



# Enhanced technique of dural closure using autologous fat graft and Gelfoam for effective management of dural tear following interlaminar endoscopic lumbar spine surgery

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## Abstract

**Background** Incidental dural tears are common complications in lumbar spine surgery, particularly in endoscopic procedures where primary closure via suturing is challenging. The absence of a standardized approach for dural closure in endoscopic spine surgery necessitates exploring alternative techniques.

**Objective** This study introduces a surgical technique for dural closure utilizing fat graft and Gelfoam, offering an effective alternative to standard approaches in endoscopic spine surgery.

**Methods** Surgical data from patients who underwent interlaminar endoscopic discectomy or stenosis decompression at Lerdsin Hospital from October 2014 to October 2021 were analyzed.

**Results** Among 393 cases, dural tears occurred in 2% (8 patients). Our technique achieved successful closure in all these cases, with no incidents of cerebrospinal fluid leakage or wound complications. The majority of patients showed favorable clinical outcomes, except for one case involving concomitant nerve root injury.

**Conclusion** This study demonstrates that using fat graft and Gelfoam for dural closure is a simple, reliable, and safe technique, particularly effective for challenging-to-repair areas in interlaminar endoscopic lumbar spine surgery.

**Keywords** Interlaminar endoscopic lumbar spine surgery · Dural tear · Dural closure · Dural repair

## Introduction

Endoscopic spine surgery has emerged as a viable treatment option for degenerative lumbar spine diseases. The interlaminar approach, in particular, has proven effective in addressing conditions such as herniated disc [1] and spinal stenosis [2, 3]. However, the incidence of dural tear in endoscopic

spine surgery ranges from 0 to 8.6%. Notably, the occurrence of dural tear is more common in stenosis decompression (3.7%) compared to discectomy (2.1%). Factors such as synovial (facet) cysts and bilateral decompression further increase the risk of dural tears [4, 5]. In contrast to the transforaminal approach [5, 6], the interlaminar approach tends to be associated with a higher likelihood of dural tears.

Incidental dural tears pose a significant challenge in lumbar spine surgery, particularly in endoscopic procedures where primary closure via suturing is often complicated by limited working space, especially when the site of the tear is in a lateral or otherwise difficult-to-repair area. Untreated dural tears can lead to various complications, including wound complications due to cerebrospinal fluid (CSF) leakage, CSF fistula formation, pseudomeningocele, meningitis, arachnoiditis, and epidural abscess. Presently, there is no established gold standard treatment for dural closure in endoscopic spine surgery. In the light of this, our study aimed to introduce a surgical technique for dural closure

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utilizing fat graft and Gelfoam, and to report the outcomes associated with this approach.

## Materials and methods

### Study population

This retrospective study included patients who underwent endoscopic spine surgery performed by a single surgeon at Lerdsin Hospital between October 2014 and October 2021. The medical records and video recordings of these patients were collected for analysis.

### Inclusion criteria

Patients were eligible for inclusion if they underwent interlaminar endoscopic lumbar discectomy or decompression for the treatment of herniated disc or spinal stenosis and subsequently developed a dural tear that was managed using a combination of fat graft and Gelfoam.

### Data collection

The following data points were collected from the medical records and video recordings:

1. Cause of Dural Tear: The factors leading to the occurrence of the dural tear were documented, including intraoperative observations and any relevant preexisting conditions.
2. Size and Locations of Dural Tear: The size of the dural tear was measured using a 3-mm dissector width, as recommended in the AOSpine Consensus Paper [7]. The precise location of the tear was recorded, specifying the affected vertebral level.
3. Surgical Technique: Details regarding the application of fat graft and Gelfoam for dural closure were documented, including the specific steps involved in the procedure.
4. Outcome Measures: The primary outcome measures included the incidence of CSF leakage and clinical signs of CSF fistular after dura closure. Complications related to the surgical procedure were also recorded.

