Original Article

Mini posterior lumbar interbody fusion with presacral screw stabilization in early lumbosacral instability

Arjun Shetty[1,2], Abhishek R Kini[2], Chacko A[1], Upadhyaya Sunil[1], Vinod K[1], Lobo Geover[1]

Abstract

Background: Surgical options for the management of early lumbosacral spondylolisthesis and degenerative disc disease with instability vary from open lumbar interbody fusion with transpedicular fixation to a variety of minimal access fusion and fixation procedures. We have used a combination of micro discectomy and axial lumbosacral interbody fusion with presacral screw fixation to treat symptomatic patients with lumbosacral spondylolisthesis or lumbosacral degenerative disc disease, which needed surgical stabilization. This study describes the above technique along with analysis of results.

Materials and Methods: Twelve patients with symptomatic lumbosacral (L5-S1) instability and degenerative lumbosacral disc disease were treated by micro discectomy and interbody fusion using presacral screw stabilization. Patients with history of bowel, bladder dysfunction and local anorectal diseases were excluded from this study. Postoperatively all patients were evaluated neurologically and radiologically for screw position, fusion and stability. Oswestry disability index was used to evaluate results.

Results: We had nine females and three males with a mean age of 47.33 years (range 26–68 years). Postoperative assessment revealed three patients to have screw placed in anterior 1/4th of the 1st sacral body, in rest nine the screws were placed in the posterior 3/4th of sacral body. At 2 years followup, eight patients (67%) showed evidence of bridging trabeculae at bone graft site and none of the patients showed evidence of instability or implant failure.

Conclusion: Presacral screw fixation along with micro discectomy is an effective procedure to manage early symptomatic lumbosacral spondylolisthesis and degenerative disc disease with instability.

Key words: Axial lumbosacral interbody fusion, lumbosacral spondylolisthesis, microdiscectomy, presacral screw
MeSH terms: Spine, lumbosacral region, spondylolisthesis, bone screw

Introduction

The management of grade one[1] lumbosacral spondylolisthesis and degenerative disc disease with instability has varied from conservative management using orthotic aids and spinal exercises to surgical decompression and stabilization. Of the surgical options available, the classical open interbody fusion and transpedicular fixation provides good results but is associated with increased osseoligamentous injury and postoperative morbidity.[2,3] This has lead spinal surgeons to shift to a variety of minimally invasive procedures as treatment options.[4-8]

Minimally invasive procedures using a standard micro discectomy with a transforamenal lumbar interbody fusion or posterior lumbar interbody fusion (PLIF) in combination with a minimally invasive transpedicular fixation procedure provides an aesthetic treatment option; however, it is technically demanding and the instrumentation is expensive.

In an effort to provide an easily replicable less technically demanding and relatively inexpensive alternative, we have combined the classic micro discectomy and the mini PLIF procedure with the placement of a presacral lumbosacral screw to achieve fixation and attempted to assess the effectiveness of presacral screw fixation as a stabilization procedure.

Materials and Methods

Twelve patients were subjected to micro discectomy and axial interbody fusion with percutaneous presacral screw fixation over a 5 years period. The indications were

[1]Department of Neurosurgery, Kasturba Medical College, Manipal, [2]Departments of Neurosurgery and Orthopaedics and Traumatology, Tejasvini Hospital and SSIOT, Kadri, Mangalore, Karnataka, India

Address for correspondence: Dr. Abhishek R Kini,
Departments of Orthopaedics and Traumatology,
Tejasvini Hospital and SSIOT, Kadri, Mangalore - 575 002, Karnataka, India.
E-mail: kiniabhishek@gmail.com

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grade 1 lumbosacral (L5-S1) spondylolisthesis (n = 4), grade 2 spondylolisthesis (n = 1), L5-S1 degenerative disc disease (n = 6) and L4-L5, L5-S1 disc disease (n = 1). In the patient with two levels disease, both levels were subjected to decompression and fusion.

All patients underwent a detailed preoperative neurological assessment and were subjected to preoperative radiographs of the lumbosacral spine followed by magnetic resonance imaging (MRI) of the spine and MRI of the pelvis to rule out aberrant vessels in the midline presacral region. All patients with degenerative lumbosacral disc disease warranting fixation as evidenced by instability on flexion extension (FE) radiographs, ligament hypertrophy and facetal hypertrophy on MRI, as well as patients with grade 1 spondylolisthesis and patients with grade 2 spondylolisthesis, which reduced to grade 1 on being positioned prone were offered the option of this procedure, as an alternative to a lumbar inter body fusion with transpedicular stabilization. Patients with a history of anorectal disease and those with a history of bladder and bowel disease were excluded.

