INTRODUCTION: Facet joints (FJs) are synovial articulations and undergo degenerative changes similar to those of other weight-bearing joints. Osteoarthritis (OA) of FJ has been considered as a potential source of low back pain and disability and contributes to 15-45% of chronic low back pain. Accurate description of FJ geometry is necessary for evaluation of degenerative processes within the joint. Facet joint space width (FJSW) is a well defined parameter in evaluating OA [1]. Topographical patterns within anatomically defined zones on the surface of the FJ are an important parameter to evaluate FJ OA. The aim of this study was to determine lumbar facet joint topography distribution patterns in vivo and its correlations with age, level and presence of lower back pain.

METHODS: IRB-approved study to obtain lumbar CT scans of 96 subjects (51M, 45F, age range 20-59 y.o.; 62 healthy and 34 symptomatic). A total of 1920 FJ surfaces models were created from individual CT images producing point clouds and corresponding triangular meshes. The normal vectors of each polygon were calculated and mean normal vector of the joint surface was registered on the surface centroid (Fig. 1a). A clinically relevant local coordinate system was established there with z axis oriented in the cranial direction (Fig. 1c). Using a spherical coordinate system (with the origin fixed in the surface centroid) we divided each facet surface into 5 zones: superior (green), inferior (blue), medio-ventral (red), latero-dorsal (yellow), and central (white) zone (Fig. 1b). Each point was assigned to a zone based on its position (radial distance from spherical coordinate origin) and inclination angle (from z-axis). Since facet surfaces do not have a perfect circular shape, the central zone diameter was normalized such that the central zone covers 20% of the entire area, leaving the peripheral zones to represent the remaining 80%. FJ gap was calculated as the distance between each pair of opposing surfaces (inferior facet, superior facet) at each level in supine position using a custom written least-distance algorithm (Visual C++). Average FJ space width was calculated for each zone. ANOVA and Fisher post hoc test were used to evaluate differences between zones, levels, age and symptoms. Differences between right and left sides were evaluated using paired t-test and gender comparison was carried out with an unpaired t-test. Results were reported as mean and standard error of the mean. Significance was set to alpha = 0.05.

RESULTS: Mean (±SEM) FJ space width was 1.8±0.03 mm for the central zone, 1.7±0.03 mm for the superior zone, 1.6±0.03 mm for the inferior zone, 1.6±0.03 mm for the medio-ventral and 1.4±0.03 mm for the latero-dorsal zone, respectively. Gender comparison showed greater width distribution in males in all zones (p<.0001). The data also showed FJ gap decrease starting in the 40s for the L1/L2 peripheral zones and progressing to the central zone in the 50s. No change was observed at L2/L3 in the 40s. FJ narrowing occurs in the lateral zone at all levels expect L1/L2 and L2/L3 in the 40s and progresses to L2/L3 in the 50s. In L5/S1, narrowing starts as early as in the 30s in the inferior zones and spreads to all remaining zones in the 40s. No differences were observed between right and left side. Overall space width was lower in symptomatic subjects. Inferior zone was narrower at L3/L4, L4/L5 and L5/S1 levels (p<.0001) compared with superior.

DISCUSSION: Results indicate that FJSW changes significantly after the fourth decade at every levels except L2/L3. FJSW narrowing found in symptomatic subjects indicates presence of degenerative changes as well as cartilage thinning. We assume that narrowing on the inferior and superior zone of the facet surface is due to the intensive contact of the two opposing superior/inferior joint surfaces during maximal flexion/extension as indicated in a cadaveric study by Tischer et al. [2]. Future studies will include changes in FJ contact area during various physiological motions.

SIGNIFICANCE: This in vivo study showed that narrowing of facet joint space width varies with spinal level and region within the facet joint. This technique may be used for detection of early changes of FJ associated with osteoarthritis.

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