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

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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 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. This has lead spinal surgeons to shift to a variety of minimally invasive procedures as treatment options.

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
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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
case of a 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 facet 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 interbody
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 passed using a side to side movement to open
fluoroscopic guidance till the S1
incision made just below it. A
graft later. The tip of the coccyx is palpated, and a stab
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The parts are prepared and draped. Using a 3

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.

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 lumbar sacral 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).

**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 lumbar sacral 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](image1.png)

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

![Figure 3](image2.png)

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

![Figure 4](image3.png)

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

![Figure 5](image4.png)

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

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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 sacrocccygeal 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.
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%. 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. 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

Table 1: Clinical details of patients

| Age (year) | Diagnosis | Preoperative status | Postoperative status | 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 | No pain | Motor deficit | Yes | 20 |
| 36/ female | Grade I, L5-S1 Spondylolisthesis | LBA radiating to left LL Left AJ absent | Pain relieved | Motor deficit | 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 | Pain relieved | Motor deficit | 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 | Pain persistent | Motor deficit | 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 | No LBA walking without support Grade 3 power EHL b/l AJ absent | Motor deficit | No | 15 |
| 42/ male | Degenerative disc disease L5-S1 | LBA left radiation Left EHL grade 3 power S1 dermatome decreased pinprick AJ absent | No pain | 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 in S1 dermatome | Pain relieved | No motor/sensory deficits | No | 20 |
| 42/ female | Degenerative disc disease L5-S1 | LBA radiation to Left LL Left AJ absent | Pain reduced | No motor/sensory deficits | No | 12 |
| 60/ female | Grade 1, L5-S1 Spondylolisthesis | LBA radiation to Left LL Left AJ absent | No pain | No motor or sensory deficits | No | 16 |
| 26/ female | Degenerative disc disease L5-S1 | LBA right LL radiation Right EHL grade 4 power AJ absent | Pain reduced | No motor/sensory deficits | Yes | 16 |
| 53/ male | Grade 1, L5-S1 spondylolisthesis | LBA, radiation to right LL Right AJ absent S1 dermatome pinprick absent | 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 | Pain decreased | No motor or sensory deficit Right AJ absent | Yes | 18 |
| 42/ female | Degenerative disc disease L5-S1 | LBA with left radiation Left AJ absent S1 dermatome pinprick absent | No pain | No AJ absent | Yes | 10 |
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. 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. 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.

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