Changes in Lumbar Ligamentum Flavum Thickness with Advancing Age

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Disclosures:
H.S. An: 1; U&I Inc.. 3B; U&I, Inc.; Spinal Kinetics; Advanced Biologics, Inc.; Medyssey. 4; Pioneer Inc.; Life Spine Inc.; Zimmer Inc.; Halozyme Inc.. 5; Rush University Medical Center; Spinalcyte Inc.; Baxter Inc.; Omega; OREF. G.B. Andersson: 3B; Zimmer Inc.; Pioneer Surgical., Spinal Kinetics. 5; NIH NIAMS. N. Inoue: 5; NIH NCCAM.

Introduction: Spinal stenosis of the lumbar spine represents a significant cause of disabilities in the aging adult. Nerve impingement results from both bony canal narrowing and soft tissue enlargement, with a higher rate of stenosis attributable to hypertrophy of the soft tissues including the ligamentum flavum (LF). This study examined LF thickness across different groups by age, gender, level and symptom (low back pain) in individuals to assess the attribution of LF to lumbar canal stenosis, using enhanced MR images as well as bilateral medial and lateral measurements of LF thickness.

Methods: A total of 78 volunteers (44M, 34F; 36 symptomatic, 42 asymptomatic) were enrolled in this IRB-approved study and divided into three age-groups: young (20s-30s; n=50, 30.6±5.3 y.o.), middle-aged (40s-50s; n=19, 48.0±5.8 y.o.) and an older adults group (over 60s; n=9, 71.0±7.0 y.o.). A 1.5-T MR unit was used to obtain 3.0 mm-thick axial cross-sectional views of the lumbar spinal canal as proton-density images using standard clinical sequences. Image slices at the level of the inferior aspect of the disc space from L1/2 (labeled L1) to L5/S1 (labeled L5) were chosen for analysis using custom-written Visual C++ routines. A ROI was interactively set at spinal canal including the LF, and was enlarged 800% using a bilinear-interpolation size-conversion algorithm. LF thickness was assessed using bilateral medial and lateral measurements; the medial measurement occurred at 1/3 of the length from the medial extent, and the lateral measurement occurred at 1/3 of the length from the lateral extent (Fig. 1).

Measurement lines were perpendicular to LF length. Bilateral measurements were made for 780 LFs from L1/2 to L5/S1 or 1560 sites. Average thickness by medial and lateral methods was examined by age group, gender, level and symptom (with or without low back pain). Differences were sought with unpaired t-tests (statistical significance set at p<0.05). Results are presented as mean±SEM.

Results: Mean medial LF thickness increased with age: (older 3.89±1.36 mm) vs. middle-aged (3.46±0.83 mm, p<0.01) and middle-aged vs. young group (3.16±0.90 mm, p<0.001; Fig. 2A). A different pattern was shown in the mean lateral LF thickness: the middle-aged group (3.20±0.72 mm) was larger than both the younger (2.92±0.72 mm, p<0.001) and the older groups (2.89±1.13 mm, p<0.01; Fig 2B). Average medial LF thickness in males (3.18±0.06 mm) tended to be thinner than in females (3.37±0.09 mm, p=0.08). No significant differences were detected in the lateral LF thickness between males and females (p=0.95). By level, the medial LF thickness increased caudally from L1 to L4 but it was smallest at L5. As to the lateral LF, the order of LF thickness from least to greatest was L1, L2, L3, L5, and L4. At all levels except L5, medial LF thickness was greater than lateral LF thickness (p<0.01). Conversely, medial LF thickness at L5/S1 was smaller than lateral (p<0.05). Overall, medial thickness in symptomatic subjects was not significantly different compared with that of the asymptomatic subjects (p=0.11). However, the lateral LF thickness in symptomatic patients was significantly larger than in the asymptomatic subjects (p<0.001).

Discussion: Medial LF thickness increased with age, in agreement with previous studies reporting LF hypertrophy caused by segmental instability and/or fibrosis and buckling of LF caused by disc height loss as causes of LF thickening at the central portion of the spinal canal. The lateral LF thickness was larger in the symptomatic subjects suggesting LF contribution to lateral recess stenosis. However, the lateral LF thickness in older adults was thinner than in middle-aged subjects, while it increased from younger age to middle-age. The lateral site was defined as the lateral one-third of the line connecting the lateral and medial extent of the LF. The LF attaches to the superior process of the facet joint and we noted the LF wraps around the hypertrophic superior process in the aged subjects. This morphometric change in the facet joint may explain the paradoxical thinning of the lateral LF in the oldest subjects. Medial shift of the medial border of the superior process due to hypertrophy and/or osteophyte formation may also cause apparent thickening of the medial LF. Future studies will include morphological changes of the facet joint for the evaluation of LF morphology.

Significance: The present study measured the LF thickness at medial and lateral sites aiming to evaluate contribution of the LF to the spinal canal stenosis and lateral recess stenosis with a computer-assisted standardized method in vivo.

Acknowledgments:

References:
Fig. 1 (A) Original PD MR image, box shows the initial ROI. (B) 800% Bilinear interpolation enlargement of the ROI. Arrows indicate medial LF and lateral thickness dimensions.

Fig. 2 Medial LF thickness (A) and lateral LF thickness (B) by age groups (young, middle-aged and older). Data is shown as mean ± SEM. Statistical differences: ** = p<0.01 and *** = p <0.001