Operative procedure

All patients routinely underwent a preoperative bowel preparation. Under anesthesia the patients were positioned prone on a spinal frame. A foleys catheter can be introduced into the rectum with its bulb insufflated to delineate the rectum; however, we have not found this to be necessary nor do we routinely perform it. Fluoroscopy was used to note the position of the sacrum and assess the proposed trajectory angle of the screw from its entry point at the anterior border of the S1-S2 junction. The antero-posterior projection was used to ensure that the spinous processes be equidistant from the facet joint and to take any scoliosis, if present, was taken into consideration. In some cases, entry point may need to be taken higher up on the S1 body to compensate for the curvature of the sacrum.

The parts are prepared and draped. Using a 3 cm midline incision a L5-S1 microdiscectomy is performed, and the disc space is prepared for an interbody fusion. The inferior aspect of the L5 lamina can be harvested for use as a bone graft later. The tip of the coccyx is palpated, and a stab incision made just below it. A blunt tipped shunt introducer is introduced along the anterior surface of the sacrum under fluoroscopic guidance till the S1-S2 junction is reached. The introducer is passed using a side to side movement to open up the presacral space [Figure 1].

A 28 F intercostal drainage tube with trocar is then passed along the passage created under fluoroscopic guidance to reach the S1-S2 junction and its midline position confirmed.

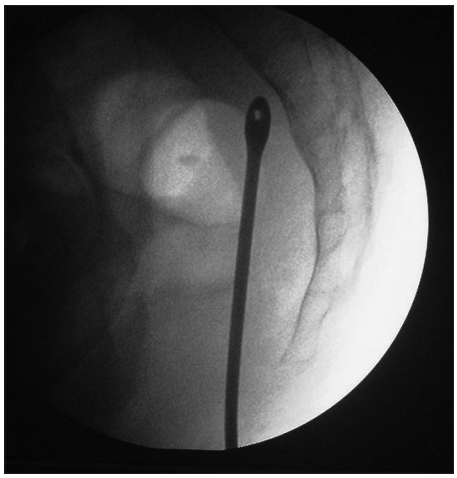

Figure 1: Lateral fluoroscopic view of sacrum showing a blunt tipped introducer dissecting the presacral space

At this stage distraction at the L5-S1 space can be attempted if needed using a vertebral dissector introduced into the disc space through the lumbar incision. The trocar of the intercostal tube is removed and the tube cut to the required length and now serves as a protective sheath through which a guidewire (steinman pin) is introduced and docked into the S1-S2 junction in the midline [Figure 2].

Using a power drill under fluoroscopic guidance, the steinman pin is passed through S1 to L5 till it crosses the upper cortex of L5 [Figure 3]. A cannulated tap is passed over the pin and then the cannulated screw (7 mm) of the appropriate length is placed after which the steinman pin and the intercostal tube are withdrawn [Figure 4]. The discectomy site is now examined under the microscope to clear the disc space again after which the harvested bone combined with cortico-cancellous bone graft is used to perform an interbody fusion.

Postoperatively oral feeds were started after 24 h, after confirming bowel sounds. Radiograph of the lumbosacral spine and computed tomography (CT) scan of the lumbosacral spine were done in the immediate postoperative period along with a detailed neurological evaluation. After evaluation of the presacral screws on the postoperative radiograph and CT scans, patients were graded into optimal and suboptimal screw placement. Optimal screw placement was defined as the screw trajectory passing through the posterior 3/4th of the S1 body and sub optimal where the trajectory passed through the anterior 1/4th of the S1 body. Patients were mobilized on a lumbosacral brace on the 3rd postoperative day, which was advised to be continued further till 6 weeks.