### Statistical analysis

Descriptive statistics were used to summarize the demographic characteristics of the study population and the outcomes of interest. The results were presented as frequencies, percentages, means, or medians, as appropriate.

## Ethical considerations

The study was conducted in compliance with the ethical principles outlined in the Declaration of Helsinki. The research protocol was approved by the institutional review board at Lerdsin Hospital, ensuring patient confidentiality and data protection.

### Limitations

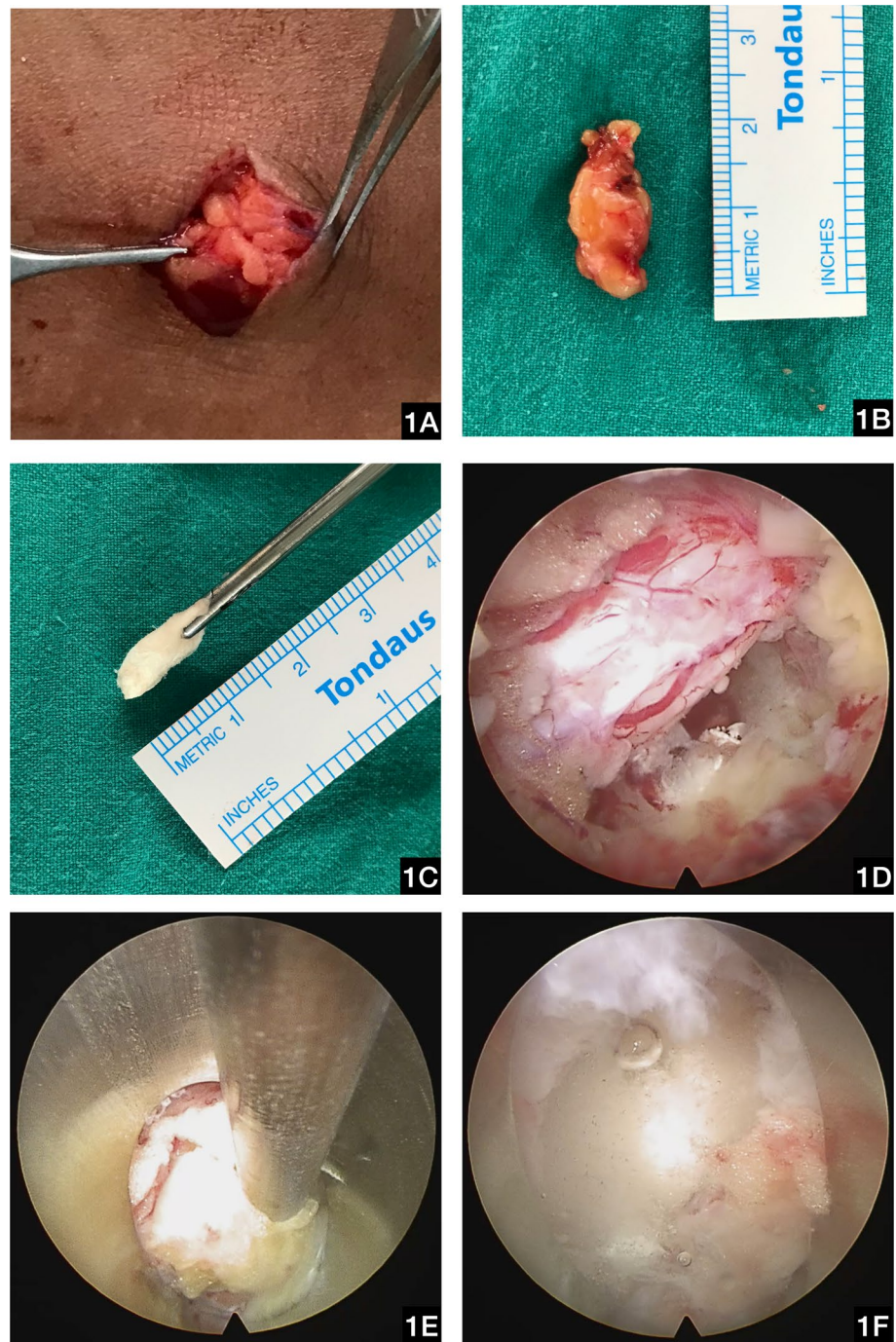
Potential limitations of this study include its retrospective design, the reliance on medical records and video recordings for data collection, and the experience and expertise of the single surgeon involved. These factors should be considered when interpreting the results.

