Archives of Neurosurgery

Volume 1 | Issue 2 Article 8

2020

L5-S1 Collapsed Space Is Not A Contraindication For ELIF. Technical Note And Preliminary Clinical Results

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Recommended Citation

Tatiana Montes González, Iris; Soriano Solis, Sergio; Eduardo Soto García, Manuel; Rodríguez García, Manuel; Reyes Rodríguez., Gerson; David López García, Víctor; and Antonio Soriano Sánchez, José (2020) "L5-S1 Collapsed Space Is Not A Contraindication For ELIF. Technical Note And Preliminary Clinical Results," *Archives of Neurosurgery*: Vol. 1: Iss. 2, Article 8.
Available at: https://www.ansjournal.org/home/vol1/iss2/8

L5-S1 Collapsed Space Is Not A Contraindication For ELIF. Technical Note And Preliminary Clinical Results

Abstract

INTRODUCTION: Extraforaminal lumbar interbody fusion (ELIF) avoids vascular, neural, and genitourinary risks of anterior and lateral techniques. However, many authors consider ELIF to be contraindicated in L5-S1, especially in the case of a collapsed space. Therefore, we aim to provide a technical note for ELIF in the context of an L5-S1 collapsed space and present our experience and the postoperative clinical results of our patients. MATERIALS AND METHODS: We collected data from the records of patients with ELIF L5-S1 level collapsed between March 2020 to June 2021, using for this study sex, age, clinical symptoms, diagnosis, L5-S1 height space, EVA, and ODI pre and post-surgery. This observational report follows the STROBE reporting guidelines. RESULTS: We collected information from 29 patient files with ELIF L5-S1 collapsed level; 55% were women, with an average age of 53.9 years. The mean height L5-S1 pre-surgery was 5.23mm, mean height post-op L5-S1 was 11.38 mm. The mean preoperative Oswestry disability scale score was 42.28, and the mean 1-month postoperative was 15.65. Mean VAS pre-surgery was 8.51 mm, mean VAS post-op 2.41. None of our patients presented neurological, genitourinary, or vascular complications.

DISCUSSION: The data found in this work show that the ELIF technique can statistically modify the height of the L5-S1 interbody space. Additionally, the Oswestry disability index and pain in VAS can be statistically improved. Our data support that ELIF is suitable for collapsed L5-S1 spaces with low complication rates than other approaches. CONCLUSION: Extraforaminal lumbar interbody fusion is a feasible and safe alternative for restoring the L5-S1 disc height with clinical improvement and significant pain control by the use of intradiscal working tubes and bullet-shaped cages,

Visual Abstract

Keywords

ELIF, restore disc height, Collapsed L5-S1 intervertebral disc space

Cover Page Footnote

Acknowledgments to our families and surgical team

Authors

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Abstract

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Materials and methods: **We collected data from the records of patients with ELIF L5-S1 level collapsed between March 2020 to June 2021, using for this study sex, age, clinical symptoms, diagnosis, L5-S1 height space, EVA, and ODI pre and post-surgery. This observational report follows the STROBE reporting guidelines.**

Results: **We collected information from 29 patient files with ELIF L5-S1 collapsed level; 55% were women, with an average age of 53.9 years. The mean height L5-S1 pre-surgery was 5.23mm, mean height post-op L5-S1 was 11.38 mm. The mean preoperative Oswestry disability scale score was 42.28, and the mean 1-month postoperative was 15.65. Mean VAS pre-surgery was 8.51 mm, mean VAS post-op 2.41. None of our patients presented neurological, genitourinary, or vascular complications.**

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Keywords: ELIF, Restore height disc, L5-S1 disc collapsed

1. Introduction

Traditionally L5-S1 disc intervertebral can be approached by different areas described in the literature, such as the anterior, oblique, and posterior approaches. The anterior approach (Anterior Lumbar Interbody Fusion) provides a frontal view of the space under a broad exposure but involves vascular and genitourinary surgical risks, such as retrograde ejaculation [1]. The oblique approach (Oblique Lumbar Interbody Fusion, OLIF) provides direct and extensive exposure to the intervertebral disc space avoiding neural and muscular injuries compared with the posterior approach. However, it is still difficult because of the risks associated with mobilization of the vessels and the presence of the iliac wing [2,13,14]. The lateral approach is not feasible at L5-S1 due to the iliac crest [1,15]. In posterior approaches, the approach to the L5-S1 space is sometimes complex due to the presence of the sacral wing, iliac crest, and the emergence of the L5 root in an almost horizontal position [3–5]. A

