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Original Article

Prevalence of Transitional Vertebra in Lumbar Disc Herniation in Bangabandhu Sheikh Mujib Medical University

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Abstract:

Background: *Lumbosacral transitional vertebrae (LSTV) occur as a congenital anomaly in the segmentation of lumbosacral spine that occur during intrauterine life. LSTV includes lumbarization and sacralization of the lumbosacral region. A transitional vertebra(TV) may have varying formations, the common feature being an atypical lumbosacral articulation between transverse process of the most inferior lumbar vertebra and the sacrum. There has been a lot of discussion regarding the prevalence of LSTV in lumbar disc herniation(LDH). Most of the studies showed increased prevalence while other studies showed TV is an incidental finding and there is no increased prevalence in LDH. LDH is a quiet common ailment encountered in neurosurgical practice. Numerous causes have been attributed to it. LSTV might have great importance in patients who clinically seem to have LDH where it's presence in plain X-ray might provide a supportive evidence for diagnosis and it can help to counsel the patient. We will be able to recommend a plain x-ray of lumbosacral spine first, having history and clinical findings suggestive of LDH and can save the cost of MRI investigation until decision for operation. Beside this LSTV is an important entity for spinal surgeons , radiologists and also for those who do interventional procedures in the spine. For this reason the prevalence of TV in LDH should be known. This study was not carried out in our country yet. So this study will enrich our demographic information and will also help the spinal surgeons to counsel the patients about their congenital spinal morphological variation and different facts related with this.*

Objectives: *General objective of this study is to observe the prevalence of LSTV in patients with LDH. Specific objective of this study was to identify the diathroidal joint or fusion between transverse process of last lumbar vertebra and ala of sacrum, to count the vertebral number from C2 to S1 in whole spine screening film, to identify the transitional vertebra as sacralization or lumbarization or absence of TV, to predict the future possibility of development of LDH from plain X-ray of lumbosacral spine.*

Methods: *This study was a cross sectional type of observational study and was conducted in Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University (BSMMU). The patients (N=45) who fulfilled the selection criteria was enrolled in this study. Patient's data were recorded in a predetermined data sheet. Patients were informed in details about the study, its merits and demerits in easy and understandable language and then informed consent was taken. Also assurance was given that all the information and records would be kept confidential and the study result would help the neurosurgeons to counsel the patients with LSTV about future*

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possibility of development of LDH from plain X-ray of lumbosacral spine. This study was not responsible for any additional harm to the patient and study had no potential risk to the patient and no experimental drugs were used in this study.

Results: *A total of 45 patients of LDH were studied to see the prevalence of lumbosacral TV in LDH. Based on history and clinical findings, 100% of patients presented with low back pain, 100% of patients presented with sciatica, and 62.2% presented with gait difficulty and 02.2% of patients presented with cauda equina syndrome. Mean age of patients having LDH herniation was 38.08 ± 10.15 years. LSTV was found in 31.11% of patients with LDH. In this study, LSTV was diagnosed by plain X ray of Lumbosacral spine (A/P view) and supplemented with MRI of L/S spine with screening of whole spine (in most cases). Diagnosis of transitional vertebra was done by researcher and was further confirmed by guide and faculty members of BSMMU. In relation to gender, prevalence of LSTV in male was 25.9% and in female was 38.9% which indicated higher prevalence of TV in female but this is not statistically significant (p value 0.356).Incidence of disc herniation in patients with TV was at the space above the transition in 85.7% of cases. The most likely explanation for this is that the motion segment cephalad to the LSTV has to bear additional stresses by virtue of it being juxtaposed to a relatively non-mobile segment*

Conclusion: *This study reveals that the prevalence of LSTV in LDH is 31.11% which is near the upper limit of its prevalence(according to literature). Association of TV with LDH can not be obtained as a control group of patient without LDH was not considered. So further study should be carried out incorporating large number of patients with control group with long study period to generalize the findings to target population.*

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Introduction:

Lumbosacral transitional vertebrae (LSTV) occur as a congenital anomaly in the segmentation of lumbosacral spine that occur during intrauterine life. LSTV includes lumbarization and sacralization of the lumbosacral region. Lumbarization refers to the segmentation and incorporation of first sacral vertebra into the lumbar spine. Sacralization is either complete or incomplete fusion of L5 vertebra to the top of the sacrum. The transition involves the fifth lumbar vertebra (sacralization) or the first sacral vertebra (lumbarization) (Olofin et al. 2001).

