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Mri-based Thickness Measurements of Lumbar Facet Joint Subchondral Bone

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Introduction: The facet joint has not been thoroughly characterized in terms of osteoarthritis and low-back pain. One sign of osteoarthritis progression is the quality of the subchondral bone microstructure. Few studies have focused on the subchondral bone thickening in the lumbar facet joints. Gaining more knowledge about this phenomenon can help elucidate facet-genic low-back pain pathways.

Methods: A 1.5T MRI unit was used to scan lumbar spines (L1-L2 to L5-S1) of 90 volunteers: mean age 37.6 years, range: 22-59 years old, (with IRB approval). The resulting images corresponded to a total of 1,800 facet joints (both left and right sides included). A custom-written C++ (Microsoft Foundation Class environment) bilinear-interpolation and size-conversion algorithm was used together with a multi-threshold segmentation technique recently developed in our laboratory to obtain subchondral bone thickness results from the middle axial-slice of each facet joint. An additional 10 cadaveric facet joints were scanned both with MRI and microCT as a means to validate this protocol. Differences between groups were determined with ANOVA and statistical significance was set at $p < 0.05$.

Results: The subchondral bone thickness values showed significant increases both with age and successive lower spinal levels. The mean subchondral bone thickness in all superior facets was 1.71 ± 0.39 mm. The mean subchondral bone thickness in all inferior facets was 1.42 ± 0.29 mm. This difference between superior and inferior sides was deemed significant due to $p < 0.01$. An overall average thickness value for the 1,800 analyzed joints was measured as 1.56 ± 0.37 mm (mean ± SD). Facet joint subchondral bone thickness values in women were shown to be much smaller than those of male subjects ($p < 0.05$).

Discussion: Subchondral bone thickening is thought to contribute to joint gap narrowing due to osteoarthritis in the facet joints. This study is the first to show quantitative results of this phenomenon, usually just diagnosed qualitatively with CT and MRI. The data showed good agreement between the MRI and microCT, and was within range of the subchondral bone thickness of the trochlear notch measured in histological sections, thus validating this technique. Subchondral bone thickness was greater in men and increased with each successive lower spinal level. These findings may suggest that the subchondral bone thickness increases with loading. Additionally, the superior facet subchondral bone was thicker than the inferior facet regardless of gender, age or spinal level. Future investigations should provide evidence to establish relationships between subchondral bone microstructure, facet joint kinematics and spinal loads.