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ORIGINAL ARTICLE

Clinical and Radiologic Outcomes of Posterior Lumbar Interbody Fusion for Postlaminectomy Pain Syndrome: A Retrospective Study of 64 Patients with Over 2 Years of Follow-up

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Background: Postlaminectomy pain syndrome (PLPS), also referred to as failed back surgery syndrome, represents a complex clinical entity characterized by persistent or recurrent lower back pain, with or without radicular symptoms, following spinal surgery. Despite advancements in surgical techniques, the management of PLPS remains challenging due to its multifactorial and heterogeneous etiologies. **Aim:** This study aimed to evaluate the efficacy of posterior lumbar interbody fusion (PLIF) in improving clinical and radiologic outcomes for patients with PLPS due to surgically correctable structural causes. **Methods:** A retrospective study was conducted on 64 patients (mean age: 48.2 years, range: 34–75 years) who underwent PLIF by a single surgeon from 2014 to 2018. Clinical outcomes were assessed using the Visual Analog Scale (VAS) for pain and Japanese Orthopaedic Association (JOA) scores. Radiologic evaluation included flexion/extension X-rays to determine fusion rates. Patients were followed up for a mean of 3.5 years (range: 2–6 years). **Results:** VAS scores improved from a preoperative mean of 8.5–1.9 at the final follow-up, while JOA scores increased from 9.3 to 23.1 ($P < 0.001$). The mean recovery rate was 79.1%, with a fusion rate of 88.7%. Complications included dural tears in 9.3% of cases, with no nerve root injuries. Satisfactory outcomes were reported in 79.7% of patients. **Conclusion:** PLIF is a safe and effective revision procedure for PLPS, offering substantial improvements in pain, function, and spinal stability. Its versatility makes it a viable option for addressing diverse structural causes of PLPS.

Key words: Dural tear, failed back surgery syndrome, Japanese Orthopaedic Association score, posterior lumbar interbody fusion, Postlaminectomy pain syndrome

INTRODUCTION

Postlaminectomy pain syndrome (PLPS), also commonly referred to as failed back surgery syndrome, is defined as a condition characterized by chronic, disabling lower back pain, with or without radiating leg pain, following one or more spinal surgeries.[1,2] In the United States, the number of lumbar spine surgeries aimed at decompression or stabilization increased from 300,413 in 1994 to 392,948 in 2000.[3] The rise in the number of primary spine surgeries has led to an increase in the incidence of PLPS, with up to 70% of patients experiencing some degree of persistent back pain for years following discectomy.[4] It is widely accepted among spine surgeons that a thorough anatomical and pathophysiologic diagnosis is essential for the successful management of PLPS.[2,5-7] However, identifying the precise anatomical source of pain is challenging in patients without prior spine surgery and becomes even more complex in those who have undergone multiple surgical procedures.[8]

The most straightforward diagnostic approach to PLPS involves searching for surgically correctable structural lesions through imaging studies while carefully correlating the clinical presentation with the observed pathology to avoid

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the potential pitfall of false-positive findings.[9] With the use of advanced imaging techniques and diagnostic injections, the structural cause of PLPS can be identified in over 90% of patients. In the three studies investigating the causes of PLPS, the most common structural etiologies include foraminal stenosis (25%–29%), painful disc (20%–22%), pseudoarthrosis (14%), neuropathic pain (10%), recurrent disc herniation (7%–12%), iatrogenic instability (5%), facet pain (3%), and sacroiliac joint pain (2%), among others.[10-12] Given the variety of underlying causes, the question arises: Can a single surgical intervention effectively address the multifaceted challenges presented by PLPS?

Numerous posterior lumbar interbody fusion (PLIF) techniques have been developed since Cloward popularized the procedure in the 1950s.[13] When combined with disc space distraction and reduction via pedicle screw instrumentation, PLIF effectively corrects deformities in both the sagittal and coronal planes while also restoring disc space height and foraminal dimensions.[14] The purpose of this study is to assess the efficacy of our PLIF technique in patients with persistent or recurrent back and leg symptoms following prior laminectomy surgeries. Our aim is to simplify the surgical management of PLPS and identify a single revision procedure that can address the complex challenges faced by these patients.

