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Brief Report

Lumbar Spine Ligament Augmentation Technique to Prevent Proximal Junctional Kyphosis: A Short Communication

Ebrahim Hejazian, Masoud Yahyazadeh, Arman Ferasat, Hadi Ebrahimi, Morteza Sharifzadeh*

Department of Neurosurgery, Faculty of Medicine, Babol University of Medical Sciences, Babol, Iran.

Background: Proximal junctional kyphosis (PJK) is a common complication following lumbar spine fusion. It may result in loss of spinal alignment, neurological symptoms, and the requirement for revision surgery. Various strategies have been proposed to minimise the risk of PJK, including the use of ligament augmentation techniques.

Materials and Methods: A simplified wire-based posterior ligament augmentation technique was applied in 12 patients undergoing posterior lumbar fusion for degenerative spinal conditions. A steel wire was passed through or over the spinous process of the vertebra one level above the upper instrumented vertebra (UIV+1) and secured to the construct to reinforce the transition zone. Patients were followed both clinically and radiographically for 6 to 12 months.

Results: No patient developed radiographic evidence of PJK, defined as a ≥10° increase in the UIV–UIV+2 angle. All fusion constructs remained stable, with no incidences of rod fracture, screw loosening, or need for revision surgery throughout the follow-up period.

***Conclusion*:** This wire-based augmentation technique is simple, low-cost, and technically feasible for routine lumbar fusion cases. Although preliminary, the findings suggest a potential role in the prevention of PJK. Further studies with larger cohorts and longer follow-up are warranted to confirm its long-term efficacy.

Keywords: Proximal Junctional Kyphosis (PJK), Lumbar Spine Fusion, Ligament Augmentation

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Corresponding author:
Morteza Sharifzadeh
Address**:**Beheshti Hospital, Ghasemi Street, Babol, Mazandaran, Iran **E-mail:**
morteza.Sharifzadeh@gmail.com

Introduction

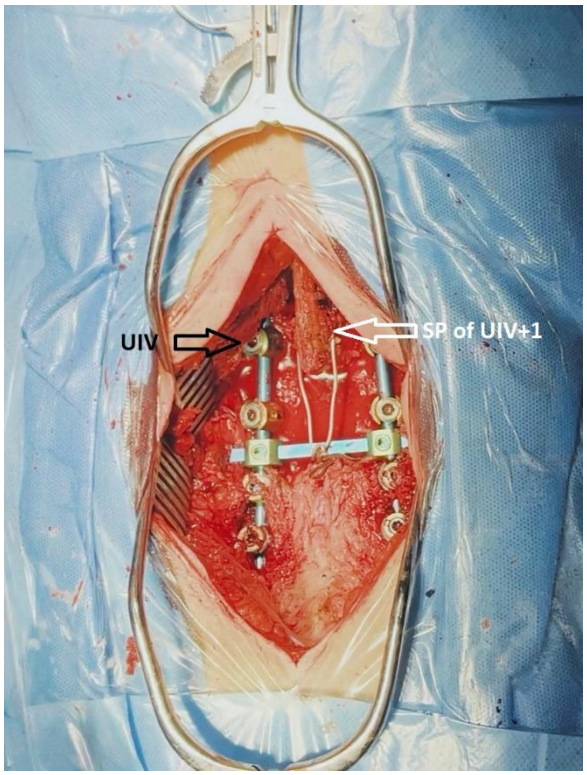
Proximal junctional kyphosis (PJK) is a common complication following spinal instrumentation, with an incidence ranging from 17% to 39% (1). It is defined as an increase of 10 degrees or more in the angle between the upper instrumented vertebra (UIV) and UIV+2 compared with the preoperative baseline (1). Preventing PJK can reduce the need for revision surgery and yield considerable cost savings (2). Several strategies have been employed to prevent PJK, one of the most promising being the recently introduced ligament augmentation technique. In this method, the junction between fused and non-fused levels-the typical site of PJK-is reinforced using tape or a tether connecting the UIV to either UIV+1 (one level above the UIV) or UIV+2, thereby strengthening the transition zone between fused and mobile segments (3-6). This technique has predominantly been investigated in thoracolumbar adult spinal deformity cases and long fusion constructs (1, 4, 5), whereas data remain scarce for conventional degenerative lumbar surgery. In the present study, we applied a wire-based ligament augmentation approach in 12 posterior lumbar fusion cases.

Materials and methods

Surgical Technique

Following standard posterior exposure and placement of pedicle screws and rods, ligament augmentation was performed in selected cases (also illustrated in Supplementary Videos 1 and 2). Case selection was guided by manual assessment of the spinous process of the vertebra one level above the UIV (UIV+1) using towel forceps; ligament augmentation was undertaken whenever instability was suspected.