## Surgical technique for dural tear repair

After completing the discectomy or decompression, the dural tear site was meticulously evaluated. The endoscope and working sleeve were then removed. To harvest the fat graft and facilitate fascial suture, the surgical incision was slightly extended by about 0.5 cm in both directions.

1. Harvesting of Autologous Fat Graft: Fat tissue from the subcutaneous layer near the incision was excised. The amount varied based on the dural defect size (Fig. 1).
2. Reinsertion of Working Sleeve and Endoscope: These were reinserted under fluoroscopic guidance.
3. Placement of Fat Graft: The graft was placed onto the dural defect using a micro-rongeur and visualized on the endoscope monitor for accurate positioning.
4. Application of Gelfoam: Gelfoam, also handled with a micro-rongeur, was laid over the fat graft for additional reinforcement.
5. Removal of Endoscope and Working Sleeve: These were removed post-dural closure.
6. Fascial Closure: The fascial layer was meticulously sutured in a watertight manner using Vicryl 1–0 sutures. A simple stitching technique with two stitches was employed, ensuring a thorough closure of the underlying tissue layers. This step is crucial for maintaining the integrity of the repair and promoting optimal healing conditions.
7. Subcutaneous and Skin Closure: Closed with Vicryl 2–0 and Nylon 3–0 sutures, respectively.
8. Postoperative Care: Patients with dural tear repair were advised a day of bed rest, while others could ambulate as tolerated.

**Fig. 1** Fat Graft Harvesting. Fat graft was harvested from the subcutaneous layer (**A** and **B**). Gelfoam was grasped with micro-rongeur (**C**). Dural tear after discectomy (**D**). The fat graft which grasping by micro-rongeur was inserted via endoscope to cover the dural defect followed by Gelfoam (**E** and **F**)



This technique ensures a secure and durable seal, leveraging endoscopic visualization for precision.

## Results

The incidence of dural tears in our interlaminar approach for lumbar spine surgery was determined to be 2% (8 out of 393 patients). Among these cases, four patients underwent had disc operation, two patients underwent stenosis

decompression operation, and two patients underwent a combination of disc and stenosis decompression operation. Table 1 provides a detailed overview of the identified causes for the occurrence of dural tears in our patient cohort.

The dural tears in our patient cohort occurred at various locations, with three patients experiencing tears at the lateral site (shoulder area) of the dural sac, two patients at the midline, two patients between the midline and lateral site, and one patient at the volar site. The size of the dural tears ranged from 2 to 9 mm. For all eight patients who had dural