All patients were followed up postoperatively in an outpatient clinic at 6 weeks, 3 months, 6 months, 1 year

and 2 years. On each followup visit, radiograph of the lumbosacral spine was done to assess the screw position, the fusion or mobility at involved level, along with a detailed neurological work up was done. Fusion was determined based on the absence of mobility on flexion and extension radiographs, absence of implant failure and evidence of bridging trabecular bone [Figures 5-7]. Subjective assessment of patients was done with the Oswestry disability index (ODI).[9]

Results

We had nine females and three males with a mean age of 47.33 years (range 26–68 years). The average operative time varied from 1 h and 25 min to 2 h and 5 min (average 1 h and 43 min). All patients could be mobilized on a lumbosacral brace on the 3rd postoperative day as is our protocol for those treated with transpedicular fixation. The hospital stay varied from 7 to 12 days (average 10.6 days).

Postoperative assessment revealed three patients to have screw placed in anterior 1/4th of the 1st sacral body, in rest nine the screws were placed in the posterior 3/4th. We have analyzed our final results at 2 years post surgery, subsequently the patients were asked to followup if any new complaints developed. The patients who did not show strong bony fusion followed up for a longer period on yearly basis, the rest were symptom free and hence did not followup. The mean followup of these 12 patients is 2.08 years. At 2 years followup 8 patients (67%) showed evidence of bridging trabeculae at bone graft site and none of the patients showed evidence of instability or implant failure (mean followup of 2.08 years). There was a significant improvement in ODI from preoperative score of 36.9% (range 26–43%) to 6 months postoperative score of 17.6% (range 10–32%) ($P < 0.05$).The ODI at

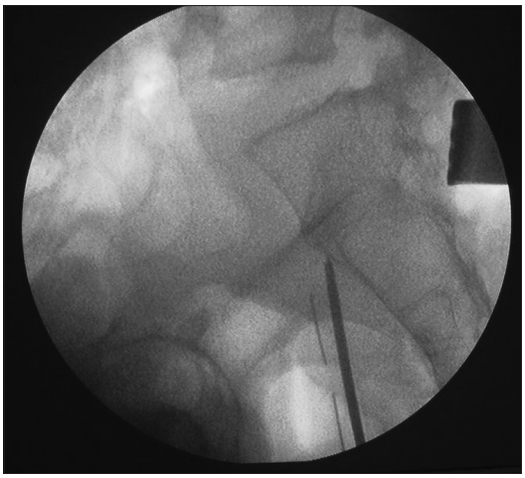

Figure 2: A fluoroscopic lateral view lumbosacral area showing a guidewire (steinmen pin) being introduced through the protective intercostals tube and docked at the S1-S2 junction

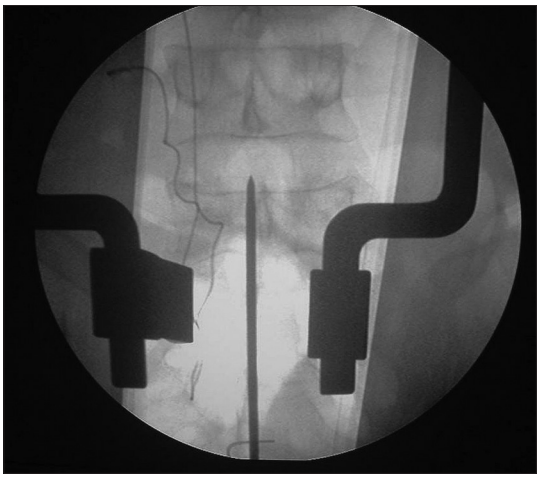

Figure 3: An anteroposterior fluoroscopic image showing central passage of guidewire up to the upper margin of L5

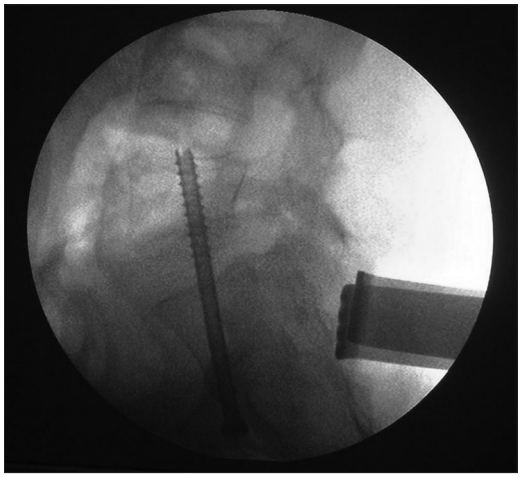

Figure 4: A fluoroscopic lateral view lumbosacral area showing cannulated screw of appropriate length passed over the guidewire

Figure 5: Preoperative T2W magnetic resonance imaging showing degenerative disc disease at L5-S1 level

Figure 6: Postoperative lateral radiograph of lumbosacral spine at 6 months showing presacral screw fixation at L5-S1 level

Figure 7: Postoperative lateral radiograph lumbosacral spine at 6 months followup showing presacral screw fixation at L4-L5 and L5-S1 levels

2 years followup was 16.9% (range 10–32%). There was no intraoperative or perioperative complication associated with the placement of the presacral screws in any patients in this series [Table 1].