Received 15 October 2021; revised 3 February 2022; accepted 3 February 2022.
Available online ■ ■ ■

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collapsed L5-S1 disc has been considered a small space for surgical work, technically complex to recover intervertebral space. A postero-lateral approach such as the Extraforaminal Lumbar Interbody Fusion (ELIF) reaches the Kambin's safety triangle [6], after partial removal of the inferior joint process turning it into a protective shield for the dural sac. The ELIF approach allows the placement of an interbody cage and transpedicular screws through a single wound while avoiding the neural, vascular, and genitourinary risks.

We aim to provide a technical note for ELIF in a collapsed L5-S1 space. We present our experience and results using the Visual Analog Score (VAS), Oswestry Disability Index (ODI), and complications rates. In addition, we provide recommendations for its implementation based on its safety and efficacy.

2. Materials and methods

We collected data from the records of patients who underwent single or multilevel ELIF between March 2020 to June 2021. We retrospectively analyzed those patients who had complete data from the ELIF technique at a collapsed L5-S1 to reduce bias. We included patients with degenerative disc disease, spondylolisthesis, spinal canal stenosis, or foraminal stenosis. We eliminated cases with incomplete files.

We collected data on sex, age, clinical symptoms, diagnosis, the height of the L5-S1 space in the presurgical radiographic images, and the postoperative size of the intervertebral space obtained. In addition, we use the visual analog scale (range 0–10) to assess pain the Oswestry disability index to assess the pre and postoperative clinical-functional condition at one month. We used the SPSS version 26 program for the statistical analysis, and the T-student test was applied, using Box plots to present the results. This observational report adheres to the STROBE guidelines.

3. Results

We reviewed 108 files; we selected and collected information from 29 patients with ELIF to manage a collapsed L5-S1 space; the mean age was 53.9 years with a standard deviation (SD) of 13.2, and 55% [16] of the sample corresponding to women.

The most frequent symptom was axial and radicular pain in 82.8%, with a motor deficit in 27.6% (8 patients). In addition, we had 5 cases (17.24%) with Meyerding grade I spondylolisthesis associated with radiculopathy Table 1.

Abbreviations

ELIF	Extraforaminal lumbar interbody fusión
ALIF	Anterior lumbar interbody fusión
OLIF	Oblique lumbar interbody fusión
TLIF	Transforaminal lumbar interbody fusión
LLIF	Lateral lumbar interbody fusión
PLIF	Posterior lumbar interbody fusión
ODI	Oswestry disability index
VAS	Visual analog scale
PEEK	Poly-ether-ether-ketone
POST OP	Post operatory

Table 2 shows the average pre and postoperative changes in the L5-S1 intervertebral space height, the visual analog scale, and the Oswestry disability index.

The mean initial height was 5.23mm (SD 2.62mm) and a 95% confidence interval (95% CI) of 4.23–6.22mm. The final height reached an average of 11.38mm (SD 1.32mm) and 95% CI of 10.87–11.88mm, reporting a statistically significant difference of 6 mm using a student's t-test (Fig. 1).

The mean preoperative Oswestry disability Index was 42.28 (SD 10.65, 95% CI 41.22–49.32), with a

Table 1. Demographic data.

	N	%
Population	29	100%
Gender		
Female	16	55
Male	13	45
Symptom		
Axial pain	5	17,24
Radicular pain	0	0
Axial and radicular pain	16	55,17
Axial and radicular pain + motor deficit	8	27,59
Diagnosis		
Radiculopathy + spondylolisthesis	5	17,24
Radiculopathy + degenerative disc disease	18	62,07
Degenerative disc disease	5	17,24
Spinal stenosis	1	3,45

Table 2. Radiological and clinical characteristics.

