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Original Research Article

A STUDY ON THE THICKNESS OF LIGAMENTUM FLAVUM IN ASYMPTOMATIC PERSONS AND PATIENTS WITH LOW BACK PAIN AND ITS VARIATION WITH GENDER IN EASTERN INDIAN POPULATION- AS MEASURED USING MRI

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ABSTRACT

Background: Lumber spinal canal stenosis is common spinal disorder in elderly patients causing low back pain. Ligamentum Flavum (LF) covers most of the postero-lateral part of spinal canal, hypertrophy of which considered an important causative factor in development of lumbar spinal canal stenosis which significantly contributes to low back pain and sciatica.

Materials and Methods: To measure the thickness of LF in in lumbar region at L1-L2, L2-L3, L3-L4, L4-L5, L5-S1 level on MRI a cross sectional MRI study of lumbar spine was carried out between the age group of 20-50 yrs in IPGMER and SSKM hospital, Kolkata. The study population comprised of two groups with a total 120 population of which first group comprised of patients with low back pain (LBP) (n=60), second group was control groups, persons without low back pain (n=60). T1 weighted magnetic resonance images of lumbar segments were taken and thickness of LF was measured on both right and left side in all lumbar segments.

Results: The mean thickness of LF in lumbar segment in LBP group was 3.47mm which was significantly thicker than control group measuring 2.63 mm.

Conclusion: Patients with low back pain had significantly thicker LF in lumbar segments when compared to asymptomatic persons in both the sides which may be a contributing factor for LBP.

KEY WORDS: Ligamenta flava, Lumbar spine, Low back pain.

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INTRODUCTION

Ligamentum Flavum (LF) is an important structure in spinal architecture. LF is a yellow elastic ligament connecting laminae of two adjacent vertebrae and extending from C2 vertebrae to S1 segment. Lumber spinal canal stenosis is the most common spinal disorder in elderly patients causing low back pain, leg pain and paresis [1]. As LF covers most of the postero lateral part of lumber spinal canal, hypertrophy of the LF is considered an important causative factor in the development of lumbar spinal stenosis, leading to compression of the dural sac and roots and significantly contributes to low back pain and sciatica [1-13]. Measurement of the thickness of LF in the lumbar segments was taken because in the lumbar segments, hypertrophic facets and thickened ligamenta flava are the most common offending structures for narrowing of spinal canal [13].

The study was a Radiological, observational, comparative study where two population groups were taken. First group was asymptomatic persons without low back pain and second group was patients with low back pain. T1-weighted Magnetic Resonance Images (T1WI) of lumbar spine was taken and thickness of LF was measured. The purpose of the study was to measure the thickness of LF in asymptomatic persons in relation to age and gender to understand how these pertinent variables influence the thickness of LF and also to measure thickness of LF in patients with low back pain. In this study, T1WI were used as the tool for the measurement by a standardized technique [14].

MATERIALS AND METHODS

A cross sectional and observational study of MRI lumbar spine was performed in the age group between 20-50 years in Eastern Indian population. This study was conducted on a SIGNA3T HDXT MRI machine (3Tesla) by GE Medical Systems in the department of Radiology of IPGMER &SSKM hospital, Kolkata over a period of 5 months from Sep 2016 to Jan 2017 after obtaining ethical committee clearance.

Our method of measuring LF is in accordance to Chokshi F. H. et al (2010). LF thickness is measured on the axial T1WI that was perpendicular to the spinal canal axis and parallel to the laminae, where LF was seen along the entire length. We made the measurement of LF at the half its length where it appeared the thickest. A normal value for LF thickness was established by measuring the thickness at half the length of the LF. Fig. 1 shows the technique used for measure-ment of LF thickness.

Subjects' Inclusion Criteria:

For symptomatic patients: Patients attending orthopaedic out-patient department with chronic low back pain where symptoms persists more than 3months in active young life and clinically diagnosed as Low Back Pain(LBP) of mechanical cause.