The term sacralization and lumbarization is better to be avoided as this demands positive identification of L5 vertebra by counting ribs in X-ray of thoracic spine (MacLean et al. 1990). A transitional vertebra(TV) may have varying formations, the common feature being an atypical lumbosacral articulation between transverse process of the most inferior lumbar vertebra and the sacrum. It is commonly classified based on the type of articulation between the transverse processes and the sacrum.

Castellvi et al. classified LSTV into 4 types (Figure1). Type I includes unilateral (Ia) or bilateral (Ib) dysplastic

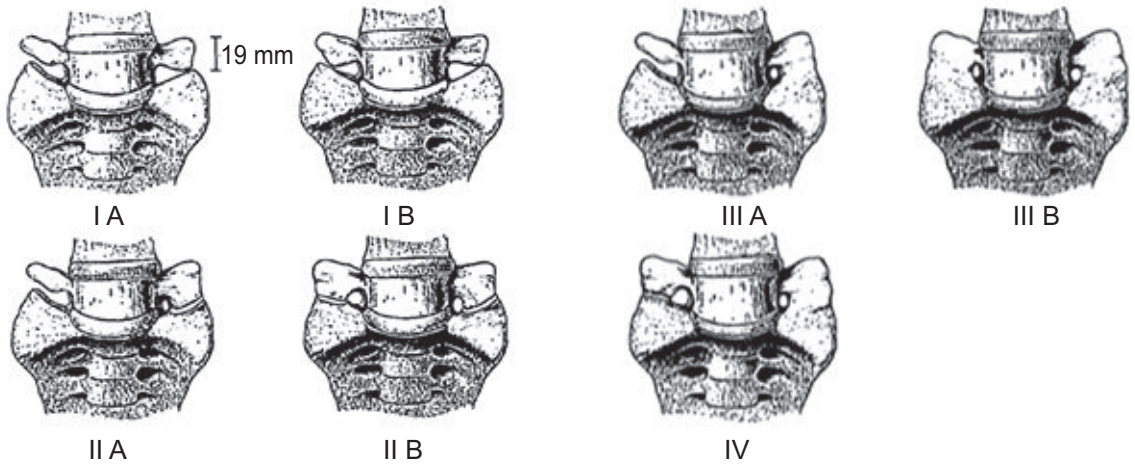

Fig.-1: *Castellvi radiographic classification system of lumbosacral transitional vertebra. (Castellvi et al. 1984)*

transverse processes, measuring at least 19 mm in width (craniocaudad dimension). Type II exhibits incomplete unilateral (IIa) or bilateral (IIb) lumbarization/sacralization with an enlarged transverse process that has a diarthrodial joint between itself and the sacrum. Type III LSTV describes unilateral (IIIa) or bilateral (IIIb) lumbarization/ sacralization with complete osseous fusion of the transverse process(es) to the sacrum. Type IV involves a unilateral type II transition with a type III on the contralateral side. (Konin and Walz 2010 and Castellvi et al. 1984)

Estimates of the prevalence of LSTV in the general population vary widely throughout the literature due to differences in definition and diagnostic modalities, ranging from 4.0% - 35.9% with a mean of 12.3%.(Konin and Walz 2010, Paik et al. 2013, Apazidis et al. 2011, Tang et al. 2014.) In a study of 211 participants, Apazidis et al. (2011) determined Type IA most common with a prevalence of 14.7%; however, Type I is generally considered to have no clinical significance and does not require further attention in clinical practice.(Castellvi et al. 1984)

The clinical significance of lumbosacral TV is controversial. In 1917, Bertolotti was the first to describe the assimilation of 5th lumbar vertebra into the sacrum and its association with low back pain. This combination is sometimes referred to as "Bertolotti's syndrome"(Jancuska et al. 2015). Studies have shown a larger than expected proportion of patients with TV among those being imaged for back pain or surgery for prolapsed disc (Hughes and Saifuddin 2006).

Hyper mobility and abnormal torque movement at the segment above the transition, subsequently can lead to early disc degeneration and herniation. Movement between the transitional vertebra and the sacrum is probably very limited owing to articulation or bony union and also to the dense fibrous and strong iliolumbar ligament at transition level (Aihara et al. 2005).