	Mean	Standard deviation (sd)
Height intervertebral space L5-S1 (mm)		
Pre-operative	5,23	2,62
Post-operative	11,37	1,32
Pain visual analog scale (0–10) (VAS)		
Pre-operative	8,51	1,08
Post-operative 1 month	2,41	1,15
Oswestry disability index (100–0) (ODI)		
Pre-operative	45,27	10,65
Post-operative 1 month	15,65	10,28

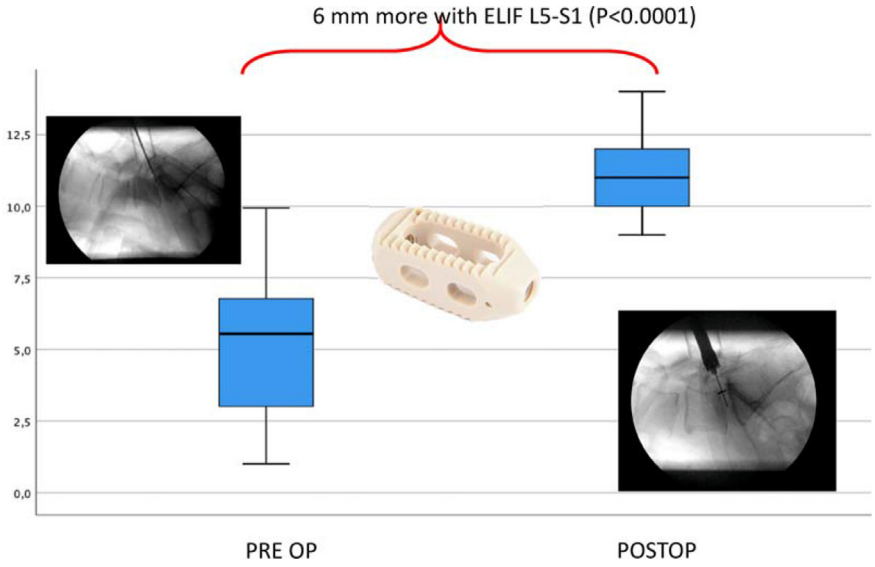

Fig. 1. Comparision height intervertebral space L5-S1 preoperative versus postoperative.

mean 1-month postoperative score of 15.65 (SD 10.28, 95% CI 11.74–19.56), reporting a statistically significant improvement of 29.62 points using a student's t-test (Fig. 2).

The mean preoperative pain by visual analog scale was 8.51 (SD 1.08, CI95% 8.10–8.93), with a mean postoperative score at one month of 2.41 (SD 1.15, CI95% 1.97–2.85), having a statistically significant improvement of 6 points test using a student's T-test (Fig. 3).

None of the patients in our series presented neurological, genitourinary, or vascular complications.

3.1. Description of the surgical technique

We performed the surgical procedures under total intravenous anesthesia with multimodal neurophysiological monitoring (somatosensory potentials, basal motor, and continuous electromyography). We position the patient prone on a Pro axis table, Jackson table, or radiopaque table with lateral rolls to avoid increased intra-abdominal pressure and reduce intraoperative bleeding [16], First, we flexed the patient's hips and knees to maintain lumbar lordosis. Then, we verified any pressure areas so that the anterior superior iliac spines must be free to avoid injury to the lateral femoral cutaneous nerve [17]. Finally, the patient is fixed to the surgical table with an adhesive cloth to avoid movements in the intraoperative period during the rotations of the table; sometimes, we have to give lumbar flexion to the table to open the workspace.

We perform standard surgical cleaning and sterile drapes placement. Next, we marked the midline, the external parapedicular line, and a line 2 cm laterally using fluoroscopy in anteroposterior projection.

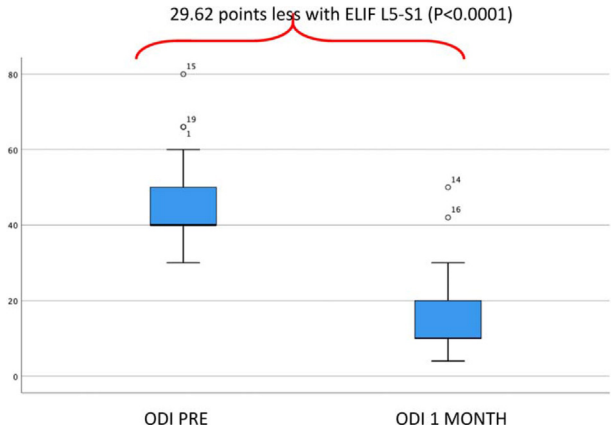

Fig. 2. COmparision odi preoperative versus postoperative at 1 month.

