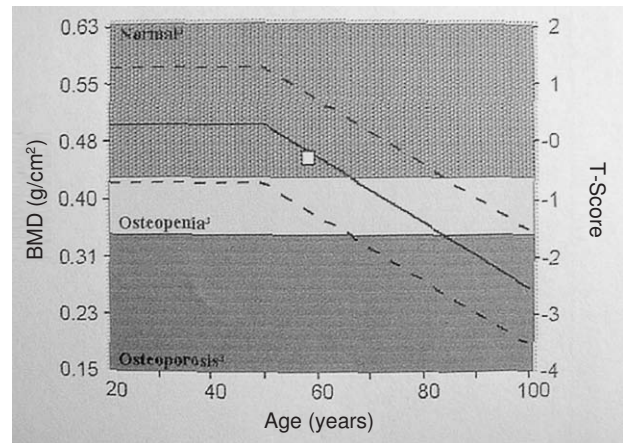

Figure 1. BMD (bone mineral density) measured by DEXA in the calcaneus.

For a fracture to be included as a study case its presence had to be confirmed radiologically.

We have used the densitometry definition of the World Health Organization (WHO), based on the fracture risk associated to the BMD level. We established a corrective factor for calcaneal measurements, so that we can define osteoporosis as a BMD value equal to or lower than 1.6 standard deviations from the mean normal value for young individuals of the same gender and race (T score).

BMD was measured by means of calcaneal dual-energy x.ray absorptiometry (DEXA) using a PIXI bone densitometer, model 30200, manufactured by Lunar Corporation (Fig. 1). The weight and height of patients both in the group under study and in the control group was recorded in order to calculate the bone mass index (BMI).

Statistical considerations

Sample size

Taking into consideration the size of our sample, the study has a statistical power in excess of 95%.

Statistical analysis

A descriptive statistical study was carried out both for the group of patients with a fracture (sample case) and for the control patients. The main values for each group were compared using Student's «t» test and a chi square analysis. The level of significance was established at p < 0.05. The software used to gather and process data were an Excel spreadsheet and the SPSS statistical package version 11.0.

RESULTS

The mean age of patients for the group under study was 70 years (range: 61-82) and 68 for the control group (range:

Table 1. Summary of results. Group under study vs. control group

	Group under study	Control group	
Age	70.4 (61-82)	67.7 (62-76)	NS
BMI	27.2 (21.6-33.3)	30.2 (25.5-38.4)	p < 0.01
BMD	0.368 (0.273-0.542)	0.472 (0.289-0.668)	p < 0.01

BMI: bone mass index; BMD: bone mineral density; NS: not significant.

62-76). There were no significant age differences between the two groups.

Mean BMD as measured by calcaneal densitometry was 0.368 (range: 0.273-0.542) for patients with a distal forearm fracture, as compared with 0.472 (range: 0.289-0.668) for patients without a fracture; a significant difference was established here (p < 0.01). This means that the mean bone density in the group of patients with an osteoporotic fracture was 22% lower than that of the control group.

Calculation of the odds ratio reflected that women older than 60 with a calcaneal PIXI T-score <–0.6 had a 10.67 higher risk of sustaining DFFs than women in the same age group with a T score > –0.6, with a 95% confidence interval from 4.64 to 24.53. Given the statistically significant differences found in BMI calculations for both groups, we carried out a multivariate analysis through a stepwise binary logistic regression, where the predictive variables were BMI and having a T-score < –0.6. The result was that the only determining variable in this study was having a T-score < –0.6 (Table 1).

DISCUSSION

DFFs are the first to occur in persons with osteoporosis or an osteoporotic risk, even before vertebral or hip fractures. For this reason they can be considered an earlier marker of osteoporosis when they are sustained after minimal energy trauma (falls from a standing position), since the bone mass of the fractured area, assessed at the contralateral forearm, is normally poorer than in similar controls in terms of age and gender[16,17].

In the last two decades, other data of interest have been added to the physiopathology of this fracture. These could be summarized by saying that, individuals with a DFF have a significantly poorer lumbar and femoral bone stock than the control subjects at the time of sustaining the fracture, which makes them more prone to subsequent osteoporotic fractures at these locations[18,19]. These findings have been confirmed in both retrospective and prospective studies of different cohorts[20].

Several central densitometric studies (of the hip and/or lumbar spine) have shown the correlation between bone density and the occurrence of hip and spine fractures[14].

Nevertheless, these devices are extremely large and costly, which makes them inaccessible to most centers. For this reason, we suggest that more extensive use be made of peripheral densitometers (and more specifically calcaneal ones) as an alternative to central densitometers, given that several studies have shown a close correlation between both systems to measure BMD[15,21,22]. The main advantage of these devices, apart from their lower cost, is that they can easily used by different units given the ease with which they can be transported[23].

We did not find in the literature any study comparable to ours with which to benchmark our results. Bouxsein et al carried out a prospective study in elderly women and they came to the conclusion that the method they used to calculate BMD, i.e. Digital X-ray Radiogrammetry, made it possible to predict the occurrence of hip, wrist and vertebral body fractures in elderly women[13]. And this is precisely the *raison d'être* of our paper: there is currently no proven index or hard-and-fast evidence that may help us better identify patients who have an increased likelihood of sustaining fractures.

The current paper offers a possible and highly significant option, which could meet the present-day requirements. However, further study is necessary in other domains in order to confirm the tendencies we have observed. For that reason, we are developing a prospective study that might allow us to determine a predictive value for peripheral calcaneal densitometries in wrist fractures.

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