

A Cadaveric Study on Lumbar Spinous Process Fusion: Risk Factor for Wrong Level Spinal Surgeries

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ABSTRACT

Introduction: The fusion of Lumbar Spinous Processes (LSP) of adjacent vertebrae may lead to errors in determining the correct spinal level. This may result in wrong level spinal surgeries around the lumbar region.

Aim: To determine the prevalence of fusion between adjacent LSP.

Materials and Methods: This study was a prospective observational study done in the Department of Anatomy, Smt. B.K. Shah Medical Institute and Research Centre, Vadodara, Gujarat, India. The present study had examined the lumbar spines in 30 formalin preserved cadavers. The fusion

between the LSP of adjacent vertebrae was recorded after the removal of soft tissue from L1 to S1 vertebrae.

Results: The present study found the fusion between the adjacent LSP in 11 (36.67%) cadavers (08 males; 03 females). The fusion between the adjacent LSP, from L4 to S1 vertebrae, was found in 10% of cadavers and was the most common pattern. The fusion between the adjacent LSP was more common in males (53.3%) compared to females (20%).

Conclusion: The occurrence of fusion between the adjacent LSP is not uncommon.

Keywords: Ligation, Lumbar vertebra, Neurosurgeon, Sacralisation, Vertebra column

INTRODUCTION

Lumbar vertebra has a vertebral body and a vertebral arch. The vertebral arch consists of a pair of pedicles and a pair of laminae, which encircles the vertebral foramen. A lumbar vertebra has a thick and stout vertebral body, a blunt, quadrilateral Spinous Process (SP) for the attachment of strong lumbar muscles, and articular processes.

Spine surgery at the wrong level is an unintended, yet not so uncommon mistake committed by surgeons around the world. This not only requires the patients to undergo additional surgeries but many times results in litigations. This type of error can cost very dearly to the financial and professional well-being of the surgeons [1]. Jhawar BS et al., have reported the incidence of wrong level lumbar spinal surgeries to be 12.8 per 10,000 surgeries [2]. Many researchers have tried to enlist the factors that have the potential to mislead the surgeons to commit this error [1-3]. Anatomical variations are major risk factors that make the determination of the correct spinal level very challenging [3-6].

The LSP is relatively superficial and easy to access. However, the fusion of SP of adjacent lumbar vertebrae is one such factor that may cause errors in counting of lumbar vertebrae which in turn may result in operating at the wrong spinal level [3]. Other anatomical variations which may lead to errors in counting of vertebral level include presence of cervical ribs, absence of thoracic ribs, hemivertebrae, sacralisation of lumbar vertebra etc., [3-6]. The preoperative assessment of patient with respect to these anatomical variations will help to prevent the errors in counting of vertebral level.

Operating at the wrong level is avoidable at least in some cases if the surgeon recognises the risk factors. The present study attempted to determine the prevalence of fusion of SP of adjacent lumbar vertebrae, which is one of the risk factors for wrong level lumbar spinal surgery. The data will be useful to determine the necessity to devise a protocol to look for this variation preoperatively, in patients posted for lumbar spinal surgery.

MATERIALS AND METHODS

This prospective observational cadaveric study was carried out at the Department of Anatomy at Smt BK Shah Medical Institute

and Research Centre, Sumandeep Vidyapeeth, Gujarat, India from August 2018-2020. Ethical approval to undertake the present study was obtained from the Institution Ethical Committee (SVIEC No: Medical/PhD/18005).

The specimens without any obvious externally visible deformity or signs of injury, pathology, or surgical procedures were included. The SP of lumbar vertebrae was examined in 30 formalin-fixed adult human cadavers (15 females and 15 males). The cadavers were placed in a prone position on a flat table with hips extended. With midline incision around the lumbar region, the superficial and deep muscles of the back were identified and removed until the lumbar vertebral column was exposed. The SP of all the lumbar vertebrae was cleaned in each specimen and was observed to find out the occurrence of fusion amongst adjacent SP.

STATISTICAL ANALYSIS

The data was recorded and analysed using Statistical Package for the Social Sciences (SPSS) version 23. Data was presented as absolute numbers and percentages.