The presence of an LSTV disrupts normal spine biomechanics and anatomy. The sacrum, lying at the base of the vertebral column, optimizes the dispersion of the weight of the upper body toward the sacroiliac (SI) joint by working as a fused mass of bony elements.(Mahato 2011c) The sacrum's ability to disperse the load depends on its size and its surface area with the SI joint. Although HOX genes regulate segmentation of the vertebral column into individual vertebral segments, formation of transitional states at the lumbosacral junction may be greatly influenced by the functional requirements of load transmission at the SI junction. According to cadaver studies, sacrum incorporating L5 possess significantly smaller heights than the normal sacrum if the fused L5 vertebra is excluded from the measurement. This process of addition or diminution of segments to or from the sacrum depends on the load bearing capacity of the normal (S1-S5) sacrum at a very rudimentary stage of its formation. Therefore, a small sacrum with inadequate SI joint surface area may incorporate L5 to enhance load-bearing capacity, while a sacrum with over competent load bearing capacity may release S1(Mahato 2010).

Bony abnormalities associated with LSTV impact surgery in the lumbosacral region. In the case of sacralization, all dimensions, including pedicle height, sagittal and transverse dimensions, and sagittal angulation are reduced, and downward slope is increased (Mahato 2011b). Lumbarization of S1 results in a shorter distance between facet and sacral promontory, more obtuse pedicles in the sagittal plane and less steep in front. Therefore, pedicle screws should be directed more obtusely in the sagittal plane and at a reduced downward inclination. LSTV possess a reduced number of trabeculae of cancellous bone. Consequently, screw placements and subsequent pullouts should be reviewed (Mahato 2011b).

The disc height below a lumbosacral segment is significantly decreased in LSTV types II, III, and IV(Luoma et al. 2004, Hsieh et al. 2000). The presence of a bilateral boney fusion decreases disc height more severely compared to segments with potential for motion (unilateral fusion). The common finding of a narrowed L5-S1 intervertebral disc associated with an LSTV should not be considered disc degeneration or displacement (Hsieh et al. 2000). In addition, the sagittal alignment is most commonly neutral, unlike the typical lordotic L5-S1 disc.

LSTV affect the terminal level of the conus medullaris (TLCM). Compared to controls, the TLCM is significantly higher in the presence of a sacralized L5 and significantly lower in the presence of a lumbardized S1. This finding may help clinicians identify the neurological discrepancies observed among neurologic injuries at the thoracolumbar junction (Morimoto et al. 2013)

Another study shows that nine times higher risk for disc degeneration suprajacent to lumbosacral transitional vertebra (LSTV) and altered function of lumbar nerve roots were associated with lumbosacral transitional vertebra (Gopalan et al. 2018)

Accurate numbering of the last lumbar vertebra can be challenging, particularly in the setting of complete segmentation anomalies such as four- or six-membered lumbar vertebrae or lumbosacral transitional vertebrae (LSTV). Some have therefore recommended obtaining a whole sagittal spine MRI for accurate numbering of the lumbar vertebral bodies in all patients (Hanson et al. 2010). The current gold standard is a whole spine image for accurate numbering of the vertebrae, which can be achieved by using a whole spine MRI localizer (Akbar et al. 2010)

An anomalous number of presacral vertebrae is 7 times more likely in the presence of an LSTV and also incidence of a concomitant thoracolumbar TV (TLTV) and vice versa. Identification of an LSTV should prompt additional imaging to verify numbering, particularly if an intervention is contemplated. Clinicians should remember that no landmark is consistently reliable, so an explicit statement regarding how the lumbosacral junction was determined must be made in the imaging report(Carrino et al. 2011).

Methods:

It was a cross sectional type of observational study which was studying in the department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University (BSMMU), Shahbag, Dhaka within March 2018-March 2020. The study population was included all patients diagnosed clinically and radiologically as a case of prolapsed lumbar intervertebral disc in the Department of Neurosurgery of Bangabandhu Sheikh Mujib Medical University. The total duration of data collection of the study was 18 months and the calculative value of sample size 40 was increased to 45 to compensate insufficient data, drop out etc. Patients of lumbar disc herniation diagnosed clinically and radiologically was admitted in Neurosurgery Department, Bangabandhu Sheikh Mujib Medical University. The data collection sheet was designed by the researcher and approved by the faculty members which contained all necessary information required for the study. It was used to collect the necessary information. Voluntary written informed consent was taken from the patients and/or the legal guardian after completely explaining to them about the purpose of the study. Detailed history of illness was taken and general and neurological examinations were carried out both in indoor and outdoor facility. PLID in MRI and plain X-ray of lumbosacral spine in A/P view was noted. Data were processed and analyzed using computer software SPSS (Statistical Package for Social Sciences) version 22. Appropriate statistical test for data analysis was done. Statistical association were done using Chi-square test. Statistical significance was set at p- value <0.05.