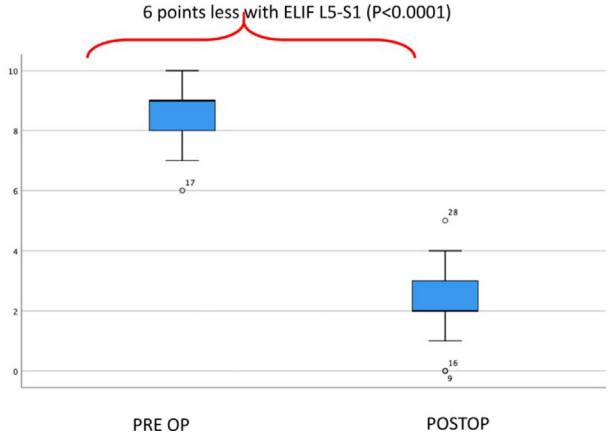

Fig. 3. Comparision VAS preoperative versus postoperative at 1 month.

Next, we marked the height of the pedicle of L5 and S1 in the lateral projection. Skin incisions are usually 2 cm long incisions. Next, we dissected the subcutaneous cellular tissue by planes to open the superficial (Camper's) and the deep (Scarpa's) lumbar fascia. Then we opened the thoracolumbar fascia followed by the fascia of the erector spine muscle to enter the muscular groove between the external aspect of the longissimus muscle and the medial aspect of the iliocostalis muscle [18]. At this point, we performed a blunt cephalo-caudal dissection with the finger at a 45° angle directed to the external pedicle line to reach the facet complexes of L5-S1, as well as the intertransverse spaces and the foramen; where the L5 exiting nerve root is more anterior, horizontal and lateral [17].

We positioned the initial tube with a blunt tip diameter of 5 mm resting on the L5-S1 facet complex. Then we placed the sequential tubular dilators until the definitive tubular retractor fixed it to the articulated arm on the table rail contralateral to the surgeon. Finally, we remove the sequential dilators and verify the final position of the tube on the L5-S1 facet complex under fluoroscopy.

We tilt the surgical table approximately 16° towards the surgeon to verify his ergonomics to avoid risky maneuvers for the patient or the surgeon. Next, we resected the remaining soft tissue on the facet joint under microscopic vision. In the facet joint, the lower facet of the superior vertebra is located medially and the sacrum facet laterally. In addition, using Penfield dissector number 4, we draw the superior edge of the sacral wing laterally, locating the extraforaminal space with the emerging root.

We reamed the lateral facet using a 2 mm matchhead lateral cutter to form a triangular area whose limits are at the base: the sacrum pedicle, the edge of the lateral facet, and a line between the apex of the lateral facet and the sacral wing. This approach allows reaching Kambin's safety triangle, where the ganglion and exit root are located at its superolateral border.

After lateral facetectomy, the fibrous ring is evident in-depth; at this point, we carefully separated the peridiscal vessels from the emerging nerve root and cut them to avoid any bleeding or nerve irritation. Then we performed an annulotomy with partial resection of the disc to insert the bullet-shaped endodiscal dilator. In a true lateral-vie of fluoroscopy, the anterior border of the dilator must coincide with the anterior border of the L5 and S1 vertebra. Therefore, in the AP projection, the anterior edge of the endodiscal dilator must exceed the midline of the disc. Then we completed discectomy through the endodiscal working tube with curettes and disc forceps to expose the bone endplates washing and vacuuming the space to remove residual disc fragments [19], Then, we placed 12.5 ccs of structural bone graft chips and 2.5 ccs of demineralized bone matrix to fill the intervertebral space. Then, we placed a Kirschner wire into a central position on the L5-S1 intervertebral space to guide the cage. Then we removed the endodiscal tubular system and inserted the cannulated bullet-shaped cage into the disc space to restore its height. At this time, we alerted the neurophysiology team and partially inserted the cage with percussion maneuvers. Then, we removed the Kirschner wire and finished insertion as anterior and central as possible regarding the spinous processes on AP fluoroscopic view. Therefore, the anterior tip of the cage should go beyond the midline, achieving anterior support and height to the neuroforamen. Figs. 4 and 5 demonstrate positioning. Note: sometimes, to achieve a proper position of the endodiscal port and cage, it is necessary to extend the bone drilling to the medial facet or even, in a few cases, partially drill the iliac wing [7,20].