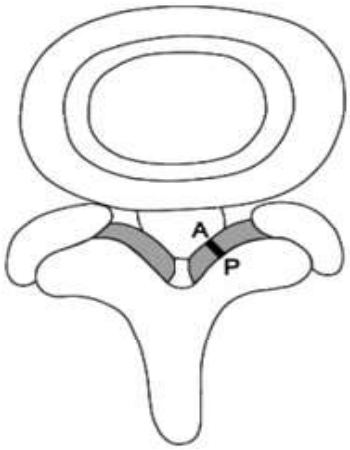
For Control group: The patients referred to MRI centre, IPGME&R &SSKM hospital for MRI of brain, shoulder joint and abdominal ailment or for MRI screening without any manifestation related to diseases involving dorso-lumbar regions.

Subjects' Exclusion Criteria: Patients with significant trauma, infection, inflammation, neoplasia and osteoporosis, osteomalacia etc were excluded from the study. Spinal deformity like scoliosis was also excluded from the study.

Sample Size: 30 male and 30 female subjects as control (CON) were studied without any back problems and similar number of male and female subjects with low back pain.

Softwares used for analysis of the study were Statistica version 6 [Tulsa, Oklahoma: StatSoft Inc., 2001] and Graph Pad Prism version 5 [San Diego, California: Graph Pad Software Inc., 2007].

Fig. 1: Measurement of LF thickness taken at the intervertebral disc level, perpendicular to the border of the laminae (*AP* is the thickness of LF).



RESULTS

Table No.1 shows mean age of Low Back Pain(LBP) group was 40.28yrs (SD=8.273).The mean thickness of Ligamentum Flavum in different lumbar spinal levels on the Right side were as follows: L1-L2:3.73mm, L2-L3:3.63mm, L3-L4:3.54mm, L4-L5:3.45mm, L5-S1:3.37mm. The thicknesses of LF on the Left side at different lumbar levels were L1-L2:3.61mm, L2-L3:3.48mm, L3-L4:3.39mm, L4-L5:3.30mm, L5-S1:3.24mm.

Table No.2 shows mean age of Control group (CON) was 40.02 yrs (SD 8.36). The mean thickness of LF on the Right and Left sides at L1L2, L2L3, L3L4, L4L5 and L5S1 levels were as follows: 2.66mm, 2.66mm, 2.67mm, 2.7mm, 2.69mm and 2.6mm, 2.54mm, 2.57mm, 2.63mm, 2.64mm respectively.

From Table No.3 we can find that the thickness of LF was significantly higher in LBP group than in Control group in each side in all lumbar segments (p value<0.05). The thicknesses of LF in both the groups were compared by Student's independent samples t test.

Table No.4 shows paired comparisons of sides in LBP group (n=60).The mean thickness of LF in L1L2, L2L3, L3L4, L4L5, L5S1 levels was significantly higher on right side than Left side in LBP group (p<0.05).

From Table No.5 we can find that in control group the mean thickness of LF was higher on right side in all lumbar segments but it was statistically significant in upper three lumbar segments only.

Table No.6 shows comparison of thickness of LF between male and female within LBP group by Student's unpaired t test. The mean thickness of LF was higher in all lumbar segments in male in LBP group except L4L5 on the left side but it was not statistically significant.

Table No.7 shows comparison of data in the control group between male (n=30) and female (n=30) and revealed no sexual dimorphism. In control group the mean thickness of LF was more in male than female except L2L3 level on both the side but it was not statistically significant.

Table1: Descriptive statistics of numerical variables – Group LBP [n = 60].

