

# Cortical and trabecular bone analysis of patients with high bone mass from the BARCOS cohort using 3D-DXA: a case-control study

J. Rodriguez-Morera<sup>1</sup>, L. Humbert<sup>2</sup>, R. Fonolla<sup>2</sup>, J. Romera<sup>2</sup>, M. Oanea<sup>1</sup>, A. Gonzalez-Lizaran<sup>1</sup>, A. DiezPerez<sup>1</sup>, X. Nogues<sup>1</sup>, L. Mellibovsky<sup>1</sup>

<sup>1</sup>InternalMedicineDepartment,ParcdeSalutMar,UniversitatAutònoma deBarcelona,Barcelona,Spain, IMIM (Hospital del Mar Research Institute), Red Temática de Investigación Cooperativa en Envejecimiento y Fragilidad (RETICEF), Instituto de Salud Carlos III FEDER, Barcelona, Spain.

<sup>2</sup>Galgo Medical, Barcelona, Spain

## Introduction

The prevalence of high bone mass (HBM) in the general population has been estimated as 0.2–1%. (1). Mutations (LPR5 gene) remains undetected in the majority of patients (2). Patients with HBM have a lower risk of fracture. DXA scans measures the areal BMD but does not provide details of the cortical bone. The 3D-DXA software (Galgo Medical, Barcelona, Spain) can quantify the volumetric BMD (vBMD), volume (for trabecular and cortical regions) and cortical thickness distribution.

## Objective

To analyze the cortical and trabecular bone of patients with HBM and control group using 3D-DXA.

## Material and methods

9 women with HBM from the BARCOS (BARCcelona Osteoporosis cohort of 1600 postmenopausal Spanish women) cohort and 9 age-matched women (control group) collected at Hospital del Mar (Barcelona, Spain) were included in this study. DXA scans (QDR 4500 SL, Hologic, Waltham, MA, USA) were performed for all the subjects. One of the inclusion criteria for HBM cases was a sum of hip and lumbar spine Z-scores equal to or greater than four. Age-matched controls not having HBM were randomly selected from patients of the densitometry department of Hospital del Mar, with no particular exclusion criteria in terms of Z-score or T-score. The 3D-DXA software was used to analyze the cortical and trabecular bone of patients and control group. 3D-DXA registers a 3D appearance model of the femur shape and density onto the DXA projection to obtain a 3D subject-specific model of the femur of the patient and quantify the volumetric BMD (vBMD), volume (for trabecular and cortical regions) and cortical thickness distribution (Figure 1). The 3D-DXA measurements for both groups were compared using Student's t-test.

## Results

No statistically significant differences were found in terms of age ( $63.9 \pm 7.6$  years for cases,  $60.9 \pm 9.3$  years for controls,  $p = 0.464$ ) and height (Table 1). The weight of HBM cases ( $79.1 \pm 13.0$  kg) was found to be significantly higher than the weight of controls ( $63.7 \pm 6.9$  kg,  $p = 0.015$ ). vBMD of HBM patients was on average higher in comparison with controls: +23% (+70 mg/cm<sup>3</sup>) for integral bone ( $p = 0.007$ ), +42 % for trabecular bone ( $p = 0.013$ ) and +3.3 % for cortical bone ( $p = 0.006$ ) (Figure 3). The mean cortical thickness was also higher: +0.29 mm (+17.7 %,  $p = 0.003$ ) (Figure 2). No statistically significant difference was found in terms of integral volume ( $p = 0.690$ ) and volume of the trabecular compartment ( $p = 0.806$ ). However, the volume of the cortex was found to be significantly higher (+2.7 cm<sup>3</sup> or +18.5 %) for HBM patients.

Table 1: 3D-DXA and DXA measurements for controls and cases at the total femur region of interest.

	Controls		Cases		Differences		
	Mean	SD	Mean	SD	Mean	Mean (%)	p-value
<b>Clinical data</b>							
Age	60.9	9.3	63.9	7.6	3.0	4.9	0.464
Weight	63.7	6.9	79.1	13.0	15.5	24.3	0.015
Height	159.7	5.7	157.4	10.9	-2.3	-1.4	0.540
<b>3D-DXA</b>							
vBMD Integral (mg/cm <sup>3</sup> )	301.0	38.1	370.9	55.3	69.9	23.2	0.007
vBMD Trabecular (mg/cm <sup>3</sup> )	111.8	27.8	159.1	42.2	47.3	42.4	0.013
vBMD Cortical (mg/cm <sup>3</sup> )	1031.1	17.6	1057.5	18.0	26.4	2.6	0.006
bmc Integral (g)	21.3	2.6	27.1	4.6	5.8	27.4	0.004
bmc Trabecular (g)	6.2	1.3	8.8	2.2	2.6	41.5	0.008
bmc Cortical (g)	15.1	2.0	18.3	2.7	3.3	21.6	0.011
volume Integral (cm <sup>3</sup> )	71.5	11.0	73.3	6.9	1.8	2.5	0.690
volume Trabecular (cm <sup>3</sup> )	56.9	9.8	56.0	5.6	-0.9	-1.7	0.806
volume Cortical (cm <sup>3</sup> )	14.6	1.8	17.3	2.3	2.7	18.5	0.014
Mean Cortical Thickness (mm)	1.67	0.16	1.96	0.20	0.29	17.7	0.003
<b>DXA</b>							
aBMD (g/cm <sup>2</sup> )	0.87	0.08	1.07	0.11	0.19	22.1	0.001
BMC (g)	29.20	3.55	36.12	6.01	6.92	23.7	0.009
Area (cm <sup>2</sup> )	33.49	3.26	33.75	2.82	0.26	0.8	0.859