After completing cage insertion, we removed any residual disc fragments in the intervertebral disc space or over the cage under the microscopic vision. Next, we verified hemostasis and confirmed the indemnity of nerves confirmed by neurophysiology. Then we removed the tubular retractor and performed muscle hemostasis to proceed with fixation. We placed cannulated, polyaxial, transpedicular screws and bars with a percutaneous technique under radiological vision or neuronavigation (O-arm).

A control scan is performed with O-arm or by fluoroscopy to evaluate the adequate placement of the implants. Finally, we performed hemostasis again, closing the fascia, subcutaneous cellular tissue, and skin by planes.

4. Discussion

Degenerative disc disease is more frequent and severe at the lumbosacral level; due to the strength in the L5-S1 segment and the range of motion, it is susceptible to acute injury or chronic degeneration. Oichi et al. [9], observed a reduced signal intensity at L5-S1 in MRI of 86.0% of participants and decreased disc height in 55.6%.

The anterior and lateral oblique approaches for the L5-S1 space [1,4,21] are associated with complications such as retrograde ejaculation due to manipulation of the hypogastric plexus, visceral injuries, and injuries to the great vessels. For example, Woods et al. [22] reported a vascular

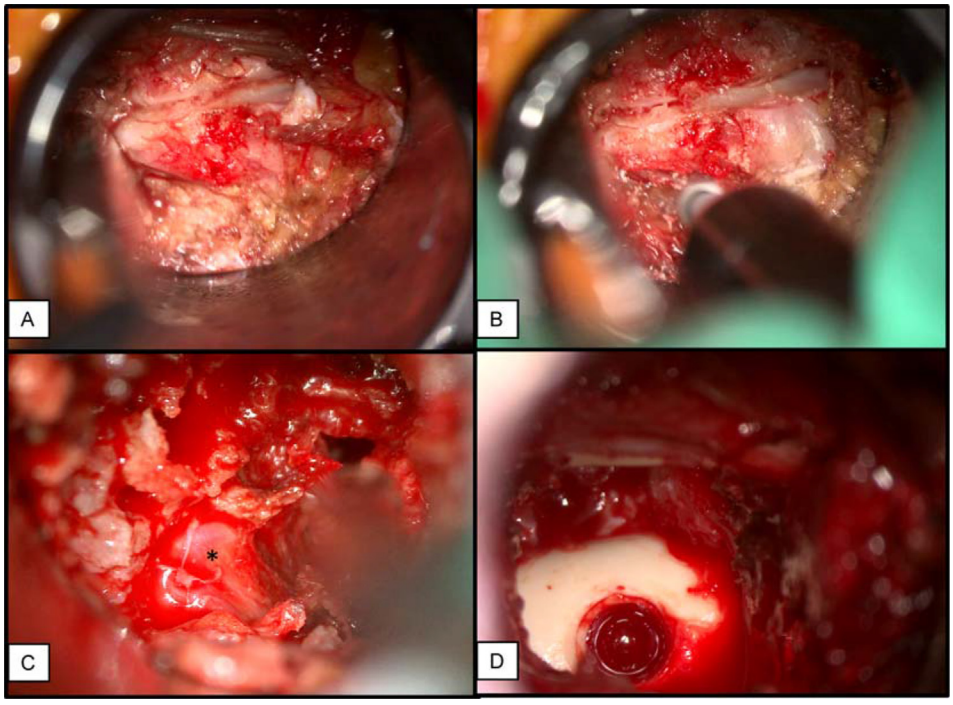

Fig. 4. A. Exposure and visualization of the facet joint. B. Lateral facet drilling to access Kambin's triangle. C. Intervertebral disc exposure and discectomy (exit root). D. Final visualization of the cage in space.*

complication rate in OLIF of 4.3%, while ALIF was 3.3%.

The anatomical limits of the L5-S1 intertransverse space and disc are medially by the superior joint process of S1 and laterally by the sacral wing and iliac crest. The L5-S1 disc space has a caudal inclination due to the sacral anatomy [20]; , making posterolateral approaches challenging. Furthermore, posterior approaches are implicated in the L5 root lesion because it emerges horizontally to the sacral wing; with a collapsed L5-S1 disc space, the working space to the intervertebral disc is severely reduced. We highlight the importance of carefully dissecting muscles from the anterior surface of the transverse processes to avoid arterial vessel injuries in this location that can cause a retroperitoneal hematoma in the postoperative period [16].

