Palabras clave: Histomorfometria ósea, composicion corporal, densidad ósea, densidad mineral ósea

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INTRODUCTION

The proximal femur and femoral neck are the study areas of choice for bone mineral density (BMD). It seems logical as it is this area which supports a higher burden of body weight and is subject to greater changes in bone remodelling. It is directly related to gender in that men are usually physically stronger than women (1). Body weight is an important determinant of bone mass and increased body weight is associated with increased skeletal mass and, consequently, less bone loss (2). As this effect occurs in all weight ranges, the influence of body weight on bone mass is relevant for all subjects. Moreover, a low weight is considered a major risk factor for low bone mass. Also, with age, these is usually a progressive loss of bone mass, a fact that is exacerbated by a decline in the height of the individual due to progressive wear of the intervertebral discs (3).

Bone histomorphometry provides information about the structural parameters of bone remodelling and has a role to play in the study of certain metabolic disorders and their treatment. Trabecular volume obtained from bone biopsy provides a thorough understanding of the variations that occur in the microstructure-related bone age, gender and bone loss and can provide information on the mechanism of bone involution (4).

The purpose of this study is to evaluate and compare involutive changes in bone structure that occur in relation to age in men and women through the study of BMD at the Ward's triangle, and trabecular volume measured at the iliac crest.

SUBJECTS AND METHODS

Sample one: The sample consisted of 70 individuals, who were not selected by any random sampling procedure and their par-ticipation in the experiment was determined randomly by attendance at hospital for the dates of the study (May 2011 to December 2012). The ages ranged from 32 to 83 years; there were 38 men and 32 women.

The measurement of bone mineral content and BMD of the proximal femur was performed using dual-energy X-ray absorptiometry (DXA) with Hologic bone densitometer QDR-4500. This instrument accurately and quickly measures bone mineral content by quantitative digital radiography which can be obtained as either bone mineral content in grams or the BMD in g/cm². Measurements were conducted on the Ward's triangle.

Anthropometric measurements of weight and height were conducted on all patients. Weight was measured by a scale measuring rod per person 113 481 in kilograms and height in centimetres. Body mass index (BMI) was calculated using the formula weight/height², and grouped according to the World Health Organization (WHO) classification of BMI < 18.5 underweight, 18.5−24.9 normal, 25−29.9 overweight and > 30 obese.

Sample two: This consisted of a total of 66 samples obtained from autopsies of judicial bodies, aged between 13 and 58 years, who had died a sudden death. Of the 66 samples studied, 42 were men and 24 were women.

The samples were obtained using a Bordier trocar for transiliac bone biopsy. This technique is done in the middle of an inverted equilateral triangle of 5 cm square, whose base corresponds to the anterior segment of the iliac crest (Figure). The biopsies were performed no later than 24 hours after death, due to the possible occurrence of autolytic phenomena that could alter bone metabolism. A transiliac cylinder, 7 mm diameter by 15 mm long, was obtained from this portion. The biopsies were processed without decalcification by dehydration in alcohol 96° and included in methylmethacrylate, making cuts with a Reichert of 3 mm thick. The sections were fixed on slides and stained with haematoxylin-eosin, Goldner trichrome and toluidine blue.

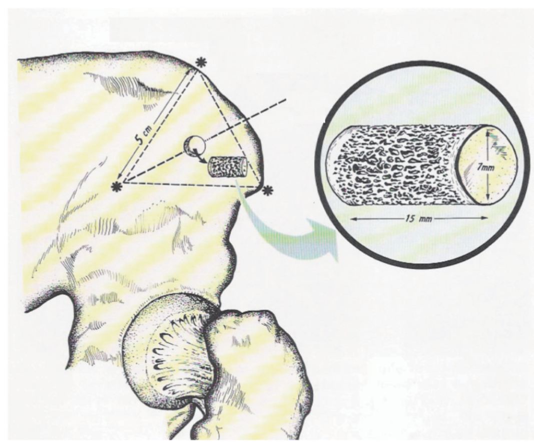

Figure: Detail of iliac biopsy.

