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High Resolution pQCT micro-architectural parameters to predict bone failure in the case of a forward fall

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Introduction

The gold standard for the diagnosis of osteoporosis is the measurement of areal bone mineral density by Dual X-ray absorptiometry. But the assessment of the bone fracture risk is still not sufficiently discriminant. Indeed, half of the patient considered non-osteoporotic will fracture [1]. In this context, the objective of this study is to evaluate whether bone micro-architecture of distal radius assessed by high-resolution peripheral quantitative computed tomography (HR-pQCT) manage to discriminate fractured from non-fractured bones obtained in a previous *ex vivo* experimental study reproducing a forward fall under dynamic loading conditions [2].

Method

Thirty radii from elderly donors (79 ± 12 y.o., 15 males, 15 females) were scanned intact using a HR-pQCT device (XtremeCT, Scanco Medical AG, Switzerland) before being loaded at 2 m.s^{-1} to mimic impact that corresponds to a fall, leading to two groups: fractured and non-fractured. Clinical standard evaluation was performed on the images in order to assess bone micro-architecture. Statistical non-parametric Spearman's test and Wilcoxon's rank-sum test were performed using R[©] software (The R foundation for statistical Computing, Austria) and p-values under 0.05 were considered as significant.

Results

On the entire population, all micro-architectural parameters were significantly correlated to the maximal load. But important differences appeared when analyzing in two groups. Regarding the fractured group, the Spearman's correlation coefficient ranged between 0.69 to 0.81 (*Tables 1*) for the trabecular parameters whereas the cortical ones were found as not significant. As to non-fractured group, no link was found with any cortical or trabecular parameters (*Table 1*). Furthermore, the fractured and non-fractured group showed in the second test a significant difference for: all trabecular parameters (*p-values* < 0.02), the cortical thickness (*p-value* < 0.05) and the experimental load (*p-value* < 0.001) but the cortical vBMD still remain non-significant (*p-value* = 0.11).

Discussion

The aim of this study was to assess whether micro-architectural parameters obtained by HR-pQCT could discriminate fractured and non-fractured bones obtained experimentally. The correlations showed that trabecular parameters assessed by HR-pQCT explained the bone strength for the fractured group. Furthermore, we found that trabecular parameters, BV/TV and experimental load showed a significant difference between the two groups (p -values < 0.02) contrary to the cortical parameters. These results are in accordance with an epidemiologic study where the authors conclude that the trabecular micro-architecture in the radius is a good predictor of incident fracture in postmenopausal women [3]. Finite element analysis will be performed to enhance our understanding of bone fracture during a fall.

References

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	Microarchitectural Parameters								
	Tt.vBMD (mg/cm ³)	Tb.vBMD (mg/cm ³)	BV/TV	Tb.N (1/mm)	Tb.Th (mm)	Tb.Sp (mm)	Tb.Sp/SD (mm)	Ct.vBMD (mg/cm ³)	Ct.Th (mm)
All samples									
r	0.68	0.62	0.62	0.45	0.73	-0.49	-0.47	0.39	0.51
p-value	<.0001	0.0003	0.0003	0.01	<.0001	0.006	0.008	0.03	0.004
Fractured									
r	0.69	0.81	0.81	0.69	0.74	-0.72	-0.74	0.36	0.48
p-value	0.007	0.0004	0.0004	0.006	0.003	0.004	0.003	0.2	0.08
Non Fractured									
r	0.30	0.10	0.10	-0.10	0.42	0.053	0.096	0.15	0.24
p-value	0.3	0.7	0.7	0.7	0.1	0.8	0.7	0.6	0.4

Table 1 : Spearman correlation (r) between the experimental load and the micro-architectural parameters.

Tt: Total, Tb: Trabecular, Ct: Cortical, vBMD: Volumetric Bone Mineral Density, N: number, Th: Thickness, Sp: Separation, SD: Standard Deviation.