MATERIALS AND METHODS

Ethical approval

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board of our institute with approval number: A202405173 and approved on 12/18/2024. Informed written consent was waived by the IRB.

Participants

We conducted a retrospective study of 64 consecutive patients diagnosed with PLPS at our institution, all of whom underwent PLIF performed by the same surgeon (KH Chao). The inclusion diagnoses for our PLPS patients, with various structural causes, included foraminal stenosis, adjacent disc degeneration with spinal stenosis, iatrogenic instability, recurrent disc herniation, pseudoarthrosis following previous posterior lumbar fusion, and discogram-positive painful discs [Table 1]. The indication for PLIF in our PLPS patients was the persistence or recurrence of back and/or leg pain following previous laminectomy despite at least 6 months of conservative treatment. These patients had a complete follow-up period of more than 2 years from April 2014 to September 2018. The cohort consisted of 40 male and 24 female patients, with a mean age of 48.2 years (range, 34–75 years). The patients in our study had undergone various previous surgical procedures, including hemilaminectomy and discectomy in 23 patients, total laminectomy with intertransverse fusion in 21 patients, and total laminectomy without fusion in 20 patients. The average time from the primary operation to our revision procedure was 6.8 years (range, 2–13 years). Three patients had undergone two lumbar disc operations, and five patients had received two posterior decompression surgeries without fusion. A total of 71 disc levels were fused using a titanium cage (VIGOR lumbar disc spacer, A-spine, Taiwan) supplemented by posterior instrumentation. One-level fusion was performed in 57 patients, while 2-level fusion was performed in 7 patients. To enhance bony fusion, laminectomy bone chips were placed at the front of the cage to enhance bony fusion.

Table 1: Inclusion diagnosis of 64 postlaminectomy pain syndrome

Diagnosis	*n* (%)
Foraminal stenosis	8 (12.5)
Adjacent disc degeneration with spinal stenosis	15 (23.4)
Iatrogenic instability	13 (20.3)
Recurrent disc herniation	10 (15.6)
Pseudoarthrosis of previous intertransverse fusion	5 (7.8)
Discogram-positive painful disc	13 (20.3)

Settings and design

All patients were evaluated using anteroposterior and lateral plain X-rays, as well as dynamic flexion and extension views, to assess for signs of instability, including traction spurs, reductions in disc height, and vertebral body displacement. In addition, all patients underwent gadolinium-enhanced magnetic resonance imaging for further evaluation.

The clinical symptoms of our patients were assessed by an independent physician (SC Shen) using the Visual Analog Scale (VAS) for pain and the Japanese Orthopaedic Association (JOA) score for low back pain, both preoperatively and at 3, 6, 12, and 24 months postoperatively, as well as at the final follow-up.[15] The JOA score is a 29-point system, with parameters including subjective symptoms (9 points), clinical signs (6 points), restrictions in activities (14 points), and urinary bladder function (6 points maximum). A higher score indicates a more normal overall patient status. The recovery rate of the JOA score was calculated using the Hirabayashi formula.[16] Surgical outcomes were evaluated based on the recovery rate and classified using a 4-grade scale: excellent (recovery rate 75%–100%), good (50%–74%), fair (25%–49%), and poor (<25%).

Formula of recovery rate:

$$\text{Recovery rate (\%)} = \frac{\text{Postoperative JOA score} - \text{Preoperative JOA score}}{29 - \text{Preoperative JOA score}} \times 100$$

Anteroposterior and lateral X-rays were obtained at each time interval, with flexion/extension dynamic X-rays performed at 24 months after PLIF and at the final follow-up. Fusion was considered solid if an anterior bridging fusion mass was present and there was no motion observed on flexion/extension dynamic X-rays. In cases of uncertain fusion, computed tomography was used for further assessment. The minimum postoperative follow-up was 2 years, with a mean follow-up duration of 3.5 years (range, 2–6 years).

Statistical analysis

Statistical analysis was performed using analysis of variance (ANOVA), followed by the Newman–Keuls test. Data are presented as mean (standard deviation [SD]), and statistical significance was defined as $P < 0.05$.

