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CECT STUDY ON PERMEABILITY OF NONIONIC CONTRAST AGENT IN HUMAN OSTEOARTHRITIS ARTICULAR CARTILAGE — ASSOCIATIONS TO MATRIX COMPOSITION AND INTEGRITY

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Objective: To investigate permeability of a nonionic contrast agent in human articular osteoarthritis (OA) cartilage and related the results to tissue composition, integrity, and mechanical properties of the human primary knee OA, and to evaluate the change and interaction of bone and cartilage composite unit between different stages of OA.
Methods: The human tibial plateaus were obtained from patients undergoing total knee arthroplasty (TKA). After gross observation , the cartilage-bone complex samples (d=12mm, n=40) were taken out from the most weight-bearing regions in the internal areas of the medial and lateral plateaus and divided into A, B, C three parts. A group was evaluated the severity of subchondral bone by Micro-CT scanning system, and stained with histological and immunohistochemical staining. B group was evaluated by nano-indentation and other biomechanical testing. C group was processed contrast agents to strengthen scanning method under CECT to detect the permeability.
Results: The bone histomorphometric study showed that BMD, BV/ TV, TMD, Tb.N and Tb.Th in later stage were significantly higher than that of the early stage while Tb.Sp and SMI were lower ($P<0.05$), there were statistically significant differences between each stage ($P<0.05$). Permeability results showed that the permeability of cartilage was associated with cartilage degeneration, and the penetration rate of stage III was the fastest. The severity of articular cartilage degeneration, as assessed by Makin scores, was significantly correlated with BMD ($r=0.83, P<0.001$), BV/T V ($r=0.79, P<0.001$) and Tb.Th ($r=0.65, P<0.0\ 01$), and inversely correlated with SMI ($r=-0.76$, $P<0.001$), and positively with the contrast agent concentration. Mechanical test results showed that stage III was the one with the lowest elastic modulus of OA cartilage, and stage IV was one with the maximum bone elastic modulus, hardness of the OA cartilage.
Conclusion: The interactions of bone and cartilage composite unit is crucial in OA progression. The subchondral bone remodeling is closely related with cartilage degeneration. The contrast-enhanced scanning method based on CT can detect the permeability of cartilage and reflecting the cartilage degeneration.

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TBS PRECISION AND ACCURACY COMPARISON BETWEEN THE HOLOGIC AND GE-LUNAR DXA SYSTEMS

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Objective: Precision error in bone architecture is critical since lower precision error allows for the detection of smaller changes in architecture. Agreement between manufacturers is important for diagnostic concordance. Here we compared the short-term precision and agreement of two fan-beam DXA systems, the Lunar Prodigy (GE Medical Systems, version 10.10) and the Delphi A (Hologic version Apex 4.3), a new measure for lumbar spine architecture, trabecular bone score (TBS) where the same women were scanned on both makes.
Methods: Ninety women from three centers with a mean age of 62 years old (ranging 50 to 82 years) were scanned twice on each system with repositioning between scans. ISCD recommendations were followed for both scanning and analysis. All of the scans were performed using the 30-second scan modes. Furthermore, the scans were batch analyzed using Medimaps TBS clinical Data Analyzer 2.2.1.
Results: We found that three subjects had to be excluded because of an anatomic anomaly. The TBS precision errors (%CV) for GE and Hologic systems were similar but significantly different: 1.74% vs. 1.97%, $p<0.05$. The Spearman Rank correction between GE and Hologic TBS scores was $r=0.73$ but with significant slopes and intercepts in the Deming regression relationship (TBSHologic = 0.86*TBSGE+0.20). Using the same scans and analysis, the BMD precision was 1% and the intermachine BMD agreement was $r=0.99$.
Conclusion: We conclude that TBS values have a modest precision and inter-system agreement compared to BMD. Significant TBS changes over time on the same individual would need to exceed 4.8% to be considered real.

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THE ROLE OF INTRA- AND INTER-OPERATOR VARIABILITY IN HR-pQCT PRECISION

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Objective: The role of the operator on HR-pQCT precision has not been systematically investigated, though likely contributes significant measurement variability, especially in multicenter cross-sectional studies. At scan time, the operator acquires a 2D projection (scout view) of the limb, then visually identifies a reference anatomic landmark, which defines the scan region. Variability of region localization greatly affects bone quality measures, especially where large spatial variations in morphology occur, such as in the ultradistal radius. We evaluated short- and long-term intra-operator and inter-operator precision in scan localization, and the corresponding effect on bone parameters. For reference we compared this to scan-rescan precision.
Methods: To simulate the scan localization process, we recreated the graphical user interface (GUI) of the HR-pQCT acquisition software (XtremeCT, Scanco Medical AG), specifically the scout view visualization and reference line positioning components. Eight operators, from eight centers performed the landmarking procedure in a set of 56 scout images of the radius and tibia. The scouts corresponded to in vivo exams with double-stack (220 slice) acquisitions. Based on the position of each operator's reference line, standard-size acquisition subvolumes (110 slices) were extracted for analysis to determine the impact on bone parameters. Specifically, we evaluated: 1) Intra-operator short-term precision for 8 operators on a set of 15 scout images, repeated thrice; 2) Intra-operator long-term precision (6-24 months) for 2 operators; and 3) Inter-operator variability for 8 operators on 56 scout images. Landmark location precision was calculated in millimeters as the RMS of the SDs for each scout (SDRMS) and the effect on bone parameters as the coefficient of variation (CVRMS). Scan—rescan precision was calculated on 57 radii and 63 tibiae reproducibility scans.
Results: Positioning the tibia was highly reproducible, even across multiple operators (SDRMS=0.30mm, CVRMS<1.96%). Errors for the radius were significantly greater ($p<0.05$), and particularly high across operators (SDRMS=0.61mm, CVRMS=8.48% for Ct.Th). Ct.Th was considerably more sensitive to position variability than density and structure measures. Compared to scan-rescan precision, operator precision errors were generally greater for density and Ct.Th, and less for structural parameters.
Conclusion: In conclusion, HR-pQCT operator precision errors were moderately high for the radius over time, within and across operators. Positioning variability contributes greater overall measurement error than patient motion. More rigorous operator training using standard tools, such as the presented GUI, would greatly benefit future multicenter studies. Alternatively a more reproducible anatomic landmark for positioning should be considered, as well as the development of automatic landmark detection techniques.

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EFFECT OF SPATIAL DISTRIBUTION OF BONE STRUCTURE ON FAST WAVE GENERATION IN CANCELLOUS BONE

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