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Magnetic Resonance Imaging Measurement of Ligamentum Flavum Thickness and its Relations with Age, Sex and Asymmetry

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Abstract

Background: Ligamentum flavum (LF) when thickens can contribute to spinal canal stenosis and nerve roots compression.

Objective: To Assess the relationship of Ligamentum flavum with age, sex and side

Patients and Method: This was a cross-sectional study conducted at MRI unit in Al-Hilla teaching hospital. Included 60 patients aged 20–80 years with low back pain and/or radiculopathy. Patients with a history of previous lumbar surgery or radiotherapy, congenital anomalies, scoliosis, spondylolisthesis, cardiac pacemakers, aneurysms, clips and metallic implants and joint replacements were excluded.

Results: The mean LF thickness at left side was 3.50 ± 0.6 mm in males and 3.72 ± 0.69 mm in females. In right side the values were not much different where the mean LF thickness in males and females was 3.30 ± 0.64 and 3.52 ± 0.66, respectively. Female had thicker LF than male but the difference did not reach the statistical significance.

It had been found that the mean LF thickness in both sides increased with advancing age, ($p < 0.05$). According to the level, it had been significantly found that in both sides the LF was thicker at the L4–L5 level than other two levels, and no statistically significant differences had been found between both sides when compared at each level

Conclusion: Advanced age and female gender were found to be independently raise the risk of LF thickness, The study suggest that LF measurement should be interpreted in conjunction with patients' variables specially age and gender.

Keywords: Ligamentum flavum (LF); Magnetic Resonance Imaging (MRI).

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Introduction

Low back pain (LBP) is a common medical condition and the associated disability and medical cost have a significant impact on the community.[1-3] With the increasing longevity of our population and the resulting increasing proportion of middle-aged and elderly persons, the problem of low back pain is becoming a significant health care issue. Given the potentially devastating effects of this

medical condition, early diagnosis and treatment are essential for positive outcomes.[4]

Lumbosacral pain may occurs as result of several causes, including degenerative and congenital spinal stenosis, neoplasm, infection, trauma, and inflammatory or arthritic processes, with degenerative joint and disk disease accounting for the vast majority of cases.[5]

The relation between low-back pain and abnormalities in the lumbar spine is controversial as abnormal findings are often seen in asymptomatic patients on plain radiographs, CT studies and MRI studies. Degenerative changes in the disc are already seen in one-third of healthy persons between 21 and 40 years old.[6]

Hypertrophy of the ligamnetum flavum (LF) represent important causative factor in the compression of the dural sac and roots.[7] And significantly contributes to lower back pain and radiculopathy[8,9] even in the absence of a bulging annulus fibrosus, herniated nucleus pulposus, or osseous spurs. A cut of 4 mm has been fixed as lower normal for LF.[10,11]

The reasons for LF thickening are not completely understood, but they are probably related to mechanical instability and asymmetrical stresses on the facets.[12,13]

Materials and Methods

This was a cross-sectional study conducted at MRI Unit in Al Hilla teaching hospital in Babylon governorate, Iraq during the period; January to September 2019.

Included (60) patients (32 female and 28 male) aged 20–80 years who were referred to the MRI unit for lumbosacral evaluation due to low back pain and/or radiculopathy. Patient was excluded if he/she had a history of previous lumbar surgery, radiotherapy, congenital anomalies, scoliosis, spondylolisthesis and cardiac pacemakers, aneurysms, clips and metallic implants, joint replacements and when the MRI examination does not included any of L3/4, L4/5 & L5/S1 level were excluded. MRI of the lumbar spine is performed in both sagittal and axial planes.

Any abnormality on sagittal views should be confirmed on axial views and vice versa. On T1-weighted images, ligamentum flavum reflects intermediate- to low-signal intensity T2-weighted images optimize contrast between disk, bone, and CSF. All examination were performed by the same MRI system using MRI sequences for lumbosacral evaluation with the followings imaging parameters:

Sagittal T1 WI. TSE TE = 8 ms TR = 500 ms

Sagittal T2 WI. TSE TE = 100 ms TR = 4000 ms

Axial T2 WI TE = 100 ms TR = 4000 ms

Data were collected including the demographic and clinical variables. Radiological data and evaluation of axial (T2W) & sagittal (T1W & T2W) MRI images and measurement of the ligamentum flavum were performed or supervised by expert specialist radiologists additionally, any ancillary degenerative findings like facet joint hypertrophy were assessed.

Statistical Analysis: was performed using the statistical package for social sciences (SPSS) version 25. Data were managed and analyzed according to the type of variables and appropriate statistical tests and procedures were applied accordingly.

