ORIGINAL RESEARCH PAPER
Volume-8 | Issue-9 | September - 2019 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

A STUDY ON LUMBOSACRAL TRANSITIONAL VERTEBRA (LSTV) AND ITS SIGNIFICANCE IN LUMBAR DISC SURGERY.

Neurosurgery

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ABSTRACT

Introduction: Lumbosacral transitional vertebra (LSTV) is a congenital spinal anomaly defined as either sacralization of lumbar segment or lumbarization of sacral segment of the spine. Inaccurate identification of LSTV may lead to wrong level disc surgery with resultant failed back syndrome.

Aim: To analyse the incidence, age & sex distribution of LSTV in low back pain patients. To analyse the intraoperative measures to avoid wrong level surgery in LSTV patients.

Materials & methods: This study was done prospectively in 244 cases admitted with lowback pain and underwent surgery for lumbar disc prolapse in a tertiary care hospital near Chennai. Pre op evaluation done to identify LSTV, intra op C-arm and correlation with pre op image to identify correct level for surgery. Post op image to confirm correct level surgery was done for all cases.

Conclusion: The reliability of combined radiological methods (x ray LS spine with D12, MRI sagittal to count from c2, MRI axial to look for iliolumbar ligaments) to identify LSTV is 100%. Intra operative image guidance with C arm and correlation with preop imaging will reduce the Surgical error to 0 %.

KEYWORDS

INTRODUCTION

Lumbosacral transitional vertebra (LSTV) is a congenital spinal anomaly defined as either sacralization of the lowest lumbar segment or lumbarization of the most superior sacral segment of the spine. Lumbarization is either complete or incomplete fusion of the upper sacral vertebrae, while sacralization is either complete or incomplete fusion of L5 vertebra to the top of the sacrum.

Correct identification of LSTV is essential because of its clinical implications and surgical management. Inaccurate identification may lead to wrong localization in lumbar disc surgery with resultant failed back syndrome[1].

Surgical errors occurs in low back pain patients when MR imaging confined to the lumbar spine is reported without accompanying conventional radiographs or cervicothoracic MR localizers[2].

While using intraoperative radiographs during spinal surgery for confirmation of disc level, especially in patients with LSTV anomaly, it is important to correlate prior MR imaging with these radiographs. Correlation of the intraoperative radiograph with the preoperative imaging can avoid surgical intervention at wrong level.

AIM OF STUDY

- To analyse the incidence, age & sex distribution of LSTV in low back pain patients.
- To analyse the various methods of identifying and numbering LSTV preoperatively through imaging.
- To analyse the various intraoperative measures to avoid surgical intervention at wrong level in patiens with LSTV while doing lumbar disc surgery

MATERIALS AND METHODS

This study was done prospectively in 244 cases admitted with lowback pain and underwent surgery for lumbar disc prolapse in a tertiary care hospital near Chennai.

Inclusion criteria:

Any patient with low back/ radicular pain with radiologically significant lumbar disc prolapse, who are potential candidates for surgery.

Exclusion criteria:

Low back pain patients who are managed conservatively.

Patients who are not willing for surgery

Methodology:

All the patients underwent

1. Detailed history and thorough examination.
2. Radiological evaluation with
   - X ray lumbosacral spine (including D12 spine)
   - MRI LS spine with cervicothoracic localizer (counting from c2)
   - MRI axial view to look for iliolumbar ligaments

To assess LSTV

3. Surgical treatment for appropriate patients
   - Ø Lumbar laminectomy and discectomy,
   - Ø Hemilaminectomy and discectomy,
   - Ø Microlumbar discectomy
4. Intra operative image guidance during surgery (C arm) with preoperative image correlation to avoid surgical intervention at wrong level.
5. Post op x ray taken to confirm correct level of surgery.

RESULTS

Incidence of LSTV:

Of the 244 cases studied, LSTV was seen in 32 cases and the observed incidence was 13.1 %.(Chart 1), which is comparable to the various studies in the literature. The prevalence of LSTV reported in the literature ranges from 4 to over 35% .[3-6]. In a systematic review of comparable observational studies from 1986 to date we found a mean prevalence of 12.3%. The highest incidence of 35.9 % was found in Erken et al series with a study population of 729. The lowest incidence of 4% was found in Hsieh et al with a population of 1668. This wide range may be explained by differences in diagnostic criteria, imaging techniques, and confounding factors between the investigated population samples.