Results:

The Study was carried out of 45(N) patient, The mean age was (38.08 ± 10.15) years and the lowest and the highest ages were 23 years and 65 years respectively.

Table-I

Distribution of the study subjects according to age (N=45)

Age (years)	Frequency (n)	Percentage
≤30	13	28.9
31 – 40	18	40.0
41 – 50	9	20.0
>50	5	11.1
Mean ± SD	38.08 ± 10.15	
Min – max	23 – 65	

This figure demonstrates that about 60% of patients of LDH were male giving a male to female ratio of roughly 6:4.

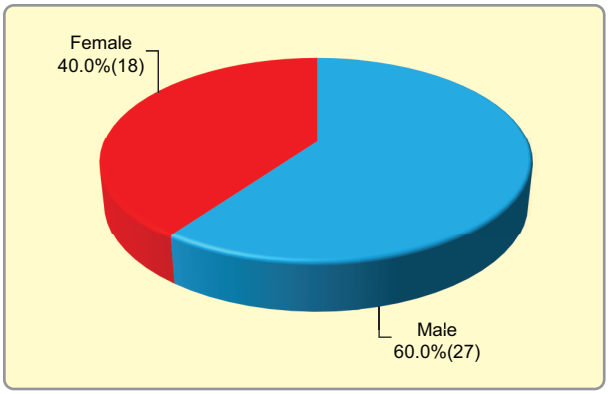

Fig.-2: *Pie chart showing distribution of the study subjects according to gender*

Table-II
Age distribution of the patients of LDH with transitional vertebra

Age (years)	Frequency (n)	Percentage
≤30	5	35.7
31 - 40	4	28.6
41 - 50	1	7.1
>50	4	28.6
Mean ± SD	40.64 ± 13.73	
Min - max	23 – 65	

Table II. shows mean age of patients of LDH with TV was (40.64 ± 13.73) years.

Table-III
Age distribution of the patients of LDH without transitional vertebra

Level	Frequency (n)	Percentage
d”30	8	25.8
31 - 40	14	45.2
41 - 50	8	25.8
>50	1	3.2
Mean ± SD	36.93 ± 8.07	
Min - max	25 – 54	

Table III. shows mean age of patients of LDH without TV was (36.93 ± 8.07) years.

Table-IV
Distribution of the patients according to presenting complaints N=45)

Presenting complaints	Frequency (n)	Percentage
Lower back pain	45	100.0
Radiation of pain to lower limbs	45	100.0
Tingling and numbness sensation	40	88.9
Gait difficulty	28	62.2
Constipation	1	2.2
Urinary retention or incontinence	1	2.2

Table IV. shows the clinical presentation that 100% of patients presented with low back pain, 100% of patients presented with sciatica, and 62.2% presented with gait difficulty and 02.2% of patients presented with cauda equina syndrome.

Table-V
Clinical examination findings of the study subjects (N=45)

	Frequency (n)	Percentage
Restricted SLR	38	84.4
Femoral stretch test	1	2.2
EHL (weak)	35	77.8
FHL (weak)	18	40.0
Ankle jerk (diminished)	18	40.0
Knee jerk (diminished)	5	11.1
Heel/Toe (impaired)	35	77.8
Sensory impairment in dermatomal distribution	31	68.9

Table V. Shows examination findings of the patients of LDH which were as restricted SLR in 84.4% of cases, Femoral stretch test positive in 2.2%, weak EHL in 77.8% of cases, weak FHL in 40%, diminished ankle jerk in 40% of cases, heel/toe walking difficulty in 77.8% of cases and sensory impairment in dermatomal distribution in 68.9% of cases.

Table-VI
Prevalence of transitional vertebra in lumbar disc herniation (N=45)

	Frequency (n)	Percentage
Present	14	31.11
Absent	31	68.89

Table-VI shows that the prevalence of lumbosacral TV in patients of LDH was 31.11%.