Results

A total of 60 patients were included in the study their age ranged 20–80 years. They were equally distributed into three age groups with 20 years interval. They were 28 males and 32 females with a female to male ratio of 1.14:1, (Table 1). The comparisons of mean LF thickness according to age, sex, levels and sides are shown in (Table 2); According to age it had been found that, in both sides, the mean LF thickness increased with advancing age, where the higher thickness reported among patients aged 61–80 years, and lower thickness was found in those aged 20–40 years, further more, curve estimation for the correlation between age and LF thickness revealed a direct (positive) correlation, ($p < 0.05$) in both sides. (Fig. 1, 2 and 3). The comparison according to sex revealed that LF was thicker in females than males, however, the difference did not reach the statistical significance. According to the level, it had been significantly found that in both sides the LF was thicker at the L4–L5 level than other two levels, ($p < 0.05$).

Table 1: Age and sex distribution of the studied group (*N* = 60)

Variable		No.	%
Age (year)	20–40	20	33.3
	41–60	20	33.3
	61–80	20	33.3
	Mean (SD)	52.1 (15.2)	
	Range	25–78	
Sex	Male	28	46.7
	Female	32	53.3

SD: Standard deviation

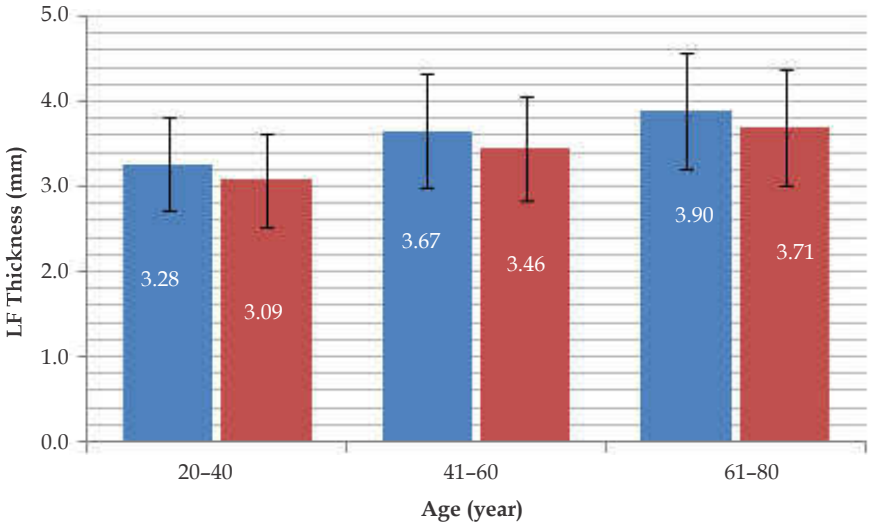

Fig. 1: Graphical comparison of the mean left and right LF thickness according to age groups.

Table 2: Comparison of mean LF thickness according to age, gender and side

Variable		Number of cases	LF thickness				*p*-value (*t*-test) Between sides
		Left		Right			
		Mean	SD	Mean	SD		
Age	20–40	20	3.28	0.55	3.09	0.55	0.285 ns
	41–60	20	3.67	0.66	3.46	0.61	0.300 ns
	61–80	20	3.90	0.69	3.71	0.68	0.394 ns
***p*-value (ANOVA) Between age groups**			0.001 sig		0.001 sig		
Gender	Male	28	3.50	0.64	3.30	0.64	0.268 ns
	Female	32	3.72	0.69	3.52	0.66	0.249 ns
***p*-value (*t*-test) between genders**			0.209 ns		0.204 ns		
Level	L3–L4	16	3.30	0.63	3.11	0.60	0.391 ns
	L4–L5	25	3.87	0.53	3.67	0.50	0.172 ns
	L5–S1	19	3.54	0.78	3.35	0.77	0.454 ns
***p*-value (ANOVA) Between levels**			0.023 sig		0.022 sig		

SD: standard deviation, ns: not significant, ANOVA: analysis of variances, SD: standard deviation, sig: significant, ns: not significant

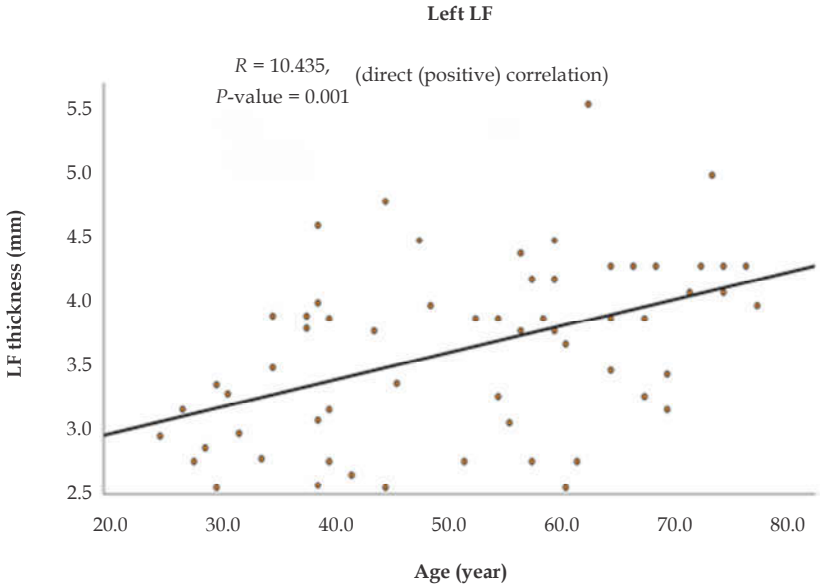

Fig. 2: Curve estimation showing a direct (positive) significant correlation between left LF thickness and age of the studied group.