**Table 1** Characteristics of dural tears in patients undergoing interlaminar endoscopic lumbar spine surgery

| No | Sex    | Age (years) | Diagnosis   | Operation      | Cause of tears  | Site of tears               | Size of tears | Clinical symptoms post-operation      |
|----|--------|-------------|---|----------------|---|-----------------------------|---------------|---------------------------------------|
| 1  | Male   | 68          | LDH L5-S1 (calcified/ protrusion)                     | IELD           | Tear by bone trimmer at calcified disc and endplate, dural sac folding in between   | Lateral                     | 9 mm          | Decrease sensation at S1 dermatome    |
| 2  | Female | 40          | LDH L5-S1 (extrusion)                                 | IELD           | Tear by dissector when manipulate lateral border of nerve root  | Lateral                     | 3 mm          | Decrease sensation at S1 dermatome    |
| 3  | Male   | 67          | LDH L4-5 (extrusion)                                  | IELD           | Tear from punching when cutting too deep at ligamentum flavum   | Midline                     | 2 mm          | No weakness or numbness               |
| 4  | Male   | 58          | Spinal stenosis L4-5 (central)                        | LE-ULBD        | Tear by Kerrison when removing ligamentum flavum and dural sac folding in between (still intact arachnoid)                                      | Between midline and lateral | 4 mm          | No weakness or numbness               |
| 5  | Male   | 41          | LDH L4-5 (extrusion) Spinal stenosis (lateral recess) | IE-LRD + IELD  | Tear from punching when rotating working sleeve to guard dural sac, punch try to cut PLL, volar site of dural infolding. Accidentally cut dural | Volar                       | 3 mm          | No weakness or numbness               |
| 6  | Male   | 80          | LDH L4-5 (sequester) Spinal stenosis (central)        | LE-ULBD + IELD | Tear by Kerrison when removing ligamentum flavum and dural sac folding in between   | Midline                     | 7 mm          | No weakness or numbness               |
| 7  | Female | 38          | Spinal stenosis (lateral recess)                      | IE-LRD         | Tear by Kerrison adhesion between ligamentum flavum and dura  | Between midline and lateral | 3 mm          | No weakness or numbness               |
| 8  | Female | 38          | LDH L5-S1   | IELD           | Tear by dissector from retraction when manipulate lateral border of nerve root, nerve root injury (underlying nerve root anomaly)               | Lateral                     | 4 mm          | Numbness at L5 dermatome and weakness |

M: Male, F: Female, LDH: Lumbar disc herniation, CSF: Cerebrospinal fluid, IELD: Interlaminar endoscopic lumbar discectomy, IE-LRD: Interlaminar endoscopic lateral recess decompression, LE-ULBD: Lumbar endoscopic unilateral laminotomy for bilateral decompression

tears, the closure technique involved the use of a combination of fat graft and Gelfoam. Notably, there were no cases of CSF leakage or wound complications observed in our study.

Following the procedure, three patients reported experiencing postoperative numbness. However, in two of these patients, the numbness spontaneously resolved during the follow-up period. The remaining patient had concomitant nerve root injury, which likely contributed to the persistent numbness. Importantly, none of the patients developed clinical symptoms related to CSF leakage or fistula following the dural closure technique employed in this study. It is worth mentioning that one patient with a nerve root anomaly (case No.8) experienced a recurrence of disc herniation and subsequently required a revision surgery involving transforaminal lumbar interbody fusion at the index level.

The follow-up period for assessing clinical outcomes ranged from 1 to 3 years. The majority of patients showed significant improvement in both leg pain as measured by the VAS and functional disability assessed using the ODI, when comparing pre-operative values to those at the last follow-up. Additionally, the Modified Macnab criteria indicated good to excellent outcomes in seven patients, with one exception being a patient who required revision surgery for recurrent disc herniation at 1 month after the initial operation (case No. 8). Table 2 provides a summary of these clinical results. These clinical results demonstrate positive outcomes in terms of pain relief and functional improvement for the majority of patients. The Modified Macnab criteria support the overall success of the interlaminar endoscopic lumbar spine surgery technique, although individual cases may require further intervention for complications such as recurrent disc herniation.

## Discussion

We introduced a novel technique for dural closure using autologous fat graft and Gelfoam in interlaminar endoscopic lumbar spine surgery, specifically crafted to tackle

the intricate challenges of dural tear repair in the confined spaces of endoscopic surgery. This technique, born from our extensive experience with fat grafts in open surgeries, signifies an innovative adaptation of these methods for endoscopic applications. Our combination of fat grafting with Gelfoam is a tailored solution for dural tears that are challenging or impossible to suture primarily.