## Conclusion

HBM patients were found to have a thicker cortex and a higher vBMD for both trabecular and cortical compartment, while having femurs with similar size than controls. These findings were not described previously and could explain the lower risk of fracture described in this group of patients

## References

- Gregson CL, Steel SA, O'Rourke KP, Allan K, Ayuk J, et al. (2012) 'Sink or swim': an evaluation of the clinical characteristics of individuals with high bone mass. *Osteoporos Int* 23: 643–654.
- Sarrión P<sup>1</sup>, Mellibovsky L<sup>2</sup>, Urreiziti R<sup>1</sup>, Civit S<sup>3</sup>, Cols N<sup>1</sup>, García-Giralt N<sup>2</sup>, Yoskovitz G<sup>2</sup>, Aranguren A<sup>4</sup>, Malouf J<sup>5</sup>, Di Gregorio S<sup>6</sup>, Río LD<sup>6</sup>, Güerri R<sup>2</sup>, Nogues X<sup>2</sup>, Díez-Pérez A<sup>2</sup>, Grinberg D<sup>1</sup>, Balcells S<sup>1</sup>. Genetic analysis of high bone mass cases from the BARCOS cohort of Spanish postmenopausal women. *PLoS One*. 2014 Apr 15;9(4):e94607. doi: 10.1371.

Figure 1: 3D-DXA software (Galgo Medical, Barcelona, Spain)

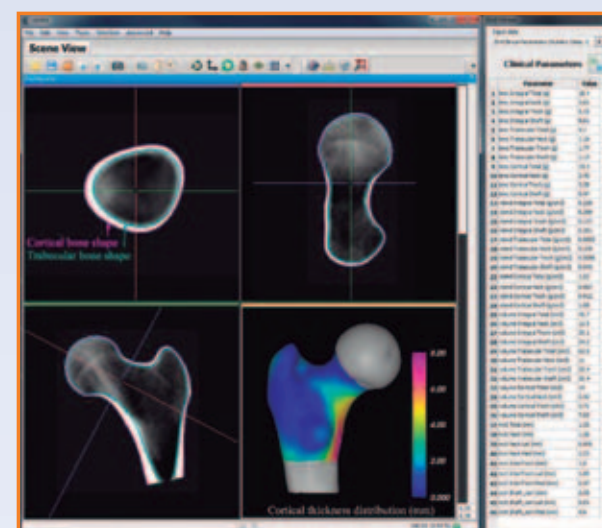


Figure 2: Color map showing statistically significant differences ( $p < 0.05$ , Student's t-test) in cortical thickness between HBM cases and controls, in mm (top) and as a percentage (bottom).

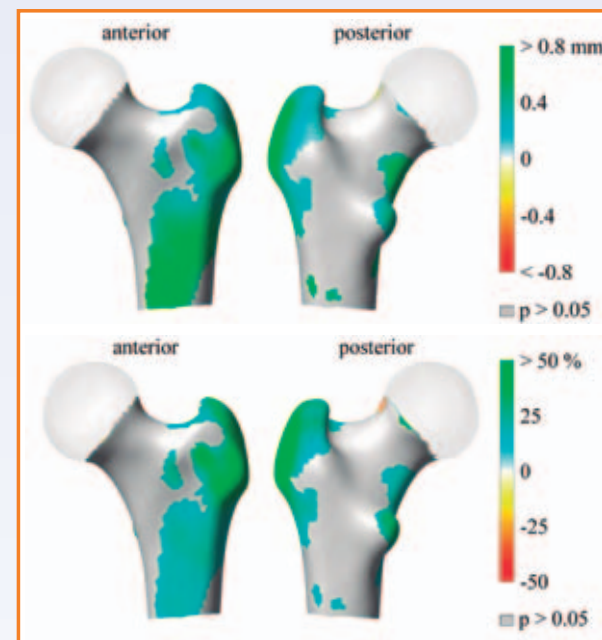


Figure 3: Front slice showing the average vBMD values for controls (left) and HBM cases (right)