The samples were studied through a Leica DMLB microscope and images were captured with a Sony CCD camera adapted to a digitizing card. After obtaining the images scanned at 1x, bone section was edited and image analysis was performed using the programme IMAGE J.

Trabecular volume results were obtained for each sample. These were defined as the ratio between the total trabecular volume (most osteoid mineralized matrix) and the volume occupied by the trabeculae plus the bone marrow (total volume of the biopsy once the cortical bone has been removed) and the cortical surface in length and width. A method was devised using Visilog and Visual Basic to study the morphometric parameters.

V = total trabecular area/total trabecular area
+ medullary area = mm^3/mm^3

These data were exported to SPSS 15.0.1, a descriptive study carried out by age group, tests of analysis of variance (ANOVA) and bivariate correlations. All data are expressed as mean ± standard deviation ($\bar{x}$ ± SD), considering a statistical significance of $p < 0.05$.

RESULTS

Sample one: The weight, height and BMD were higher in men than in women, as shown in Table 1. The age of the individual also presented a high level of negative correlation with BMD (r = -0.56); weight (r = 0.295) and height (r = 0.264) also showed a positive correlation with BMD.

Table 1: Weight, height and bone mineral density by gender

Gender	Weight (Kg)	Height (m)	Body mass index	Bone mineral density
Women	64.01 ± 12.6	1.50 ± 0.06	28.06 ± 4.6	0.49 ± 0.16
Men	67.021 ± 12.1	1.65 ± 0.07	24.7 ± 3.7	0.52 ± 0.14

Values are mean ± SD

When comparing measured BMD in Ward's triangle with BMI categories, we found that as BMI values increased, so did the BMD values, as shown in Table 2.

Table 2: Bone mineral density measurements by body mass index (BMI) categories

Bone mineral density	
BMI	**Ward's**
< 18.50	0.491 ± 0.17
18.50–24.9	0.498 ± 0.17
25–29.9	0.526 ± 0.16
> 30	0.532 ± 0.14

Values are mean ± SD

When we classified the sample by age and gender and observed BMD measurements, we saw that there was a decrease in BMD in everyone 41 years and older, in men and in women alike, as shown in Tables 3 and 4.

Sample two: The trabecular volume index showed a high correlation with age, r: -0893, $p < 0.001$. A negative correlation was observed between the trabecular volume and age in women (r = -0.820, $p < 0.000$) and in men (r = -0.956, $p < 0.000$). When we classified the sample by gender and age group, there was a decrease in trabecular volume measurements with age in women; in men, there was an increase in the age group of 21 to 30 years and then a progressive decrease with advancing age, as shown in Table 5.

Table 3: Comparison of age groups by areas of measurement of bone mineral density (BMD)

BMD (g/cm²)	Age groups (year)	n	Mean	Descriptive Std deviation	Typical error
	< 40	10	0.59740	0.153903	0.048668
Ward's triangle	41−50	14	0.62071	0.139130	0.037184
	51−60	12	0.53800	0.104737	0.030235
	> 61	34	0.42753	0.133641	0.022919
	Total	**70**	**0.50937**	**0.155269**	**0.018558**

Table 4: Comparison measures of bone mineral density in Ward's triangle by gender and age groups

Gender	Ward's triangle (g/cm²)				
	Age groups (year)	n	Mean	Std deviation	Typical error
	< 40	5	0.8226	0.34	0.15
	41−50	6	0.7370	0.62	0.25
Men	51−60	6	0.6245	0.54	0.22
	> 61	15	0.3609	0.84	0.21
	Total	**32**	**0.5330**	**0.20**	**0.03**
	< 40	5	0.7714	0.07	0.03
	41−50	8	0.6857	0.63	0.02
Women	51−60	6	0.5535	0.06	0.02
	> 60	19	0.3868	0.05	0.01
	Total	**38**	**0.5267**	**0.16**	**0.02**