Table-VII
Prevalence of transitional vertebra in relation to gender (N=45)

Gender	Number of transitional vertebra	% of transitional vertebra
Male (n=27)	7	25.9
Female (n=18)	7	38.9
p-value	0.356	

* Chi-square test was done to measure the level of significance

Tables VII. reveals prevalence of transitional vertebra in male is 25.9% and in female 38.9% which indicates higher prevalence of transitional vertebra in female but this is not statistically significant (p value 0.356)

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Table-VIII

Distribution of patients of lumbar disc herniation with transitional vertebra by level of disc herniation (14 out of 45).

Level	Frequency (n)	Percentage
3rd space above transition	1	7.1
2nd space above transition	0	0
Space above transition	12	85.7
Space below the transition	0	0
Space just above & 2nd space above the transition	1	7.1

Table VIII. Shows that the most of the patients of transitional vertebra has disc prolapsed at the level just above the transition(85.7%).

Table-IX

Distribution of patients of lumbar disc herniation without transitional vertebra by level of disc herniation (31 out of 45).

Level	Frequency (n)	Percentage
L2/3		
L3/4	2	6.5
L4/5	13	41.9
L5/S1	10	32.3
L4/5+L5/S1	6	19.4

Table IX. Shows that the most of the patients of lumbar disc herniation without transitional vertebra have disc prolapsed at L4/5 level (41.9%) followed by at L5/S1 level (32.3%) and at L4/5+L5/S1 level (19.4%)

Discussion:

A total of 45 patients of LDH were studied to see the prevalence of lumbosacral TV in LDH. Prasad et al. (2006) reported the common age group of LDH patients was 31-40 years. The mean age of LDH patients in other studies were 41.6 years (Kermani 2004) and 42 years (Hakkiken et al. 2007). The study of Otani, Konno and Kikuchi (2001) showed the mean age of patients of LDH with TV was 35+15 years and in those without TV was 41+14 years. In my study mean age of patients having LDH was 38.08 ± 10.15 years which corresponds to previous study. Various studies showed different sex frequencies of LDH patients. Prashad et al.(2006) showed in their study that among 180 patients, 65.6% were male and 34.4% were female. Bhattarai (2018) showed among 947 patients 452 (47.7%) were male and 495 (52.3%) female with male to female ration of 1:1.17.

Male constitute of this study 60% and female constitute 40% giving a male to female ratio 6:4. In our department of neurosurgery the bed allocated for the male patients are more than that of the female which might be the cause for discrepancy in male female ratio. Lansche and Ford (1960) observed that the patients with LDH presents with complaints of low back pain and sciatica in 90.8% cases and low back pain only in 3.3% cases and sciatica only in 5.9% cases. Cauda equina syndrome caused by lumbar disc herniation accounts for between 2 - 4% of all lumbar disc operations (Kotsuik, 2004). Radulovic et al. (2004) stated that cauda equina syndrome from lumbar disc herniation accounts for up to 2-3% of all disc herniation. In this study, 100% of patients presented with low back pain, 100% of patients presented with sciatica, and 62.2% presented with gait difficulty and 02.2% of patients presented with cauda equina syndrome.

Vroomen, Krom and Wilmink (2000) mentioned that positive results on the SLR test were especially likely in patients with compression in the axilla of the nerve root sleeve (80%), irrespective of vertebral level. Patients with LDH restricted SLR was found in 84.4% of cases, Femoral stretch test positive in 2.2%, weak EHL in 77.8% of cases, weak FHL in 40%, diminished ankle jerk in 40% of cases, heel/toe walking difficulty in 77.8% of cases and sensory impairment in dermatomal distribution in 68.9% of cases. Bhattarai (2018), showed the overall prevalence of LSTV in the Nepalese population was 14.7% with significantly higher prevalence in patients with lumbosacral radiographs than with KUB radiographs.

Sekharappa et al. (2014) showed the prevalence of LSTV among urology outpatients, spine outpatients and discectomy patients was 8.1%, 14%, and 16.9% respectively.

