QUANTITATIVE ASSESSMENT OF BONE MICROARCHITECTURE IN THE HUMAN KNEE USING PHOTON-COUNTING CT IS FEASIBLE

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Introduction

Visualization and quantification of bone microarchitecture are important in bone growth, aging, and disease studies. Bone microarchitecture can be non-invasively assessed using micro-computed tomography (μCT). While it is considered the gold standard for non-invasive imaging of bone, its applications have been limited due to its small field of view (FOV); more importantly, usage is limited to ex vivo analyses, hence, it cannot be used to evaluate bone and bone adaptive responses in a patient. High-resolution peripheral quantitative CT (HR-pQCT) is considered the gold standard for in vivo imaging of bone microstructure, but is limited in use because of the rather small FOV and a relatively long acquisition time [1]. Photon-counting CT (PCCT) is a promising alternative with a larger FOV and much shorter scanning time. It is unknown whether bone microstructure can be quantified using PCCT. Therefore, this study aimed to investigate the feasibility of using PCCT in quantifying bone microstructure and compare it to HR-pQCT.

Materials and methods

After obtaining ethical approval, one human cadaveric knee was scanned with PCCT (in-plane resolution: 0.14 mm; slice thickness: 0.10 mm), and HR-pQCT (0.06 mm voxel size). Anterior, central, and posterior volumes of interests (VOIs), each subdivided in three volumes of 2.5 mm height [2] (Figure 1) were defined in the load-bearing regions, resulting in 36 VOIs. Identical VOIs were mapped in PCCT and HR-pQCT images using image registration. Bone volume fraction (BV/TV), trabecular thickness (Tb.Th), trabecular separation (Tb.Sp), trabecular number (Tb.N), and structural model index (SMI) were quantified.

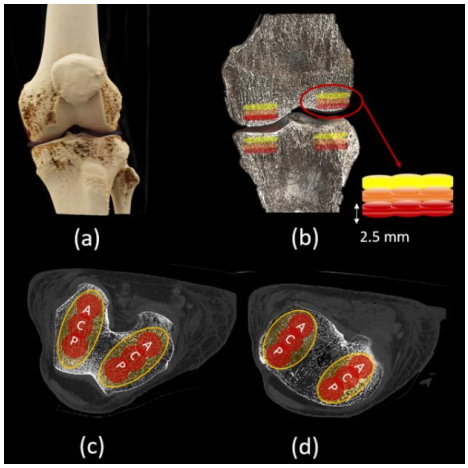

Figure 1: PCCT-based 3D rendering of the knee (a); location of the VOIs in the coronal view (b), in the femoral condyle (c), and in the tibial condyle (d).

Results

BV/TV, Tb.Th, and Tb.Sp were highly correlated; correlations were lower for Tb.N and SMI (Table 1, Figure 2).

	r	*p*
BV/TV	0.84	< 0.001
Tb.Th	0.82	< 0.001
Tb.Sp	0.81	< 0.001
Tb.N	0.59	< 0.05
SMI	0.58	< 0.05

Table 1: Correlation between PCCT- and HR-pQCT-based parameters in 36 VOIs.

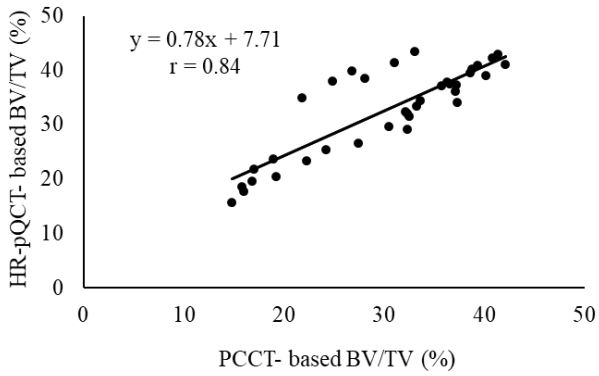

Figure 2: PCCT- and HR-pQCT- based BV/TV was highly correlated in 36 VOIs.

Conclusion

The good agreement between PCCT and HR-pQCT suggests that PCCT is a promising technique to visualize and quantify bone microstructure. The work will be extended to a larger number of knees. Moreover, μCT will be used for further evaluation of PCCT.

References

1. Mys et al, JBMR 34:867-874, 2019.
2. Kroker et al, Bone 97:43–48, 2017.