RESULTS

Clinical outcomes

The mean operative time was 4.2 h (range, 3.5–5 h) for one-level PLIF and 5.0 h (range, 4–6.5 h) for two-level PLIF. The mean blood loss was 650 ml (range, 450–1200 ml) for one-level PLIF [Figure 1] and 950 ml (range, 750–2500 ml) for two-level PLIF [Figure 2]. The mean VAS pain score (SD) improved from 8.5 (0.5) preoperatively to 1.9 (0.4) at the final follow-up. The mean JOA score (SD) was 9.3 (2.1) preoperatively, 22.2 (3.4) at 1 year postoperatively, and 23.1 (3.7) at the final follow-up. The JOA score at 12 months postoperatively was significantly better than at 6 months postoperatively ($P < 0.05$), with no significant

Figure 1: (a and b) Preoperative radiographs of a 55-year-old female showing iatrogenic instability of L4/5 after laminectomy and discectomy. (c) A preoperative magnetic resonance image showing spinal stenosis with herniated lumbar disc of L4/5. (d) A lateral postoperative radiograph at final follow-up showing solid fusion with restoration of collapsed disc and partial reduction of spondylolisthesis of L4/5

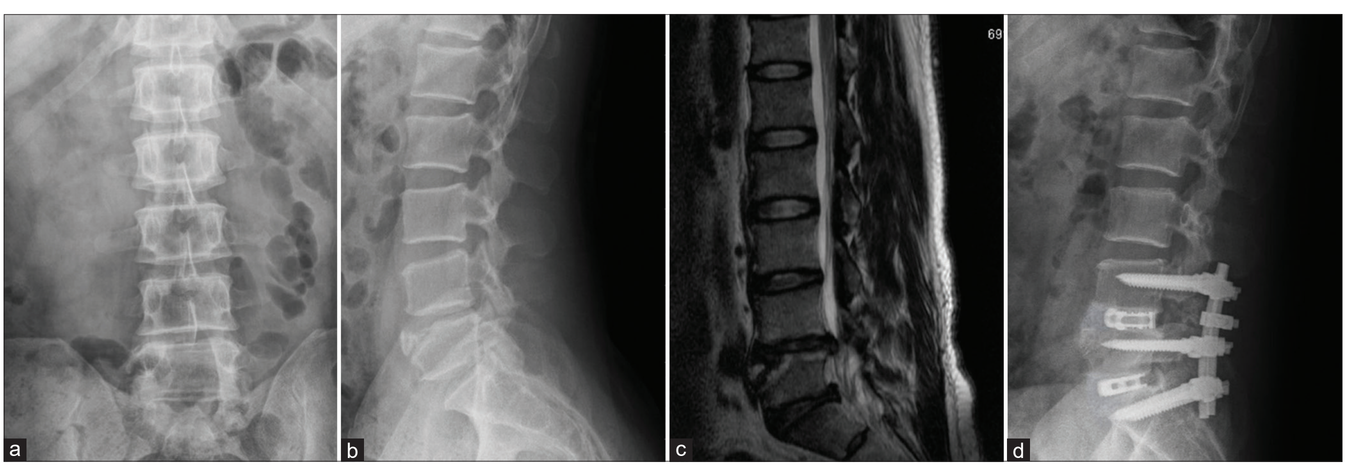

Figure 2: (a and b) Preoperative radiographs of a 34-year-old male with painful disc showing disc space narrowing of L4/5. (c) A preoperative magnetic resonance image showing a dark disc with herniation of L4/5 and L5/S1. (d) A lateral postoperative radiograph at final follow-up showing solid fusion after 2-level PLIF

difference observed between subsequent time intervals after 12 months [Figure 3]. The mean recovery rate (SD) was 75.8% (16.0) at 1 year postoperatively and 79.1% (17.9) at the final follow-up. Outcomes were classified as follows: 26 cases as excellent, 25 as good, 9 as fair, and 4 as poor. There were no nerve root injuries during the revision surgeries.

We further classified our patients into six groups based on the different structural causes of PLPS. The recovery rates for each group were as follows: foraminal stenosis, 81.3% (13.9); adjacent spinal stenosis, 76.6% (11.8); iatrogenic instability, 78.2% (20.3); recurrent disc herniation, 78.0% (19.8); pseudoarthrosis, 73.3% (28.3); and discogram-positive painful disc, 76.6% (19.4). Statistical analysis revealed no significant difference in the recovery rates among these groups.