In a recent meta-analysis [10] authors compared the anterior versus posterior approach finding no significant difference in fusion rates between ALIF versus TLIF (88.6% vs. 91.9%, P = 0.23). The dural injury was significantly lower in the ALIF group (0.4% vs. 3.8%), while blood vessel injury was significantly higher (2.6% vs. 0%). We detected no differences in neurological deficit (6.8% vs. 7.9%) and infection rates (4.9% vs. 4.3%). In our ELIF cases, the medial facet protects the dural sac and nerves from incidental durotomy, a complication present in posterior approaches, especially in degenerative pathologies of the spine [11,12].

The ELIF technique has multiple advantages. It later enters through a muscular interval between the medial plane's longissimus and the iliocostalis. It allows the integrity of the erector spine muscle in the postoperative period with no evidence of fat atrophy or degeneration on follow-up magnetic resonance imaging at six months [20]. In addition, it allows a lower risk of fibrosis formation between the dural sac and emerging roots by using an extraforaminal working canal at 45° from the midline. It allows posterior decompression of the spinal canal, the lateral recess, and nerve root by performing (if necessary) an extension of resection of the medial facet and resection of the yellow ligament in the same surgical act. The presence of previous abdominal surgeries does not contraindicate ELIF as in anterior and lateral approaches. It avoids genitourinary complications, abdominal viscera, injury to the great vessels, the lumbar plexus, and muscles such as the psoas described for anterior or lateral techniques [1,4].

Our technical description provides tips that make ELIF possible in a collapsed L5-S1 disc space, contrasting this aspect to current knowledge considering ELIF contraindicated. We hope that our technique can make surgeons aware of its benefits when considering a surgical approach for their patients, avoiding the complications of anterior or lateral approaches. However, posterolateral techniques can suffer from the suboptimal cage or screw positioning,