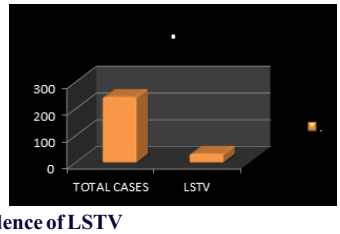

Chart 1: incidence of LSTV

Sex distribution:
Among the total 244 cases, 174 were male (71.3%) and 70 patients (28.7%) were females. Among the LSTV patients (32 cases),22 were males (68 .7 %). and remaining 10 were females (36.3 %). Female slightly outnumber the males in the incidence of LSTV. The incidence of LSTV among male population were 12.6 % (22 out of 174). The incidence of LSTV among female population were 14.2 % (10 out of 70) as in chart 2.

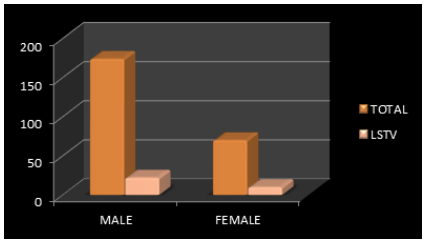

Chart 2: sex distribution of LSTV

Age distribution:
Age group varies from 21- 59 (mean 42.5). The incidence was more observed in 4th through 5th decade as the disc disease is also common in that age group. Among the study population (244 cases), the age distribution is as follows : 8 patients are in the age group 20-30 (3.3%), 90 patients are in the age group 30-40 (36.9 %), 98 patients are in the group 40- 50 (40.2 %) and 48 patients were in the group 50-60 (19.8%) as in chart 3.

Among the 32 cases of LSTV, 1 patient is the group 20-30 (3.1 %), 14 patients were in the group 30-40(43.7 %),12 patients were in the group 40-50(37.5 %)and 5 were in the group 50- 60 15.6 %). The common age group of LSTV(30 -50) parallels with that of lumbar disc prolapse.

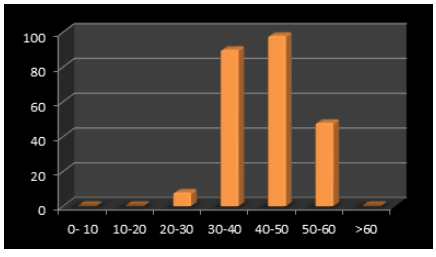

Chart 3: age distribution of cases

Sacralisation vs lumbarisation:
Of the 32 cases of LSTV, 22 were sacralized vertebra (68.7%) and 10 were lumbarised vertebra (31.3 %). Among 22 cases of sacralisation, 16 were male and 6 were females and the ratio of male to female with sacralisation is approximately 3 : 1. Among 10 cases of lumbarisation , 6 were male and 4 were female and the ratio of male to female with lumbarisation is approximately 1.5 : 1.

LSTV can be sacralisation or lumbarisation as already described, of which sacralisation is more common compared to lumbarisation. Sacralisation is more than 2/3rd common than lumbarisation(Chart 4). In almost all the series, sacralisation is more common than lumbarisation approximately in the ratio of 2:1 to 3:1 , except in the series of Kim et al[7], where lumbarisation is common(Table 1). In a systematic review of comparable observational studies from 1986 to date we found a mean prevalence of sacralisation 78 % and lumbarisation 22 % (approximately in the ratio of 3 : 1).

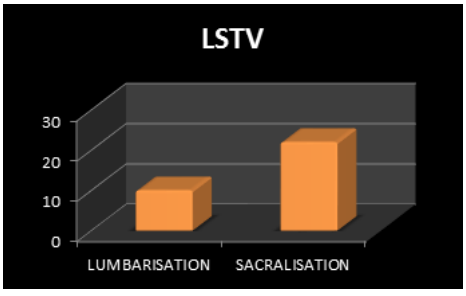

Chart 4: Distribution Of LSTV

Table 1: Prevalence of lumbarisation / sacralisation in various studies :

AUTHOR	LSTV	LUMBARISATION	SACRALISATION
Hughes	67	21 (31.3 %)	46 (68.7 %)
Steinberg	85	20 (23.5 %)	65 (76.5 %)
Kim	41	29 (70.7 %)	12 (29.3)
Chithriki	37	15 (40.5 %)	22 (59.5 %)
Santiago	26	10 (38.5 %)	16 (61.5 %)
Peh	17	9 (52.9 %)	8 (47.1 %)
Hald	792	341 (43.05 %)	451 (56.95 %)
Hahn	24	9 (37.4 %)	15 (62.6 %)
Leboeuf	61	32 (52.5 %)	29 (47.5 %)
TOTAL	2206	486 (22.03 %)	664 (77.97 %)
Present study	32	10 (31.3 %)	22 (68.7 %)

Level of disc prolapse and LSTV:
Of the 244 cases studied, 132 had L4L5 disc prolapse (54%), 110 were L5S1 disc prolapse (45 %) and other levels were 2 cases (<1 %).