Luoma et al. (2004) found that the prevalence of lumbosacral transitional vertebra was 30% and was associated with increased risk of degenerative change

in discs above the transition among young men and with decreased risk in disc below among middle aged men. Li, Yang and Niu (2006) showed that in 81.8% cases of TV, LDH occurred at the upper disc of the TV. Delport et al. (2006) found 30% incidence of TV in a 300 consecutive lumbar spine patients presented for evaluation of axial, referred, and/or radicular pain. Castelvi et al. in 1984 showed that the incidence of lumbosacral transitional vertebra among general population varies greatly, ranging from 4% to 24% depending on size and population studied.

Dai (1999) showed only 15.8% of incidence of LSTV in normal subjects and 35.1% of incidence in patient with low back pain. The difference was highly significant (P<0.01).

In my study, LSTV was found in 31.11% of patients of LDH. TV was diagnosed by plain X ray of Lumbosacral spine (A/P view) and supplemented with MRI of L/S spine with screening of whole spine. Diagnosis of TV was done by researcher and was further confirmed by guide and faculties of BSMMU. For diagnosis of LSTV , Castellvi's radiographic classification system was used. Castellvi's type I has been considered a variation of normal due to the presence of a mobile disc caudal to the vertebra in question and so was not called a TV in the study (Sekharappa et al. 2014). Castellvi also stated that Type I has no clinical significance and does not require further attention in clinical practice(Castellvi et al. 1984). So, Castellvi's type II, III and IV was included as TV in my study and type I was not considered.

Higher prevalence of LSTV in females was found in study of Sekharappa et al.(2014), whereas Nardo et al.(2012),Uçar D et al.(2013) and Uçar BY et al.(2013) reported higher LSTV prevalence in males than in females. My study reveals that prevalence of TV in male is 25.9% and in female is 38.9% which indicates higher prevalence of TV in female which is not statistically significant (p value 0.356).

Hypermobility and abnormal torque movements at the level immediately above the transitional vertebra result in degenerative changes at the level above the anomalous articulation.(Luoma et al. 2004, Aihara et al. 2005). Disc protrusion and/or extrusion occurs more often at the level supradjacent to the LSTV than at the same level in patients without an LSTV (45.3% vs. 30.3%). This is also true for disc degeneration (52.8% vs. 28%), facet degeneration (60.4% vs. 42.6%) and nerve root canal stenosis (52.8% vs. 27.9%) (Vergauwen et al. 1997). Otani et al.(2001) reported 83% of patients with a disc herniation in the presence of an LSTV experienced symptoms arising from the last caudal mobile segment. Patients with disc herniation and no transitional vertebrae most frequently (59%) had symptoms arising from the 2nd last mobile segment (Otani et al. 2001).

Disc bulge or herniation is exceedingly rare at the interspace below a transitional vertebra. Increasing the mechanical connection of a lumbosacral transitional vertebra protects the disc at the transitional level (Aihara et al. 2005, Chang et al. 2004, Otani et al. 2001, Elster 1989, Li et al. 2006, Wigh et al. 1981). Prashad et al. (2006) showed frequencies of disc prolapses at various levels as follows; 34.4% at L4/5 level, 26.7% at L5/S1 level, and 25.6% at multiple levels. Kortelainen et al. (1985) showed occurrence of 56.8% of disc herniation at L4/5 level and 40.8% at L5/S1 level. Incidence in this study of disc herniation in patients with TV was at the space above the transition in 85.7% of cases, at the space above as well as 2nd space above the transition in 7.1% cases, 3rd space above the transition in 7.1% of cases and no herniation was found at level just below the transition. The most likely explanation for this is that the motion segment cephalad to the LSTV has to bear additional stress by virtue of it being juxtaposed to a relatively non-mobile segment which is similar to a mono-segmental fusion(Sekharappa et al. 2014).

In patients of LDH without TV, I found disc herniation at L4/5 level in 41.9% of cases followed by at L5/S1 level in 32.9% of cases and at L4/5+L5/S1 level in 19.4% of cases. Here disc prolapse is not so much predominant in single specific level like transitional vertebra. Study reveals that mean age of patients of LDH with TV was (40.64 ± 13.73) years and mean age of patients of LDH without TV was (36.93 ± 8.07) years which is against the different studies done previously. This may be due to small sample size and purposive sampling.

Conclusion:

This study reveals that the prevalence of LSTV in LDH is 31.11% which is near the upper limit of its prevalence(according to literature). Association of TV with LDH can not be obtained as a control group of patient without LDH was not considered. So further study should be carried out incorporating large number of patients with control group with long study period to generalize the findings to target population.

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