	Valid N	Mean	Median	Minimum	Maximum	Standard.Dev.
Age	60	40.28	41.00	21.00	50.00	8.273
Durn of LBP	60	3.13	3.00	0.50	7.00	1.480
L1L2_R	60	3.73	3.70	3.00	4.20	0.289
L1L2_L	60	3.61	3.60	3.00	4.10	0.287
L2L3_R	60	3.63	3.60	3.10	4.10	0.222
L2L3_L	60	3.48	3.40	3.00	4.00	0.234
L3L4_R	60	3.54	3.50	3.20	3.90	0.200
L3L4_L	60	3.39	3.40	3.10	3.80	0.189
L4L5_R	60	3.45	3.40	3.10	4.00	0.205
L4L5_L	60	3.33	3.30	3.00	3.8	0.188
L5S1_R	60	3.37	3.30	3.10	4.20	0.264
L5S1_L	60	3.24	3.20	3.00	4.10	0.238

Table2: Descriptive statistics of numerical variables – Group CON [n = 60].

Valid N	Mean	Median	Minimum	Maximum	Standard Deviation
Age	60	40.02	41.00	21.00	50.00	8.36
DurnLBP	60	0.00	0.00	0.00	0.00	0.00
L1L2_R	60	2.66	2.70	2.00	3.10	0.23
L1L2_L	60	2.60	2.60	2.10	3.20	0.29
L2L3_R	60	2.66	2.70	2.10	3.10	0.23
L2L3_L	60	2.54	2.60	2.00	3.10	0.29
L3L4_R	60	2.67	2.70	2.00	3.20	0.30
L3L4_L	60	2.57	2.60	1.90	3.10	0.30
L4L5_R	60	2.70	2.80	1.90	3.30	0.34
L4L5_L	60	2.63	2.60	1.90	3.90	0.33
L5S1_R	60	2.69	2.70	2.00	3.70	0.31
L5S1_L	60	2.64	2.60	2.10	3.40	0.31

Table 3: Comparison of numerical variables between LBP and CON groups – Student's independent samples t test (n=120).

	Mean LBP	Mean CON	t-value	df	p	Valid N LBP	Valid N CON	Standrard Deviation LBP	Standard Deviation CON
Age	40.28	40.02	0.17559	118	0.861	60	60	8.27	8.36
L1L2_R	3.73	2.66	21.96439	118	0.000	60	60	0.29	0.24
L1L2_L	3.61	2.60	18.82895	118	0.000	60	60	0.29	0.30
L2L3_R	3.63	2.66	22.95102	118	0.000	60	60	0.22	0.24
L2L3_L	3.48	2.54	19.49923	118	0.000	60	60	0.23	0.29
L3L4_R	3.54	2.68	18.13501	118	0.000	60	60	0.20	0.31
L3L4_L	3.39	2.57	17.68983	118	0.000	60	60	0.19	0.31
L4L5_R	3.45	2.70	14.36835	118	0.000	60	60	0.21	0.35
L4L5_L	3.30	2.63	13.1407	118	0.000	60	60	0.18	0.33
L5S1_R	3.37	2.69	12.91436	118	0.000	60	60	0.26	0.31
L5S1_L	3.24	2.64	11.8800	118	0.000	60	60	0.23	0.31

Table 4: Paired comparisons of sides in LBP group (n = 60).

	Mean	Stad.Dv.	N	Mean Diff.	Std.Dv. Diff.	t	df	p
L1L2_R	3.73	0.289						
L1L2_L	3.61	0.287	60	0.118	0.068	13.554	59	0.000
L2L3_R	3.63	0.222						
L2L3_L	3.48	0.234	60	0.150	0.081	14.291	59	0.000
L3L4_R	3.54	0.200						
L3L4_L	3.39	0.189	60	0.143	0.095	11.744	59	0.000
L4L5_R	3.45	0.205						
L4L5_L	3.30	0.188	60	-0.395	4.176	-0.733	59	0.467
L5S1_R	3.37	0.264						
L5S1_L	3.24	0.238	60	-0.332	3.607	-0.712	59	0.479

Table 5: Paired comparisons of sides in CON group (n = 60).

