

Instrumented Reduction and TLIF for Adult Grade Four Isthmic Spondylolisthesis.

Hossam Salah Eldin Taha M.D., FRCS (Eng.)

Department of Orthopaedic Surgery, Faculty of Medicine, Cairo University, Egypt.

Abstract

Background Data: The management of high grade spondylolisthesis remains controversial; with advocates for in-situ fusion and others for reduction.

Purpose: To report the clinical and radiological results and the operative technique of a personal case series of adult Grade 4 isthmic spondylolisthesis that underwent instrumented reduction and TLIF.

Study Design: Retrospective clinical and radiological evaluation of a case series.

Patients and Methods: Twelve patients with grade 4 isthmic spondylolisthesis were retrospectively reviewed. All patients presented with disabling back pain, 83% with leg pain, 66% crouched while walking and 16.5% presented with caudae quina syndrome. They all underwent posterior decompression, instrumented reduction and TLIF at the slipped level.

Results: The mean preoperative VAS for back pain of 7.3 dropped to 2.2 and of 8 to 1.9 for leg pain. The mean preoperative ODI of 41 dropped to 12 at the latest follow up. Solid fusion was obtained in 75% with another 16.7% stable constructs without bridging bony fusion.

Conclusion: Instrumented surgical reduction and TLIF provides a safe and effective way of treating adult high grade spondylolisthesis. (2012ESJ023)

Keywords: isthmic, TLIF, grade 4 spondylolisthesis, instrumented reduction.

Introduction

Although high-grade slips, defined as grade 3 and above, represent a minority of all patients with spondylolisthesis¹, the treatment of this small group of patients has been the topic of on-going debate. Suggested surgical treatments have varied from non-instrumented in situ fusion^{4,10} to instrumented reduction and interbody fusion with reduction. The method of interbody fusion has varied from anterior interbody fusion (ALIF) to posterior lumbar interbody fusion (PLIF)^{2,21,22}. In-between, partial

reductions and trans-sacral fixation using screws or fibular allografts have also been suggested^{8,24,26}.

Although the concept of reducing spinal deformity before fusion is attractive, the issue of surgical reduction versus in situ fusion remains controversial^{13,16,19,27}.

Harms and Jeszenszky³ suggested a modification of the traditional PLIF that involved the placement of bone graft and titanium mesh cages, *via* a transforaminal route (TLIF), into the disc space that had previously been

distracted using pedicle screw instrumentation. Such an approach can be accomplished without exposing more than the ipsilateral foramen, and retraction on the thecal sac is minimal. Both PLIF and TLIF theoretically allow for 3-column fixation and fusion. The TLIF procedure is gaining popularity^{11,12,17,20,23,25}.

The purpose of this study is to retrospectively review a case series of adult grade four isthmic spondylolisthesis treated by surgical reduction and TLIF and to report their clinical and radiological outcome.

Patients and Methods

Between March 2004 and July 2009, 12 adults aged 24 to 46 years (mean 35.7) with symptomatic lumbosacral Meyerding grade IV isthmic spondylolisthesis were treated by posterior lumbar decompression, TLIF at the disk space of the level of the slip, pedicle screw fixation, and reduction of the listhetic vertebra. There were eight females and four males.

On admission before the surgery, the complaint was incapacitating pain in the back in all 12 patients and 8 (66%) patients crouched while walking. Ten (83%) patients showed symptoms of spinal stenosis with claudication, and radicular pain and numbness of the lower extremity not responding to non-operative management. Two patients (16.5%) complained of dysfunction of the bowel and bladder, and one of the two had required catheterization a month before surgery.

Radiological investigation for all patients included standing antero-posterior & lateral plain radiographs of the lumbosacral spine, dynamic films and MRI. Seven patients had a CT scan as well. The following radiological parameters were measured; percentage of slip, sacral slope (SS), pelvic incidence (PI), the pelvic tilt (PT) and the lumbo-sacral angle⁷ (Figure 1).

Surgical Technique:

All cases were treated by posterior lumbar decompression, L4 to S1 pedicle screw fixation, TLIF at the disk space of the level of the slip, and reduction of the listhetic vertebrae. One stage procedure was carried out in all patients. The surgery was designed to decompress the neural canal adequately and to relieve the spinal stenosis; to clear the disk space carefully; to correct the kyphosis at the lumbosacral junction in as safe a manner as possible, while attempting to restore normal alignment to the

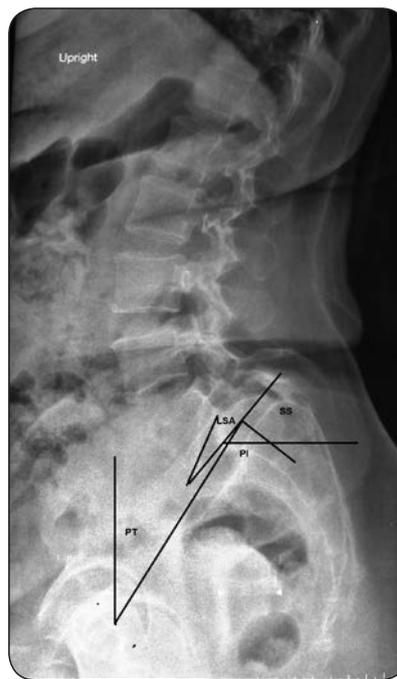


Figure 1. Radiological measurements taken in this series: Lumbosacral angle (LSA), Sacral slope (SS), Pelvic incidence (PI), and Pelvic tilt (PT).

sagittal plane; and to obtain a stable construct to facilitate 360 degree arthrodesis of the spine, in order to prevent recurrence of lumbosacral kyphosis.