Radiographic outcomes

A total of 71 disc levels underwent PLIF. Of these, 63 levels (88.7%) were adjudicated as solid fusions, while 8 levels (11.2%) were classified as non-unions due to the absence of an anterior bridging fusion mass. There were no instances of implant failure at the final follow-up.

Complications

Dural tear was a major complication during the revision posterior decompression and discectomy, occurring in six patients (9.3%) in our series. Dural tears were immediately repaired with watertight closure using 5-0 nonabsorbable sutures and fibrin glue. One case of persistent leakage was followed by wound dehiscence, for which delayed repair and closure were performed; the wound healed within 2 weeks. Dual cage insertion was unsuccessful in two patients due to severe fibrosis around the dura and nerve root, and both were classified as poor results clinically, with poor recovery rates at the final follow-up. Cage subsidence occurred in one patient, who was also classified as having a poor clinical outcome.

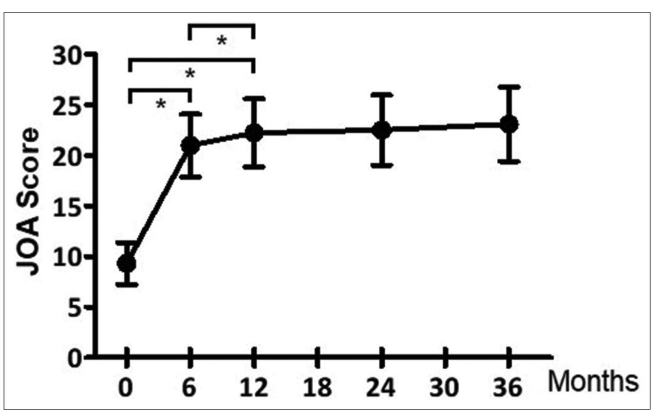

Figure 3: Japanese Orthopaedic Association score at different time interval. JOA = Japanese Orthopaedic Association. The symbol *indicates a statistically significant difference between time intervals

DISSCUSSION

PLPS is a common and challenging clinical problem, with diagnosis often remaining unclear. From a nonoperative perspective, rehabilitation may be less effective in reducing pain in postsurgical patients compared to their nonoperated counterparts despite similar improvements in physical capacities.[17] revision surgery remains an option, though the surgical risks are high due to the need for meticulous dissection of fibrotic scar tissue, excessive retraction of scarred nerve roots and dura, and the potential for dural tears and nerve root injury. Ebeling *et al*. reported a complication rate of 13% following repeated discectomy, with dural tears and infections being the most common issues.[18] In our series, the rate of dural tear was 9.3%, which is lower than that reported by Ebeling *et al*.

Transforaminal lumbar interbody fusion (TLIF), introduced by Harms and Rolinger,[19] provides mechanical stability similar to PLIF but through a unilateral approach, aiming to reduce approach-related morbidity.[20] Chen *et al*. reported a series using TLIF for the treatment of recurrent lumbar disc herniation.[21] PLIF can also be employed for recurrent disc herniation, allowing interbody fusion at the recurrent site, while providing easy access to the spinal canal through the contralateral, unscarred site for a smooth and effective procedure. Ames *et al.*'s cadaveric study indicated no biomechanical difference in stability between single-level PLIF and TLIF, with motion restriction enhanced in both groups when pedicle screws were placed.[22] Selznick *et al*. reported their results of minimally invasive interbody fusion for revision lumbar surgery, concluding that minimally invasive revision PLIF and TLIF are technically feasible, not associated with increased blood loss or neurological morbidity, but require expert anatomical knowledge and significant experience to perform safely.[23]

Badawy *et al*. reported the outcomes of instrumented posterolateral fusion in the treatment of PLPS, achieving overall satisfactory results in 80% of their patients, with a complication rate of 13% dural tear.[24] However, in cases of PLPS associated with segmental kyphosis, painful discs, or the presence of vacuum disc with severe disc collapse, restoring lumbar lordosis and normal disc height through instrumented posterolateral fusion can be challenging. PLIF, combined with an intervertebral spacer, addresses these issues effectively, providing enhanced stability and the potential for solid fusion. The PLIF procedure can restore sagittal alignment through a single posterior approach [Figure 4].