Table 5: Comparison measures of trabecular volume by gender and age groups

Gender	Age groups (year)	n	Trabecular volume Mean	Std deviation	Typical error
Men	< 20	7	27.8	1.67	0.63
	21−30	19	29.6	2.22	0.51
	31−40	5	25.3	0.12	0.56
	41−50	7	22.5	1.35	0.51
	> 51	4	21.6	0	0
	Total	**42**	**26.85**	**3.56**	**0.55**
Women	< 20	6	30.01	1.52	0,62
	21−30	3	30	0	0
	31−40	2	25.30	0	0
	41−50	9	22.49	0.61	0.20
	> 51	4	18.50	0	0
	Total	**24**	**24.87**	**4.50**	**0.91**

Values are mean ± SD

DISCUSSION

The present study demonstrates that there is a significant relationship between age, volume and trabecular BMD measured at the Ward's triangle in men and women (5). The Ward's triangle, for anatomical definition, has been considered an anatomical region rich in trabecular tissue. In general, the femur consists of cortical bone and cancellous bone, the latter being more dependent on the changes. Over the years, it was possible to observe how the spongy structure disintegrates gradually, resulting in the loss of trabecular bone, cavitation within the head, neck and greater trochanter of the femur or the greater tuberosity of humerus, advancing from the medullary cavity of the long bone shaft toward the head of it and finally cortical thinning (6).

In the present study, the group of subjects studied showed a positive correlation between weight and BMD. Correlation was described in previous studies (7), as is the case with size, reflecting the importance of mechanical action weight and height on the mineral content of the skeleton. Both the weight and size will condition the BMI (BMI = weight/height^2), which in turn will condition BMD.

In Table 2, we observe that as BMI increases, so does the BMD. Recent studies have shown the association between BMI and BMD (8), therefore, BMI anthropometric measure seems to be the most influential in determining bone mass. Good correlations were found between muscle strength and BMD. It is likely that good correlations between these reflect the importance of the mechanical action of the muscles on the skeleton as a determinant of its mineral content (9). Decades ago, Frost developed a model that explains the influence of mechanical loading on bone development (10).

As shown in Tables 3–5, the study of age with respect to the quantification of BMD allows us to confirm the downward trend in bone mass with advancing age. Bone mass peak maximum is reached approximately 40 years old, starting to fall from 41 years. The maximum reduction is reached around age 80 years. These results are consistent with those of other authors with work in different studies using radiographic and imaging techniques (11).

There is a decrease in bone mass with age in both men and women (Tables 4 and 5); men lose less bone during the ageing process, so that BMD is higher in men than women of any age (12). This may be caused by sex hormones such as oestrogen and testosterone which play an important role in the maintenance and decreased mass with age. In this study, the ilium was chosen to represent the changes that occur in both cortical and cancellous bone as part of the skeleton, as seen in Tables 4 and 5. The study of age on the quantification of histomorphometric parameters allows us to confirm the tendency for bone mass to diminish with advancing age. Again we can see by gender that a decrease in trabecular bone occurs with increasing age in males and females, but in men the peak bone mass is reached at approximately 30 years of age and begins to decrease at 31 years of age. These results coincide with those of other authors of a recent study based on a population of men and women between the ages of 21 and 97 years where bone microarchitecture was examined (13). In this study, we found that women had less trabecular volume than men. Moreover, it was observed that in both genders, decreased trabecular bone volume occurred along with BMD. This indicates that BMD is relatively sensitive to changes in the trabecular compartment.

In conclusion, this study shows involutional changes that occur in BMD and Ward's triangle in the bone structure. During the ageing process, a decrease in the measured BMD occurs in paralell with the decreasing of the trabecular volume; this decrease occurs later in men than women, about 41 years old. In addition, both weight and height have a great influence on BMD and changes in bone that occur, and as we have seen, BMI is a very important determinant of BMD.

AUTHORS' NOTE

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