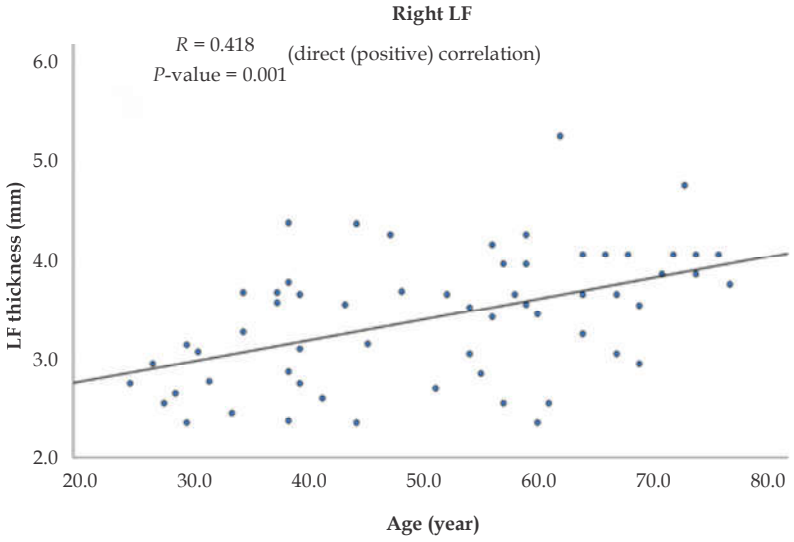

Fig. 3: Curve estimation showing a direct (positive) significant correlation between right LF thickness and age of the studied group.

Discussion

Regarding effects of age on LF; the findings of the present study were in concordance with most of previous studies of LF (Akreyi et al.,[8] Kolte et al.,[14] Okuda et al.,[9] Abbas et al.[15] and Altinkaya et al.[16] Twomey and Taylor[17]) that suggested the LF thickness is an age-dependent phenomenon. In all these studies, significant changes in LF thickness were seen at the L4–L5 and L5–S1 spinal levels as age increased.

On the contrary; Safak et al.[10] and Fukuyama et al.[18] found that there was no association between LFT and increasing age. Safak et al.[10] suggested that mechanical stress and degeneration seemed to be more important factors in LF hypertrophy than age and gender.

In this study, we found that females were having thicker LF than that in males at the three studied lumber levels; this is in agreement with Akreyi et al.[8] and they attributed that to the nature of the Iraqi women's work. Interestingly; in these two Iraqi

studies (our study and Akreyi et al.[8] study), females found to have more LF thickening compared to Iraqi males. Up to our Knowledge, we don't found a similar result in the previous articles concerning LFT. On the contrary, Safak et al.[10] and Abbas et al.[15] found that there is no statistically significant difference between male and females regarding the LFT.

In this study don't found statistically significant differences in LFT with respect to the side (right or left) when measured at the same level and this is true at all studied levels. This is in agreement with Kolte et al.[14] and Chokshi et al.[19] but in disagreement with Abbas et al.[15] who found that the right sided LF is thicker than left LF while Safak et al.[10] who found that the left sided LF is thicker than right LF.

Abbas et al.[15] explained that it could be attributed to the right thoracic built in rotation in non-scoliotic spine at the mid and lower thoracic vertebrae. They assumed that there would be a compensatory rotation to the left of the lumbar spine that increases the tension forces in the right spine complex leading, in time, to a greater thickening of the right LF.

Conclusion

1. LFT is more in females than males but without statistical significance.
2. LFT increased with advancing age Therefore, interpreting LF thickening should be done without considering patient's age else over- or underestimation may result.
3. Among lower lumbar levels, LF was thicker at L4/5 LF than at L3/4 & L5/S1 levels.
4. There was no significant difference in LFT regarding the side.
5. When each of all aforementioned variables taken independently, the advanced age was the stronger predictor of thicker LF, followed by spinal level L4/L5, and female gender

Ethical Clearance: The study protocol was approved by the Scientific council of the college of Medicine, Babylon university and the department of Radiology. Signed informed consent was obtained from each patient before examination and enrollment in the study, all data were kept confidentially and collected in accordance with the World Medical Association Declaration of Helsinki Ethical Principles For Medical Research Involving Human Subjects.

Conflict of Interest: Authors declared none

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