A transverse hole was drilled through the spinous process of UIV+1, and a steel wire was passed through this hole. The wire was then secured to the construct-either the rods or cross-connectors-to strengthen the junction between fused and non-fused levels **(Figure1)**.



Tension was applied by twisting the wire until adequate firmness was achieved; alternatively, tensioning could be performed by pulling the crosslink distally before fixation to the rods (3). The excess wire was subsequently trimmed.

The procedure was adapted to individual patient characteristics: for instance, the wire could be passed over rather than through the UIV+1 spinous process, or tied to the preserved UIV spinous process where appropriate. Despite these minor variations, the essential technique was consistent across all cases.

All procedures were executed with meticulous care to safeguard the dura and neural structures. Two supplementary videos demonstrate the cable fixation and tensioning steps. Written informed consent was obtained from all participants, and the study received approval from the institutional ethics committee.

Cases and Follow-Up

The technique was applied in 12 patients (five males and seven females) undergoing posterior lumbar fusion for degenerative lumbar pathology, with ages ranging from 42 to 71 years. All patients were followed both clinically and radiographically at regular intervals for 6 to 12 months (minimum 6 months).

During follow-up, no patient developed radiographic evidence of PJK, defined as an increase of ≥10 in the UIV–UIV+2 angle compared with preoperative alignment. All constructs preserved stable lumbar alignment and demonstrated satisfactory fusion on imaging. No cases of rod fracture, screw loosening, or reoperation were observed.

Discussion

This preliminary series demonstrates that posterior ligament augmentation using a single cable is technically feasible in lumbar fusion surgery. Unlike most published methods in deformity surgery-which commonly employ multiple bands or cables spanning from the UIV to UIV+2-our technique is straightforward and time-efficient.

The efficacy of ligament augmentation has already been well established in the thoracolumbar spine. In our cohort, with a minimum follow-up period of six months, no instances of PJK were observed and no revision surgeries were required. It is noteworthy that most cases of PJK occur within the first six months after surgery (5).

Previous studies have primarily utilised straps or tapes as augmentation materials (3, 7), whereas only a few have reported using cables or wires (1, 5). Some techniques extended the augmentation to UIV+1 (4, 8, 9), while others included UIV+2 or even UIV+3 (1, 5, 7, 10).

Consistent with the approach described by Safaee et al. (1, 5), we employed a cable rather than straps. However, in contrast to their method-which

necessitates two wires connecting the UIV, UIV+1, and UIV+2-we used a single wire linking the spinous process of UIV+1 to the construct or to the UIV spinous process. This modification simplifies the procedure and reduces operative time compared with the more elaborate technique.

Furthermore, our method remains applicable even when the UIV spinous process is absent, such as after laminectomy. Some authors have suggested that extending augmentation beyond UIV+1 allows for a smoother transition of forces across the junction and enhances osseous anchorage, thereby lowering the risk of tether pull-through (3).

Our experience suggests that ligament augmentation by connecting UIV+1 to the construct or to UIV using a wire represents a simple and safe technique for routine lumbar fixation. Steel wires are inexpensive and readily available in most operating theatres.

We hypothesise that strengthening the posterior ligamentous complex-especially in high-risk cases where posterior tension bands are disrupted at unfused levels-may lower the incidence of PJK. Suitable cases include those with inadvertent soft-tissue compromise at uninstrumented vertebrae during surgical dissection.

In routine lumbar procedures, when intraoperative assessment of UIV+1 reveals potential instability and fusion of that level is not planned, this quick, low-cost technique should be considered.

This report has several limitations. First, the number of cases was small, and the follow-up period was relatively short. Second, the absence of a control group limits comparative interpretation. Third, our technique was not evaluated against other anti-PJK strategies, such as hook fixation or cement augmentation. Further prospective studies are required to assess the efficacy of this method in routine, non–long-segment lumbar fusion.

Conclusion

In summary, we describe a simple, wire-based posterior tether technique to augment the proximal junction in lumbar spine fusion. By passing a steel wire through or over the UIV+1 spinous process and securing it to the construct or UIV, the posterior ligamentous complex is reinforced at a critical transition zone. In our twelve-patient series, this method was easy to implement and showed no junctional failures or hardware complications during short-term follow-up. While the results are preliminary, they suggest that ligament augmentation may have a role in lumbar spine fusion. Further studies are warranted to evaluate its clinical benefits.

Supplementary Materials

Two videos (Supplementary Videos 1 and 2) demonstrating the described procedure are submitted with the manuscript.

Ethical Approval

This study was approved by the Ethics Committee of Babol University of Medical Sciences (Approval Code: IR.MUBABOL.HRI.REC.1404.102). All patients provided written informed consent for publication of their de-identified data.

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Conflict of Interest Statement

The authors declare that there is no conflict of interest.

Author Contributions

All authors contributed equally to the conception, design, execution, and writing of this manuscript.

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