Among those patients with LSTV (32 CASES), 22 were L4L5 disc prolapsed (68.7 %), 10 were L5S1 disc prolapse (31.3%) and other disc levels were 0%.(Chart 5)

All cases with sacralised vertebra have L4L5 disc prolapse and all cases with lumbarised vertebra have L5S1 disc prolapse. Disc herniation is always noted above the transitional vertebra and not below that level (L4L5 disc prolapse in sacralisation and L5S1 disc prolapsed in lumbarisation)[8,9]

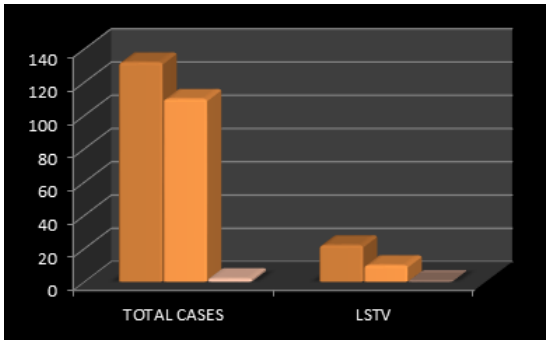

Chart 5: level of disc prolapse and LSTV

Preoperative image localisation :
All patients in the study population (244 cases) planned for lumbar disc surgery were evaluted for the presence of LSTV using the following three radiological methods. Plain X ray LS spine (including D12), MRI LS Spine sagittal view with cervicothoracic localizer to count the vertebra from C2, MRI axial view to identify iliolumbar ligaments for confirmation of LSTV (lumbarisation / sacralisation)(chart 6). The reliability of identifying LSTV is 100% when these combined radiological methods were used.

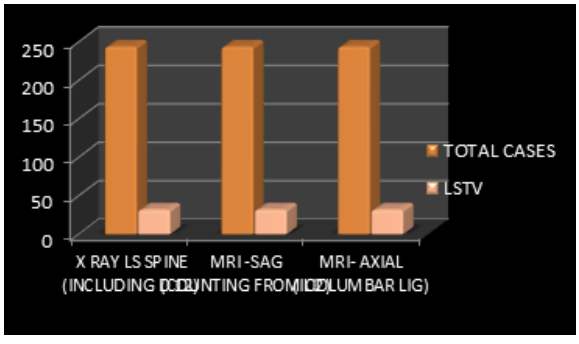

Chart 6: pre op imaging and LSTV

Intra operative level localisation :
All the cases diagnosed preoperatively with LSTV (32 cases) underwent surgical procedure with intraoperative image guidance with C- arm. Post op lumbosacral spine x ray were taken to confirm correct surgical level. Among the 32 cases of LSTV cases operated with these image guidance and preop image correlation, surgical error was 0 %(chart 7)

DISCUSSION:

Developmental defects occurring at the lumbosacral border can result in transitional vertebrae that have a mixture of lumbar and sacral characteristics. The morphology of the affected vertebra is intermediary or transitional with a combination of lumbar and sacral anatomical structures. The resulting combination of characteristics produces a variety of morphological configurations collectively referred to as lumbosacral transitional vertebrae (LSTV). The developmental defects that result in LSTV are thought to be caused by a delay in the timing threshold events occurring at the lumbosacral junction. This causes developmental fields to overlap or expand beyond normal parameters, resulting in boundary shifts at the transitional areas of the vertebral column. Boundary shifts at the lumbosacral junction can occur caudally (lumbarization) or cranially (sacralization).

Classification:

In 1984, Castellvi et al described a radiographic classification system identifying 4 types of LSTVs on the basis of morphologic characteristics. O'Driscoll[10] et al developed a 4-type classification system of S1–2 disk morphology by using sagittal MR images, depending on the presence or absence of disc material and the AP length of the disk .