Discussion

Grade 1 spondylolisthesis and degenerative disc disease with instability can be treated by a variety of surgical options. The morbidity and osseoligamentous trauma associated with open interbody fusion and transpedicular fixation[2,3] have led to surgeons opting for a variety of minimally invasive procedures.[5,8]

Marotta *et al*.,[10] proposed the use of presacral percutaneous approach to internally decompress the disc space and subsequently fuse the lumbosacral segment using a percutaneously placed screws. A micro discectomy with a mini PLIF procedure provides disc decompression and can also address osseoligamentous compression which is often associated with degenerative disc disease we have used this fairly standard procedure in combination with a percutaneously placed presacral screw to achieve fixation. Preexisting anorectal pathology, past anorectal surgery, high grade spondylolisthesis and significant scoliosis are contraindications for this procedure.[11] In addition, we have avoided this procedure in patients with bladder and bowel complaints and patients with a history of sexual dysfunction. While placing the presacral screw it is essential to stay within the coronal safe zone between the left and right internal iliac vessels and a sagittal safe zone between the anterior sacrum and the rectum.[12,13]

While preoperative angiograms to assess the presacral vessels have been recommended by some surgeons the complications associated with the injury to the midline splanchnic nerves, inferior hypogastric plexus and presacral venous plexus are more likely than the risk of internal iliac artery injury.[13] The presacral screw should correctly pass through the retro sacral fascia as this would ensure a minimum distance of about 0.8 cm between the screw and the splanchnic nerves.[13-15]

Avoidance of injury to midline structures is ensured by the use of gentle dissection with a blunt tipped introducer and the use of a protective sheath (in our case an intercostal drainage tube) during the instrumentation procedure.

The curvature of the anterior surface of the sacrococcygeal complex dictates the entry point and the trajectory angle of the presacral screw. The commonly accepted point of entry is the S1-S2 junction.[10,13] In cases where there is an increased curvature of the sacrum especially in females and cases with spondylolisthesis a higher entry point would be needed to prevent the screw trajectory from transgressing the canal posteriorly. The selection of an entry point higher in the S1 body results in a reduction of screw purchase on the sacral body. A preoperative X-ray in the prone position with a line joining the tip of the coccyx to the proposed entry point could be used to predict the trajectory of the presacral screw. We also feel that this procedure is best avoided in cases with spondylolisthesis above grade 1. In our study, a higher entry point leading to the screw passing in the anterior 1/4th of the sacral body was seen in three patients. All three were female and 2 cases had spondylolisthesis.

Immediate operative complications during placement of presacral screws in the first 5000 AxiaLif procedures was reported to be 1.081.[10] Possible complications include bleeding and hematoma formation, bladder and sexual dysfunction and rectal injury. We have had no complications in the cases treated by us. The efficacy of a spinal fusion