Our approach not only aligns with but also expands upon the principles established by Perry Black [8], where fat grafts were effectively used alongside fibrin glue and Surgicel or Gelfoam in open and microscopic spinal surgeries. However, our method innovatively extends these principles to the realm of full endoscopic surgery, offering a less invasive yet equally effective solution. The comprehensive work of Lewandrowski et al. [5], Müller et al. [4], Oertel et al. [9], and Choi et al. [10] lays a solid foundation on dural tear management in spinal surgeries, but our study introduces a novel perspective by addressing the unique challenges inherent to interlaminar endoscopic discectomy.

In the microendoscopic surgery field, techniques like those reported by Oertel et al. [9] using muscle graft and fibrin patch/sealant (with or without Gelfoam) are affective for microendoscopic surgery. However, in full endoscopic spine surgery, which often requires a continuous fluid irrigation system, the situation differs. Shin et al.'s report on primary closure via suturing, while valuable, demands high surgical skills and specialized instruments and is limited to repairable dural tears [11]. In contrast, our technique is designed to be simpler and more adaptable, effectively addressing a broader range of tear scenarios, including unrepairable tears in the constrained space of endoscopic surgery.

Endoscopic spinal techniques have been shown to yield outcomes comparable to open microsurgical procedures in terms of patient satisfaction, functional restoration, and pain relief [1–3]. However, incidental dural tear remains a common complication. Our technique offers a practical and effective solution for these tears, particularly beneficial for middle-sized tears (2–9 mm). Nevertheless, the current lack

**Table 2** Clinical results and outcome measures

| No. | Last follow-up (years) | Pre-op VAS leg | Pre-op ODI | Last follow-up VAS leg | Last follow-up ODI | Modified Macnab criteria |
|-----|------------------------|----------------|------------|------------------------|--------------------|--------------------------|
| 1   | 2                      | 8              | 62         | 1                      | 9                  | Good                     |
| 2   | 1                      | 8              | 50         | 1                      | 14                 | Good                     |
| 3   | 1                      | 5              | 28         | 0                      | 28                 | Good                     |
| 4   | 2                      | 5              | 58         | 0                      | 4                  | Good                     |
| 5   | 1                      | 9              | 88         | 3                      | 46                 | Good                     |
| 6   | 1                      | 7              | 54         | 1                      | 14                 | Good                     |
| 7   | 3                      | 10             | 44         | 0                      | 0                  | Excellent                |
| 8   | 2                      | 9              | 64         | Revision: TLIF         |                    | Poor                     |

of a defined threshold for converting to open dural repair highlights an important area for further research.

Within our interlaminar approach, we emphasize the importance of meticulous surgical techniques to prevent dural tears, particularly in situations involving excessive cutting of the ligamentum flavum, manipulation near the nerve root, and adhesions between the ligamentum flavum and the dural sac. Factors such as large disc herniations, severe spinal stenosis, and nerve root anomalies increase the risk of dural tears.

The clinical outcomes of our dural closure technique have been generally favourable, with most patients showing significant improvements in VAS leg pain and ODI scores. This suggests that our method of managing dural tears did not negatively impact the overall clinical outcomes post-operation. However, it is important to note cases with nerve root injury or recurrence disc herniation, which required reoperation, were observed.

While our method has shown promising results, we much acknowledge the limitations of our study. The incidence of dural tears was approximately 2 per cent, resulting in a relatively small sample size that may impact the generalizability of our findings and warrant a cautious approach when interpreting the results. Additionally, our technique was primarily evaluated for middle-sized dural tears, leaving its efficacy on larger tears untested. This knowledge gap underlines the need for further research to determine the optimal application of our technique in managing larger dural tears.

## Conclusion

Dural closure using fat graft and Gelfoam in interlaminar endoscopic lumbar spine surgery is a simple, reliable, and safe technique for managing dural tears. Our study demonstrated no cases of CSF leakage or serious complications. This technique shows promise in addressing difficult or unrepairable areas of dural tears.

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**Data availability** The data supporting the findings of this study are available upon reasonable request.

## Declarations

**Conflict of interest** None of the authors has any potential conflict of interest.

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