Degenerative changes and LSTV:

Patients with LSTV are often suggested to be prone to various secondary pathologic spinal conditions including intervertebral disc herniation and/or degeneration, facet joint arthrosis and spinal canal or foraminal stenosis. For most conditions, however, convincing evidence is lacking in the scientific literature.

Elster et al [11] noticed a significant difference in the distribution of degenerative disc herniation, as it occurred in patients with LSTV, was nine times more common at the level immediately above the transitional vertebra compared to patients without LSTV. The increased risk for disc herniation or degeneration at the disc level above the LSTV was confirmed by other studies .

Luoma *et al* [12] showed that disc degeneration above the LSTV was more frequent in young patients ; but during aging these degenerative disc changes became less obvious and were masked by regular degenerative changes.

Increased disc degeneration of the disc above a LSTV is attributed to its relative hypermobility This may be analogous to the advanced degeneration adjacent to a block vertebra or an interbody fusion mass . Conversely, LSTV is reported to prevent the development of degenerative disc disease of the disc below the LSTV the disc below. In this study, in all cases of LSTV, disc prolapse is at the level above the transitional vertebra, and is comparable with that of all studies.

Wrong-Level Spine Surgery:

The accurate assessment of spinal segmentation is crucial in eliminating surgical and procedural errors because most wrong-level spine surgery occurs in patients with variant spine anatomy, including LSTVs[1]. Hahn et al[13] first described the use of a sagittal cervicothoracic MR localizer to better evaluate transitional vertebrae. Another technique used to correctly number an LSTV is locating the iliolumbar ligaments[14], because they reliably arise from the L5 transverse processes. The iliolumbar ligament functions to restrain flexion, extension, axial rotation, and lateral bending of L5 on S1. It is seen as a low-signal-intensity structure on both axial T1- and T2-weighted MR images as a single or double band extending from the transverse process of L5 to the posteromedial iliac crest.

Surgical errors occur when MR imaging of the lumbar spine is reported without accompanying conventional radiographs or cervicothoracic MR localizers. Lack of correlation by the operating surgeon of intraoperative radiograph with the preoperative sagittal MR imaging can lead to the dreaded consequence of wronglevel spine surgery. To prevent this complication, it is imperative that there is communication between the radiologist and the surgeon regarding numbering of vertebra.

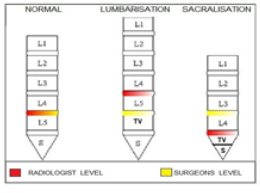

Figure 1: depicting possibility of erroe in LSTV

While doing lumbar disc surgery, the surgeon will identify the disc level (for eg. L4L5 level, the most common level of disc prolapse) by counting from below upward from the last space .whereas, the radiologist will give the report by counting from above downwards from the C2 body (MRI) or last rib (x ray).

Both surgeons level and radiologist level will coincide if the vertebral configuration is normal without any transitional vertebra, as shown in the (figure1). red marking represents radiologist level and yellow marking represents surgeons level.

In cases of lumbarisation, due to the presence of additional space between S1 and S2 , the surgeon will go one level below the radiologist level and both will not coincide resulting in wrong level surgery. Similarly, in cases of sacralisation, due to the absence of space between L5 and S1, the surgeon will go one level above the radiologist level, resulting in wrong level surgery.

So, in cases of LSTV, intraoperative image guidance with c-arm and correlation with the preoperative imaging can avoid surgical intervention at wrong level.

CONCLUSION

1. LSTV occurs in significant percentage of patients with low back pain. (13.1% in this study) without sex predilection and 30- 50 years being the common age group.
2. An association between the transitional vertebra and herniation in the disc above has been found in patients with low back pain .i.e., Disc herniation is always noted above the transitional vertebra and not below that level (L4L5 disc prolapse in sacralisation and L5S1 disc prolapse in lumbarisation)
3. Sacralisation is common LSTV than lumbarisation approximately in the ratio of 2:1
4. The reliability of combined radiological methods (x ray LS spine with D12 , MRI sagittal to count from c2, MRI axial to look for iliolumbar ligaments) to identify and correctly numbering LSTV is 100 %.
5. Intra operative image guidance with C arm and correlation with preop radiological imaging will avoid surgical intervention at wrong level (Surgical error 0 %)
6. With recent trends of minimally invasive techniques in spine surgery, knowledge of LSTV is important in disc localization

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