Table 1: Clinical details of patients

Age (year)/ sex	Diagnosis	Preoperaive status	Preoperative ODI	Postoperative status	Followup (6 months) ODI	Followup status at 6 months	Fusion after 2 years	Followup ODI (2 years)
27/ female	Degenerative disc disease	LBA right LL radiation Right EHL grade 4 Right AJ absent	41	No pain Motor deficit persistent	20	No pain Motor deficit persistent	Yes	20
36/ female	Grade I, L5-S1 Spondylolisthesis	LBA radiating to left LL Left AJ absent	26	Pain relieved, walking Left AJ absent	10	Pain relieved, walking Left AJ absent	Yes	10
68/ female	Degenerative disc disease. L5-S1, L4 L5 IVDP	LBA, radiation to b/l LL b/l EHL distal grade 4 b/l AJ absent	31	Pain relieved No motor/ sensory deficits b/l AJ absent	18	Pain relieved No motor/ sensory deficits b/l AJ absent	Yes	20
54/ female	Degenerative disc disease L5-S1	LBA, radiation to b/l LL b/l EHL distal grade 4 b/l AJ absent	32	Pain persistent Motor defidit grade 5 b/l AJ absent	22	Pain relieved Motor defidit grade 5 b/l AJ absent	Yes	20
61/ female	Grade II, L5-S1 Spondylolisthesis	LBA radiating to LLs b/l grade 3 power in EHL Pinprick absent in L5 and S1 dermatomes B/L AJ absent	43	No LBA walking without support Grade 3 power EHL b/l AJ absent	16	Walking without support Left grade 3 EHL power persisting	No	15
42/ male	Degenerative disc disease L5-S1	LBA left radiation Left EHL grade 3 power S1 dermatome decreased pinprick AJ absent	37	No pain No motor/ sensory deficit AJ absent	13	No pain No motor/ sensory deficit AJ absent	Yes	10
66/ male	Degenerative disc disease L5-S1	LBA radiation to left LL Left EHL grade 4 power Pinprick absent L5 dermatome	40	Pain relieved No motor/ sensory deficits	19	Pain relieved No motor/ sensory deficits	No	20
60/ female	Grade 1, L5-S1 Spondylolisthesis	LBA radiation to Left LL Left AJ absent	36	Pain reduced No motor/ sensory deficits	12	Pain reduced No motor/ sensory deficits	No	12
26/ female	Degenerative disc disease L5-S1	LBA right LL radiation Right EHL grade 4 power AJ absent	40	No pain AJ absent	18	No pain no motor or sensory deficits	Yes	16
53/ male	Grade 1, L5-S1 spondylolisthesis	LBA, radiation to right LL Right AJ absent S1 dermatome pinprick absent	42	Pain persistent No motor or sensory deficit Right AJ absent	32	Pain persistent No motor or sensory deficit Right AJ absent	No	32
33/ female	Grade 1, L5-S1 Spondylolisthesis	LBA, b/l LL radiation b/l EHL grade 4 power Pinprick absent in L5 and S1 dermatome Right AJ absent	36	Pain decreased b/l EHL grade 4+Right AJ absent No sensory deficit	21	Pain decreased b/l EHL grade 4+Right AJ absent No sensory deficit	Yes	18
42/ female	Degenerative disc disease L5-S1	LBA with left radiation Left AJ absent S1 dermatome pinprick absent	39	No pain AJ absent	11	No pain AJ absent	Yes	10

ODI=Oswestry disability index, LBA=Low backache, EHL=Extensor hallucis longus muscle, AJ=Ankle jerk, b/l=Bilateral, LL=Lower limb, IVDP=Inter vertebral disc prolapse

procedure is based on the degree of stability achieved and the incidence of nonfusion and implant failure associated with the procedure. Biomechanical studies have shown transsacral rods to reduce range of movements in FE lateral bending (LB) and axial torsion (AT) by more than 40%.[10] The use of bilateral screws reduces range of movements in AT and LB by as much as 65–70% but only about 50% in FE. Data regarding stability and fusion with presacral stabilization is largely from studies related to the AxiaLiF procedure.[10] Proponents of the AxiaLiF procedure propose using stand alone presacral screws only in cases where the disc annulus is not intact and to augment the presacral

screws with pedicle screws or facet screws in cases where the annulus is breached, studies using this protocol have reported up to 90% fusion rates in augmented cases with 80% fusion in stand alone cases.

We have placed 2 screws one on either side of the midline to further increase stability.[16] We believe that ensuring that the screw crosses the upper cortex of the superior vertebra provides added stability by the construct. On 2 years followup, there has been no evidence of instability or implant failure however clear evidence of bony fusion has been seen in only 8 cases. However, all four cases in whom fusion has not occurred had excellent relief of pain and declined a supplemental posterior fixation.

We have not had any implant failure in the cases operated by us. But the possibility of implants breaking or backing out needs to be addressed. Studies with axial instrumentation (AxiaLiF) have reported removal of fractured implants via anterior sacral resection and with the aid of an expanding tool and retrieval expanding flex sub assembly provided by the manufactures or via an anterior sacral resection procedure.[13,17] We propose that the screws that have backed out can be extracted via the use of a grasping forceps aided by fluoroscopy and an endoscope. In cases where the fractured implant has embedded in the bone we propose to use an intercostal tube sheath in the presacral space to guide a Kirschner wire to dock on to the entrance of the lumen of the cannulated screw after which a large bore cannulated reamer could be used to extract the screw with a thin rim of adjoining bone.

