INTRODUCTION:
Changes in load transmission through the facet joint have been considered as an important factor in intervertebral disc degeneration and osteoarthritic changes of the facet joint [1, 2]. Therefore, facet joint surface area is an essential parameter for calculation of stress/pressure on the facet joint. Information on facet surface area is also important for designing implants of the spine. Considerable variation of the facet has been noticed clinically [3], but little information on the facet joint surface area is available due to complex and three-dimensional (3D) geometry of the facet joint surface. We hypothesize that the facet joint surface area is level dependent; it can be measured using a subject-based 3D computer model. The purpose of the current study was to establish an in vivo 3D measurement technique of the lumbar facet joint surfaces and to analyze the level dependency of the facet joint surface area.

METHODS:
Twenty-six asymptomatic volunteers (14 males and 12 females: 24-59, mean 39.4) were recruited to participate in this non-invasive imaging study and underwent CT scans in a supine position (IRB approved). 3D point-cloud models of the facet joint surface were reconstructed from the CT images [4]. Polygons were created from the point-cloud data. Area of each polygon was calculated and summated throughout the entire facet joint surface (Fig.1). Model generation and area measurement were done by custom software written in VC++ under Microsoft Foundation Class programming environment. Right and left side or superior and inferior facet joint area in a same level were compared with a paired t-test. Right and left facet joint surfaces were compared to investigate level and gender effects. The averaged facet joint areas at different levels were compared using ANOVA with a Fisher’s post-hoc test. The purpose of the current study was to establish an in vivo 3D measurement technique of the lumbar facet joint surfaces and to analyze the level dependency of the facet joint surface area.

RESULTS:
There were no significant differences between male and female subjects in superior and inferior facet joint at any levels. Overall, averaged values in terms of right and left were 157.3 mm² in female vs. 179.9 mm² in male (p=0.1) on the superior facet joint surface, and 165.1 mm² in female vs. 179.5 mm² in male (p=0.3) on the inferior facet joint surface. The facet joint surface area at each level showed no statistical differences between right and left facets except L2/3 inferior facet joint (p=0.05). Greater inferior joint surface area was shown only at left L5/S1 level. Overall, both superior and inferior facet joint areas (in right, left and averaged) increased as the level being lower (p<0.001, Fig. 3). In the superior facet joint surface, the right and left averaged joint surface at L5/S1 level was larger than those at L3/4 (p<0.002), L2/3 (p<0.001), and L1/2 (p<0.001), and the area at L4/5 was larger than those at L2/3 (p<0.004) and L1/2 (p<0.001), and the area at L3/4 was larger than at L1/2 (p<0.008). In the inferior facet joint surface, the right and left averaged joint surface at L5/S1 level was larger than those at L4/5 (p<0.0001), L3/4 (p<0.0001), L2/3 (p<0.0001), and L1/2 (p<0.0001), the area at L4/5 was larger than those at L3/4 (p<0.01), L2/3 (p<0.01) and L1/2 (p<0.01), and the areas at L3/4 and L2/3 were larger at L1/2 (p<0.03).

DISCUSSION:
The current study demonstrated significant level differences on the facet joint surface area. The superior and inferior facet joint areas at L5/S1 were 2.0 and 2.5 folds larger than those at L1/2 level. Most of the facet joint surface area did not show statistical difference between the right and left sides; however, the subjects used in the current study were healthy normal subjects and results may be different in the subjects with disc and facet degeneration. Although the current study also did not demonstrate gender differences, the larger sample size may demonstrate larger facet joint surface area in male. The future study will include larger number of healthy subjects and also include symptomatic subjects.

REFERENCES:

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