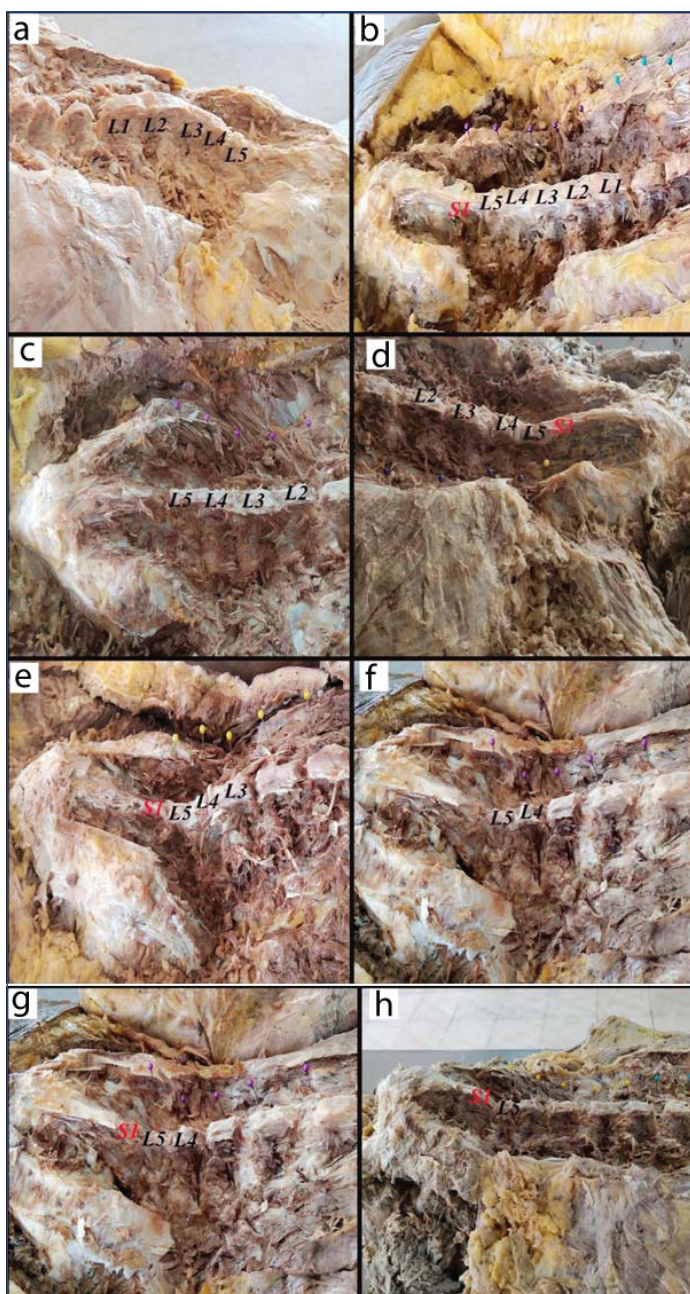
RESULTS

The present study has examined the lumbar spine in 30 adult cadavers (range of 60-95 years, mean of 77.5 years). The fusion between adjacent SP was noted in 11 cadavers (36.67%). The fusion of the SP of L4 to S1 was most common and was found in three specimens [Table/Fig-1]. The fusion of the adjacent LSP was more common in males (53.3%) compared to females (20%) [Table/Fig-2].

The fusion of the SP was so complete that no trace of the line of fusion was evident in any specimen. The transverse processes of none of the adjacent lumbar vertebrae were found to be fused.

DISCUSSION

The problem of Wrong Level Spinal Surgery (WLSS) is a unique surgical problem with detrimental consequences for both the patient and the surgeon. WLSS occurs when a surgeon performs decompression, resection, or reconstructive procedure on an



[Table/Fig-1]: Showing fusion of spinous process of lumbar vertebra: a) Fusion of L1 to L5 spinous process; b) Fusion of L1 to S1 spinous process; c) Fusion of L2 to L5 spinous process; d) Fusion of L2 to S1 spinous process; e) Fusion of L3 to S1 spinous process; f) Fusion of L4 to L5 spinous process; g) Fusion of L4 to S1 spinous process; h) Fusion of L5 to S1 spinous process.