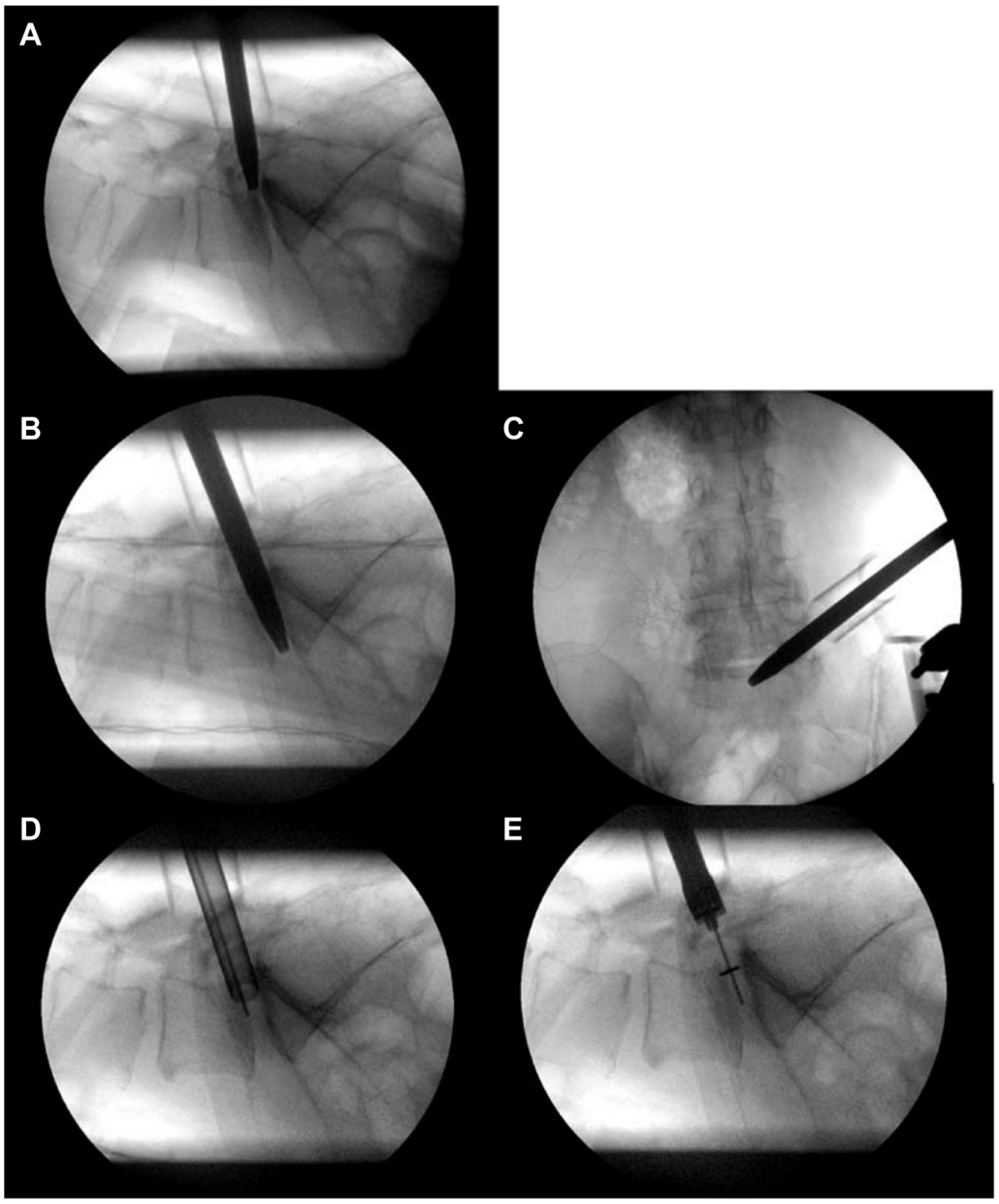

Fig. 5. X-ray transoperative A. Lateral view: tubular retractor with endodiscal dilator. B and C. Endodiscal dilator insertion, lateral and AP view. D. Endodiscal cannula with K-wire insertion. E. Cage insertion with K-Wire.

pseudoarthrosis, radiculopathy, epidural or subdural hematomas, peridural fibrosis [23], radiculitis [17], cerebrospinal fluid fistula, and muscle atrophy with fatty degeneration [8], We recommend performing a meticulous dissection and hemostasis protecting the nerve roots from the heat of bipolar coagulation to help avoid these complications.

The data found in this work show that the ELIF technique can statistically modify the height of the L5-S1 interbody space, as shown in Fig. 2. Additionally, the score of the Oswestry disability index and pain in VAS can be statistically improved, as shown in Figs. 3 and 4. Our data support that ELIF is suitable for this segment rather than an anterior or oblique approach by avoiding significant risks and placing inter somatic cage and transpedicular screws. More than just possible, ELIF is effective in restoring disc height with a wedge technique using an endodiscal dilator, a bullet-shaped guided cage insertion, and extending drilling to the medial facet or the iliac wing in the needed case [7,8].

Our work highlights that it is possible to restore the height of the L5-S1 intervertebral disc space

through the ELIF technique with good results while avoiding complications of the anterior or lateral techniques. Our study opens up opportunities to compare with other techniques such as ALIF, TLIF, PLIF, and LLIF, even in the future to evaluate merger rates and the risk of subsidence of the cages, angles of segmental and global lordosis. Our main limitation is the small sample and that we did not evaluate patients' comorbidities, although it was not the purpose of this research; long-term follow-up is also required. Our research did not present conflicts of interest and was not funded.

5. Conclusion

Extraforaminal lumbar interbody fusion is not a contraindication for a collapsed L5-S1 intervertebral disc space. In fact, according to our results, it is a safe surgical alternative that effectively restores the intervertebral height. In addition, it requires the use of an endodiscal tubular dilator shaped like a blunt pen and bullet cages. Good clinical results support its use avoiding unnecessary hazards from other techniques.

Funding disclosure(s) statement

We have neither Conflict of Interest nor any financial relationship to disclose.

We have no other funding to disclose other than authors own.

Acknowledgment

Thanks to our surgical team Dr. Enrique Flores Soria, Dr. Danahe Díaz Franco, anesthesiologists, Dr. Oscar Sanchez Escandon, neurophysiologist and, Lic. Herendira Gaspar, surgical instrumenter.

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