	Mean	Std.Dv.	N	Mean Diff.	Std.Dv. Diff.	t	df	p
L1L2_R	2.66	0.239						
L1L2_L	2.60	0.297	60	0.060	0.220	2.117	59	0.039
L2L3_R	2.66	0.237						
L2L3_L	2.54	0.291	60	0.127	0.232	4.228	59	0.000
L3L4_R	2.68	0.309						
L3L4_L	2.57	0.309	60	0.108	0.199	4.208	59	0.000
L4L5_R	2.70	0.346						
L4L5_L	2.63	0.335	60	0.070	0.302	1.798	59	0.077
L5S1_R	2.69	0.311						
L5S1_L	2.64	0.311	60	0.055	0.214	1.988	59	0.051

Table 6: Comparison between male (M) and female (F) within Group LBP (n=60) Student's unpaired t test.

	Mean M	Mean F	t-value	df	p	Valid N M	Valid N F	Std.Dev. M	Std.Dev. F
Age	40.58	39.93	0.300	58	0.765	30	30	7.533	9.2320
DurnLBP	3.23	3.00	0.588	58	0.559	30	30	1.376	1.6170
L1L2_R	3.77	3.68	1.191	58	0.239	30	30	0.278	0.2990
L1L2_L	3.64	3.57	1.017	58	0.313	30	30	0.274	0.3030
L2L3_R	3.64	3.61	0.604	58	0.548	30	30	0.232	0.2130
L2L3_L	3.49	3.46	0.629	58	0.532	30	30	0.236	0.2340
L3L4_R	3.56	3.51	1.026	58	0.309	30	30	0.212	0.1840
L3L4_L	3.41	3.37	0.851	58	0.398	30	30	0.198	0.1770
L4L5_R	3.46	3.44	0.382	58	0.704	30	30	0.226	0.1800
L4L5_L	3.31	3.32	0.578	58	0.286	30	30	0.209	0.1676
L5S1_R	3.38	3.36	0.273	58	0.786	30	30	0.274	0.2560
L5S1_L	3.25	3.23	0.926	58	0.35	30	30	0.2609	0.2220

Table 7: Comparison between male (M) and female (F) within Group CON (n=60) Student's unpaired t test.

	Mean M	Mean F	t-value	df	p	Valid N M	Valid N F	Std.Dev. M	Std.Dev. F
Age	41.39	38.33	1.4224	58	0.160	30	30	7.65	9.017
L1L2_L	2.64	2.56	0.9502	58	0.346	30	30	0.273	0.326
L2L3_R	2.65	2.68	-0.5328	58	0.596	30	30	0.262	0.206
L2L3_L	2.53	2.54	-0.0972	58	0.923	30	30	0.272	0.318
L3L4_R	2.72	2.63	1.1151	58	0.269	30	30	0.293	0.327
L3L4_L	2.58	2.55	0.3334	58	0.740	30	30	0.264	0.361
L4L5_R	2.72	2.68	0.4804	58	0.633	30	30	0.354	0.341
L4L5_L	2.66	2.60	0.7375	58	0.464	30	30	0.374	0.282
L5S1_R	2.71	2.67	0.5145	58	0.609	30	30	0.322	0.301
L5S1_L	2.70	2.57	1.6351	58	0.107	30	30	0.315	0.297

Fig. 2: Axial T1 weighted image showing normal thickness of ligamentum flavum.

Fig. 3: Axial T1 weighted image showing ligamentum flavum on right side at L2 level (3.55mm).

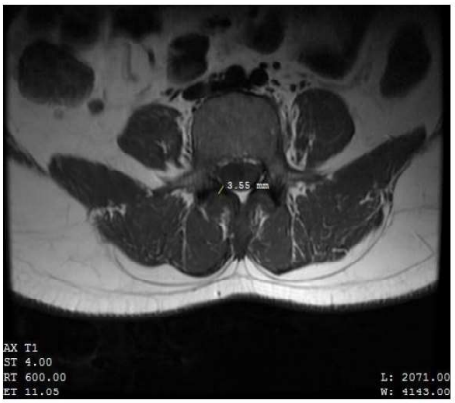


Fig 2 & Fig 3 shows the axial T1 weighted images of ligamentum flavum of normal and increased thickness respectively.