Level of fusion of the spinous processes	Sample size (Total no=30, Male 15 and Female 15)		
	Total no. of the specimen showing fusion (%)	Male specimen showing fusion (%)	Female specimen showing fusion (%)
L1 to L5	1 (3.3%)	1 (6.7%)	0 (0%)
L1 to S1	1 (3.3%)	1 (6.7%)	0 (0%)
L2 to L5	1 (3.3%)	1 (6.7%)	0 (0%)
L2 to S1	1 (3.3%)	1 (6.7%)	0 (0%)
L3 to S1	1 (3.3%)	0 (0%)	1 (6.7%)
L4 to L5	1 (3.3%)	0 (0%)	1 (6.7%)
L4 to S1	3 (10%)	3 (20%)	0 (0%)
L5 to S1	2 (6.7%)	1 (6.7%)	1 (6.7%)

[Table/Fig-2]: Frequency of fusion of Lumbar Spinous process (LSP).

unintended anatomic location along the spinal axis [7]. The knowledge of anatomical variations of spine may help in reducing the incidence of WLSS. The present study has attempted to determine the prevalence of fusion of LSP in cadavers at the Department of Anatomy at the study institute.

Although the exact incidence of WLSS remains unknown, most researchers agree that the lumbar level is more prone to WLSS. Mody M et al., had done a questionnaire-based survey among members of the American Academy of Neurosurgeons [8]. They reported that the prevalence of wrong level spinal operations to be 1 in 3110 procedures. Also, out of these wrong level operations, majority were performed on the lumbar region (71%), followed by the cervical (21%), and the thoracic (8%) regions. Jhawar BS et al., have also reported that the WLSS are more common in the lumbar region (12.8/10 000) than that of the cervical region (7.6/10 000) [2]. Ammerman JM et al., [9] have reported the incidence of wrong level lumbar spinal surgeries to be as high as 15% while Barrios C et al., have reported it to be around 3.3% [10].

Abnormal anatomy is one of the risk factors for WLSS [4]. The SP of vertebrae, because of its readily accessible location, is commonly used for counting vertebral level. However, their fusion can very easily misguide the surgeon. The aetiology of fusion may be congenital, acquired, or surgical.

There is a wide variation in the prevalence of lumbar vertebral fusion reported by various researchers [Table/Fig-3] [11-14]. This is partly due to the methods used for calculation of prevalence rate. The denominator used for calculation of prevalence rate by Sar M et al., and Vikani S and Javia MD, was the number of vertebrae [11,12]; while the studies of Deepa M and Rajasekar SS, and Sharma M et al., have used number of vertebral columns as the denominator [13,14]. The present study has observed fusion between adjacent LSP in 36.67% of the specimen, which is quite higher than other studies. This may be illusory as the findings are not confirmed by the X-rays.

Study	Sample	Data for fusion (%)
Present study	30 Lumbar spine specimens	36.67
Sar M et al., [11]	399 Dry vertebrae	0.75
Vikani SK and Javia MD [12]	185 Dry vertebrae	1.08
Deepa S and Rajasekar SS [13]	50 Dry vertebral columns	2
Sharma M et al., [14]	48 Dry vertebral columns	2.08

[Table/Fig-3]: Comparison of the index study with literature [11-14].

The present study has also found that there are wide variations in the number of adjacent LSP involved in fusion. Both these factors viz., high prevalence and the variable pattern of fusion of LSP may make the counting of the lumbar level extremely difficult for clinicians. This can very easily lead to WLSS having profound medical and legal consequences [10,15].

Considering the wide variations amongst study reports about prevalence of lumbar vertebral fusion in the Indian population, the authors recommend preoperative and intraoperative imaging in each patient to reduce the incidence of WLSS.

Limitation(s)

The findings were not confirmed with the X-ray of the concerned region. So, the higher prevalence may be illusory.

CONCLUSION(S)

The fusion between the LSP is common among the Indian adult population. The number of lumbar vertebrae involved in fusion also varies amongst individuals. Preoperative and intraoperative imaging in patients is recommended to reduce the incidence of wrong level lumbar spinal surgeries.

The authors also suggest that a large sample sized multicentric, prospective study among Indian adult population, with use of X-ray of lumbar spine, will help to determine the exact prevalence of the fusion of adjacent LSP in the population.

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