The limitations of this study are that sample size is small ($n = 12$). Larger numbers need to be evaluated before commenting on the efficacy and safety of the procedure. In addition, the feasibility and safety of salvage procedures in cases with implant failure needs to be evaluated.

To conclude the posterior lumbosacral interbody fusion with a presacral screw provides excellent stabilization with limited tissue injury. It provides an effective method to manage early lumbosacral spondylolisthesis and degenerative disc disease with instability. The procedure is easily replicable, does not need specialized expensive equipment.

References

1. Meyerding HW. Spondylolisthesis. Surg Gynecol Obstet 1932;54:371-9.
2. Perez-Cruet MJ, Fessler RG, Perin NI. Review: Complications of minimally invasive spinal surgery. Neurosurgery 2002;51:S26-36.
3. Rajaraman V, Vingan R, Roth P, Heary RF, Conklin L, Jacobs GB. Visceral and vascular complications resulting from anterior lumbar interbody fusion. J Neurosurg 1999;91:60-4.
4. Shen FH, Samartzis D, Khanna AJ, Anderson DG. Minimally invasive techniques for lumbar interbody fusions. Orthop Clin North Am 2007;38:373-86.
5. Gepstein R, Werner D, Shabat S, Folman Y. Percutaneous posterior lumbar interbody fusion using the B-twin expandable spinal spacer. Minim Invasive Neurosurg 2005;48:330-3.
6. Regan JJ, Yuan H, McAfee PC. Laparoscopic fusion of the lumbar spine: Minimally invasive spine surgery. A prospective multicenter study evaluating open and laparoscopic lumbar fusion. Spine (Phila Pa 1976) 1999;24:402-11.
7. McAfee PC, Regan JJ, Geis WP, Fedder IL. Minimally invasive anterior retroperitoneal approach to the lumbar spine. Emphasis on the lateral BAK. Spine (Phila Pa 1976) 1998;23:1476-84.
8. Bergey DL, Villavicencio AT, Goldstein T, Regan JJ. Endoscopic lateral transpsoas approach to the lumbar spine. Spine (Phila Pa 1976) 2004;29:1681-8.
9. Fairbank JC, Pynsent PB. The Oswestry Disability Index. Spine (Phila Pa 1976) 2000;25:2940-52.
10. Marotta N, Cosar M, Pimenta L, Khoo LT. A novel minimally invasive presacral approach and instrumentation technique for anterior L5-S1 intervertebral discectomy and fusion: Technical description and case presentations. Neurosurg Focus 2006;20:E9.
11. Neel A, Baron EM, Bharuk G, Malhotra R. Mastering Orthopaedic Techniques – Spine Surgery. New Delhi: Jaypee Publications; 2012. p. 171-8.
12. Erkan S, Wu C, Mehbod AA, Hsu B, Pahl DW, Transfeldt EE. Biomechanical evaluation of a new AxiaLIF technique for two-level lumbar fusion. Eur Spine J 2009;18:807-14.
13. Aryan HE, Newman CB, Gold JJ, Acosta FL Jr, Coover C, Ames CP. Percutaneous axial lumbar interbody fusion (AxiaLIF) of the L5-S1 segment: Initial clinical and radiographic experience. Minim Invasive Neurosurg 2008;51:225-30.
14. Kinugasa Y, Murakami G, Suzuki D, Sugihara K. Histological identification of fascial structures posterolateral to the rectum. Br J Surg 2007;94:620-6.
15. Havenga K, DeRuiter MC, Enker WE, Welvaart K. Anatomical basis of autonomic nerve-preserving total mesorectal excision for rectal cancer. Br J Surg 1996;83:384-8.
16. Akeen B, Wu C, Mehbod AA, Transfeldt EE. Biomechanics of paracoccygeal focus sacral fixation. J Spinal Disord Tech 2008;21:39-44.
17. Hofstetter CP, James AR, Härtl R. Revision strategies for AxiaLIF. Neurosurg Focus 2011;31:E17.

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