For PLPS associated with adjacent disc degeneration and spinal stenosis, redecompression above the affected level and restoration of disc height with instrumented fusion are required. In cases of PLPS with iatrogenic instability and

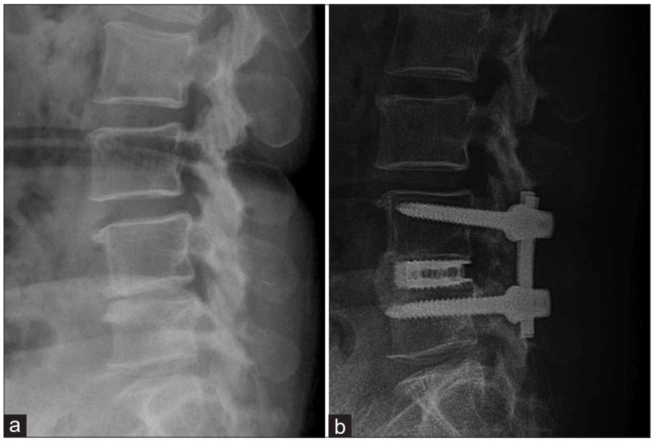

Figure 4: (a) A lateral radiograph of a 42-year-old female showing segmental kyphosis of L4/5 after laminectomy and discectomy. (b) The postoperative radiograph showing good restoration of lumbar lordosis and disc height

pseudoarthrosis following previous PL fusion, reestablishment of a stable fusion is crucial. PLIF appears to be a reasonable option to decompress the nerve root, remove the degenerated disc, restore disc height, and indirectly decompress the affected nerve root, all while achieving stable fusion through a single procedure with an acceptable complication rate. Kim and Michelsen reported their series of revision surgeries for PLPS and concluded that repair of pseudoarthrosis using conventional posterolateral fusion had a high failure rate.[25] Sears, in his series of PLIF for degenerative spondylolisthesis, suggested that PLIF offers high patient satisfaction, low complication rates, and substantial deformity correction, all achieved through a posterior-only approach.[14]

There are several limitations to our study, primarily because it does not involve a comparative analysis of different revision techniques. However, for experienced surgeons in PLIF, this technique may yield satisfactory outcomes in selected patients with PLPS. While no significant differences in recovery rates were observed among the different groups after PLIF, we cannot conclusively assert that PLIF provides equivalent clinical results across all structural causes of PLPS. We believe that the lack of statistical significance may be attributed to the small sample size. Future studies with larger patient cohorts and more extensive statistical analysis could provide further insights and potentially confirm if PLIF is particularly effective for specific structural causes of PLPS.

CONCLUSION

The most crucial factor influencing surgical outcomes in revision surgery for PLPS is the accurate identification of the structural cause, facilitated by modern diagnostic tools. Based on our clinical outcomes and the theoretical advantages of PLIF, instrumented PLIF with an intervertebral spacer proves to be a reasonable and effective revision procedure for PLPS. This approach is particularly beneficial for patients with various surgically correctable causes, including foraminal stenosis, adjacent disc degeneration with spinal stenosis, iatrogenic instability, recurrent lumbar disc herniation, painful discs, and pseudoarthrosis following prior posterolateral fusion.

Data availability statement

The data that support the findings of this study are available from the corresponding author, KHC, upon reasonable request.

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Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. North RB, Campbell JN, James CS, Conover-Walker MK, Wang H, Piantadosi S, *et al*. Failed back surgery syndrome: 5-year follow-up in 102 patients undergoing repeated operation. Neurosurgery 1991;28:685-90.
2. Raffo C, Wiesel S, Lauerman W. Determining Reasons for FailedLumbar Spine Surgery. In: Frymoyer, ed. The Adult Spine. Philadelphia: Lippincott-Raven 2003. p. 945-54.
3. Gray D, Deyo R, Kreuter W, Mirza S, Martin B. Population-based rates of inpatient and outpatient lumbar spine surgery in the United States. Paper presented at: International Society for the Study of the Lumbar Spine; 2004.
4. Dvorak J, Gauchat MH, Valach L. The outcome of surgery for lumbar disc herniation. I. A 4-17 years' follow-up with emphasis on somatic aspects. Spine (Phila Pa 1976) 1988;13:1418-22.
5. Fritsch EW, Heisel J, Rupp S. The failed back surgery syndrome: Reasons, intraoperative findings, and long-term results: A report of 182 operative treatments. Spine (Phila Pa 1976) 1996;21:626-33.
6. Gill K, Frymoyer J. Management of treatment failures after decompressive surgery: Surgical alternatives and results. In: Frymoyer J, ed. The Adult Spine: Principles and Practice. 2nd edition ed. Philadelphia: Lippincott-Raven 1997. p. 2111-33.
7. Cinotti G. Failures of surgery in lumbar spinal stenosis. Causes and management. J Bone Joint Surg 1999;81B: 142.
8. Devulder J, Deene P, De Laat M, Van Bastelaere M, Brusselmans G, Rolly G. Nerve root sleeve injections

