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Osteoporosis is a skeletal disorder characterized by a low bone mass associated to deterioration of bone microarchitecture which induce bone fragility. We have developed a high resolution digital X-Ray device (BMA™, D3A Medical Systems) to assess microarchitecture quality with the determination of a fractal parameter (Hmean) at the calcaneum. We have shown that Hmean could discriminate control cases and fracture cases⁽¹⁾.
 The aim of this preliminary study was to establish a preliminary normal curve for the parameter Hmean on healthy Caucasian French women.

Material and methods

Subjects

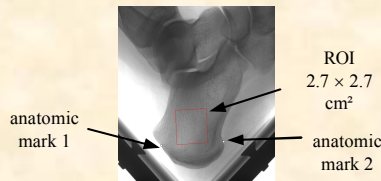
- 153 healthy women (age: 57.7 ± 14.9 years old, range from 18 to 85 years) from 4 European centers
- Women with treatment which could interfere with bone metabolism were excluded

Image acquisition

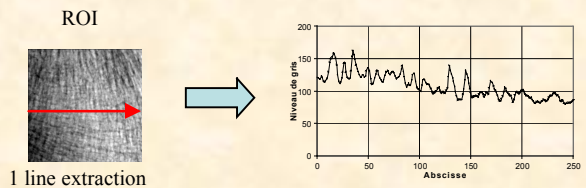
- Images were obtained on calcaneum with a direct digital X-Ray prototype (20 mAs, 55kV, focal distance 115 cm, pixel size 50 microns)
- Trabecular bone texture parameter was assessed by Hmean

ROI analysis

- The operator localized the anatomic marks, allowing the automatic positioning of the ROI



Trabecular bone texture parameter: Hmean



- Fractal model : fractional Brownian motion
 - Estimation of the fractal parameter named H: maximum likelihood estimator
- ➔ **Hmean parameter**
For n directions

Statistical analysis

- Correlation between age and Hmean was evaluated by Pearson’s correlation coefficient
- To compare the fitting degrees of the second and the third order polynomial regression, we used the Residual Mean Square Error :

$$RMSE = \frac{\sum_{i=1}^n (Y_i - \hat{Y})^2}{n - p}$$

where n is the number of observations and p the number of parameters of the regression

Results

Characteristics of the population by age group

	Age (mean ± SD)	Hmean (mean ± SD)
18-29 years (n=15)	20.87 ± 2.33	0.624 ± 0.024
50-59 years (n=70)	54.51 ± 2.89	0.626 ± 0.022
60-69 years (n=34)	63.82 ± 3.05	0.620 ± 0.023
70-79 years (n=28)	73.04 ± 2.56	0.614 ± 0.027
80-89 years (n=6)	81.67 ± 1.97	0.602 ± 0.035

Correlation between Hmean and Age

Hmean was inversely correlated with age in the global population :

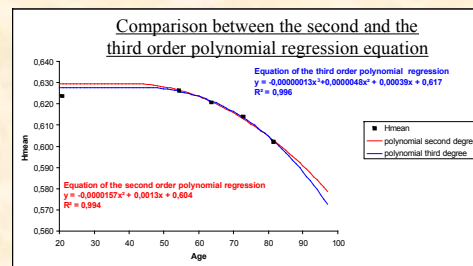
r = -0.165 p = 0.03

Conclusion

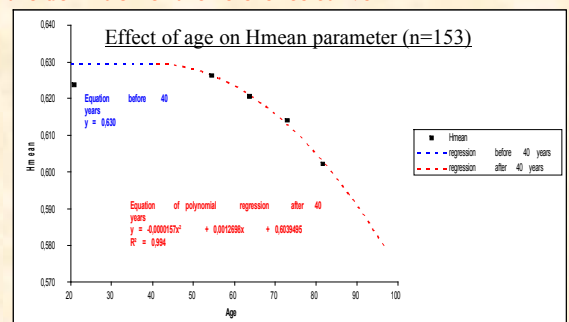
These data confirmed the decrease of the texture parameter studied with age for this population
 A larger group of healthy women has to be assessed in order to plainly validate the reference curve for Hmean

Study of the Residual Mean Square Error

- RMSE for the 3th order : **1.27 × 10⁻⁶** R² = 0.996
- RMSE for the 2^d order : **1.08 × 10⁻⁶** R² = 0.994
- RMSE 2^d order < RMSE 3th order



⇒ **The second order polynomial regression was selected for the definition of the reference curve**



(1)- C.L. Benhamou, C. Gadois, G. Lemineur, J.P. Do-Huu, E. Lespessailles : Bone Texture Analysis On Calcaneus Digitized Radiographic Images: Discriminant Value in osteoporosis. 6th European Congress on Clinical and Economical Aspects of Osteoporosis and Osteoarthritis, Vienne (Autriche). Osteoporosis International 17(suppl 1), P376, Mars 2006.