DISCUSSION

A total of one hundred twenty (120) subjects were selected, of which sixty (60) was control group and sixty (60) belonged to Low Back Pain group. Male and female distribution was similar, thirty (30) in each LBP group and control group.

The reason for choosing the lumbar levels in this study is these segments are mostly affected, due to weight bearing nature and their dependent position [15].

The mean thickness of LF in LBP group ranges from 3.73 mm to 3.37 mm on the right side and 3.61 mm to 3.24 mm on the left side respectively. The mean thickness of LF in the control group ranges from 2.66 to 2.69 and 2.54 to 2.64 on the right and left side respectively. The thickness was seen to be significantly higher in LBP group than in Control group in both the sides in all lumbar segments. The study findings corroborated with the studies of Fukuyama et a [16], Abbas et al [17], Safak et al [15], Altinkaya et al [18], Kolte V S et al [19] whereas it differed from the studies performed by Grenier et al [20], Chokshi et al [14]. The difference might be due to sample size and racial variation.

The thicknesses of LF in both the groups were compared by Student's independent samples t test. The thickness was seen to be significantly higher in LBP group in each side in all lumbar segments (p value<0.05). The present study had a similar finding with Park et al3, where they noted that the mean thickness in lumbar spinal

canal stenosis (LSCS) was 4.44mm, which was significantly higher than the thickness of LF in control group without LSCS (2.4mm) whereas in my study the mean thickness of LF in LBP group was 3.47mm which was also significantly higher than control group (2.63mm).

In the present study the difference of thickness of LF between Right and Left side and male and female was also observed. The mean thickness of LF in L1L2, L2L3, L3L4, L4L5, L5S1 were significantly higher on right side than left side in LBP group. In control group though the mean thickness was higher on right side in all lumbar segments it is statistically significant in upper three lumbar segments. In the present study the mean thickness of LF was more in case of male than female except at L4L5 in LBP group and L2L3 in control group but it was not statistically significant (p value<0.05).

Our study had a similar finding with Abbas J, Hamoud Y et al [17] where significant asymmetry had been found at L3L4 and L5S1 level. Paired t test revealed right sided LF was significantly thicker than left side. According to them this could be attributed to the right thoracic built in rotation in non scoliotic spine at the mid and lower thoracic vertebrae. A compensatory rotation to the left of the lumbar spine increases the tension force in the right spine complex, LF included, leading in time to a greater thickening of the right LF. The study findings are also consistent with the study conducted by Andrew J. Haig et al [21] and Haveen A. Akreyi et al [22] where they found that thickness of LF was thicker on right side than left side in asymptomatic individuals and individuals with LBP.

CONCLUSION

LF is an important anatomical structure, thickening of which can cause spinal and/or lateral recess stenosis resulting in LBP and leg pain. Therefore, the thickness of the LF should be measured carefully as an etiology for the pain and also for surgery in case of the suspected spinal stenosis because the thickness is liable to vary in relation to different pertinent variable. So, this study might be a helpful guide not only for the anatomist but also for the orthopaedician and neurosurgeon.

ABBREVIATIONS

MRI - Magnetic Resonance Imaging.

LF - Ligamentum Flavum.

L1-5 - 1ST TO 5TH Lumbar vertebra.

S1 - 1st Sacral Vertebra

IPGMER & SSKM - Institute of Post Graduate Medical Education & Research, & Seth

Sukhlal Karnani Memorial Hospital, Kolkata.

LBP - Low Back Pain.

N/n - Valid Subject Number

T1WI - T1-Weighted Magnetic Resonance Images

T2WI - T2-Weighted Magnetic Resonance Images

C1-12 - 1st to 12th Cervical Vertebra.

LSCS - Lumbar Spinal Canal Stenosis.

Std.Dev - Standard Deviation.

Diff - Difference.

Conflicts of Interests: None

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