in patients with failed back surgery syndrome: A comparison of three solutions. Clin J Pain 1999;15:132-5.
9. Hazard RG. Failed back surgery syndrome: Surgical and nonsurgical approaches. Clin Orthop Relat Res 2006;443:228-32.
10. Burton CV, Kirkaldy-Willis WH, Yong-Hing K, Heithoff KB. Causes of failure of surgery on the lumbar spine. Clin Orthop Relat Res 1981;157:191-9.
11. Waguespack A, Schofferman J, Slosar P, Reynolds J. Etiology of long-term failures of lumbar spine surgery. Pain Med 2002;3:18-22.
12. Slipman CW, Shin CH, Patel RK, Isaac Z, Huston CW, Lipetz JS, *et al*. Etiologies of failed back surgery syndrome. Pain Med 2002;3:200-14.
13. Cloward RB. The treatment of ruptured lumbar intervertebral discs by vertebral body fusion. I. Indications, operative technique, after care. J Neurosurg 1953;10:154-68.
14. Sears W. Posterior lumbar interbody fusion for degenerative spondylolisthesis: Restoration of sagittal balance using insert-and-rotate interbody spacers. Spine J 2005;5:170-9.
15. Japanese Orthopaedic Association Assessment Criteria Guidelines Manual.1996. p. 46-9.
16. Hirabayashi K, Miyakawa J, Satomi K, Maruyama T, Wakano K. Operative results and postoperative progression of ossification among patients with ossification of cervical posterior longitudinal ligament. Spine (Phila Pa 1976) 1981;6:354-64.
17. Rainville J, Sobel J, Hartigan CJ. Does failed spine surgery affect the outcomes from rehabilitation of chronic low back pain? Eur J Phys Rehabil Med 2003;39:171.
18. Ebeling U, Kalbarcyk H, Reulen HJ. Microsurgical reoperation following lumbar disc surgery. Timing, surgical findings, and outcome in 92 patients. J Neurosurg 1989;70:397-404.
19. Harms J, Rolinger H. A one-stager procedure in operative treatment of spondylolistheses: Dorsal traction-reposition and anterior fusion (author’s transl). Z Orthop Ihre Grenzgeb 1982;120:343-7.
20. Harms JG, Jeszenszky D. Die posteriore, lumbale, interkorporelle fusion in unilateraler transforaminaler technik. Oper Orthop Traumatol 1998;10:90-102.
21. Chen Z, Zhao J, Liu A, Yuan J, Li Z. Surgical treatment of recurrent lumbar disc herniation by transforaminal lumbar interbody fusion. Int Orthop 2009;33:197-201.
22. Ames CP, Acosta FL Jr., Chi J, Iyengar J, Muiru W, Acaroglu E, *et al.* Biomechanical comparison of posterior lumbar interbody fusion and transforaminal lumbar interbody fusion performed at 1 and 2 levels. Spine (Phila Pa 1976) 2005;30:E562-6.
23. Selznick LA, Shamji MF, Isaacs RE. Minimally invasive interbody fusion for revision lumbar surgery: Technical feasibility and safety. J Spinal Disord Tech 2009;22:207-13.
24. Badawy WS, El Masry MA, Radwan YA, El Haddidi TT. Results of instrumented posterolateral fusion in failed back surgery. Int Orthop 2006;30:305-8.
25. Kim SS, Michelsen CB. Revision surgery for failed back surgery syndrome. Spine (Phila Pa 1976) 1992;17:957-60.