Correction of the translational displacement (that is, the percentage of slippage) was a secondary consideration, and maximum correction of this displacement was not the main goal of surgery. Instead, correction of the kyphotic angle was the main goal. Reduction was achieved through the following steps: first gradual progressive distraction applied early on either to the pedicle screws or to the lamina edges using a vertebral spreader. This improved visualization of the L5 nerve root and therefore facilitated the decompression. This also allowed improved access to the L5/S1 disk space. Second, meticulous clearance of the L5/S1 disk space with the incremental use of spreaders. Third, the insertion of long sleeved reduction screws. These allow gradual translational reduction of L5 at the time of tightening of the screw nuts. Manipulation of the slotted connectors in a side loading system can have a similar effect. Additional local autograft obtained from the excised posterior elements augmented with Bicalcium phosphate bone substitute were placed in the inter-transverse space. The average time of the procedure was 220 minutes (180-300 minutes), with a mean blood loss 650 cc (400-1200 cc) (Figure 2).

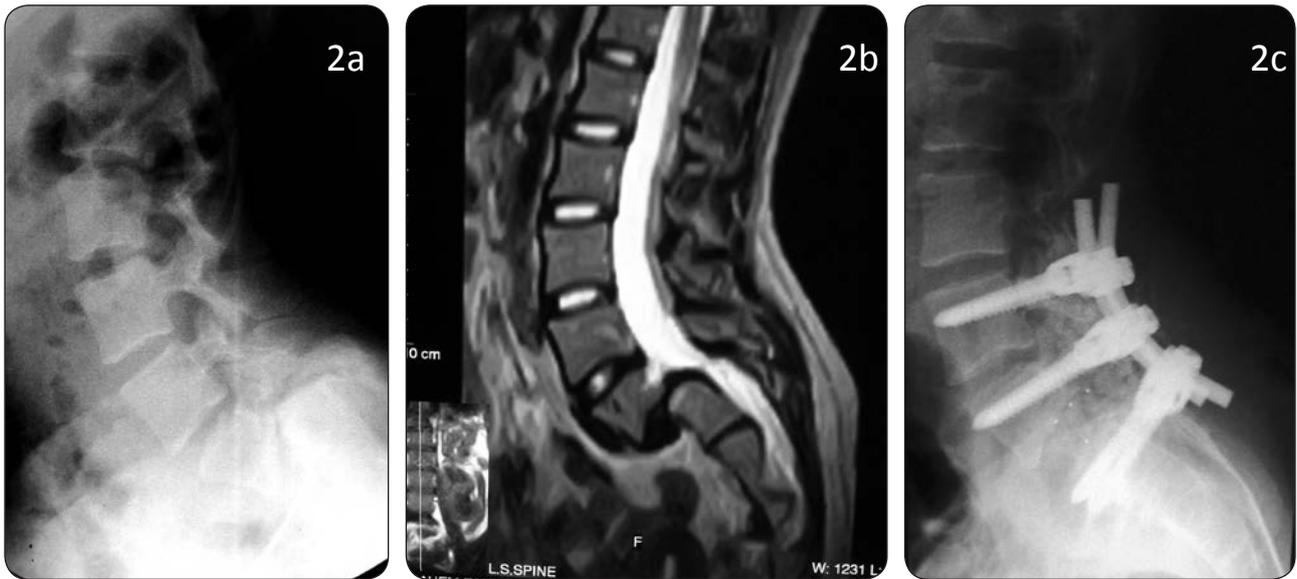


Figure 2. HF, 24 year old female **2a.** Preoperative lateral view with 98% slip, LSA 48, SS 35, PT 35 and PI 70. **2b.** Preoperative sagittal T2 MRI. **2c.** Postoperative lateral view with 12% slip, LSA 8, SS 55, PT 23 and PI 78. At her latest follow up she is essentially symptom free and doing all her house work as a mother of three.

Postoperative Management:

Patients were mobilized out of bed 48 hours postoperative, with the mean hospital stay being 6 days (4-9 days). Patients were instructed to wear a soft lumbosacral corset for 3 months.

Outcome Measures:

Patients had their back and leg pain severity assessed separately each on a visual analogue scale (VAS), 0 meaning no pain and 10 maximum pain. The Oswestry Disability Index (ODI) was used to assess the functional state of the patients¹⁸.

Results

The mean preoperative VAS for back pain of 7.3 dropped to 2.2 and the mean preoperative VAS for leg pain of 8 dropped to 1.9 and the mean preoperative ODI of 41 dropped to 12 at the latest follow up.

Of the two patients who had a lesion of the cauda equina before the operation, at follow-up one showed partial improvement of function of the bladder and the condition of the other patient who had mild dysfunction of the bowel and bladder preoperatively had complete resolution at follow-up (Figure 2).

All patients resumed normal daily activity without restriction. At the latest follow-up, 9 patients were completely free of pain in the back, while three had occasional episodes of intermittent discomfort in the low part of the back.

All patients were relieved of the radicular pain of spinal stenosis. Eleven patients felt that the deformity had been improved substantially, while one felt that she still had a mild deformity.

Overall patient satisfaction was assessed by asking the patients a direct question and whether they would recommend the surgery to a friend. Eleven out of twelve (91.7%) replied positively and were therefore satisfied with their surgery.

X-rays revealed solid bony fusion in 9 patients, two patients had no clear bridging bony fusion but with no evidence of instrumentation failure or progression of deformity and were symptom free. One patient developed a fracture of the sacral screws following a minor fall 18 months following the surgery. She was offered revision surgery but declined and remained under follow up with intermittent back pain. No neurologic complications or wound infections were encountered (Figure 3).

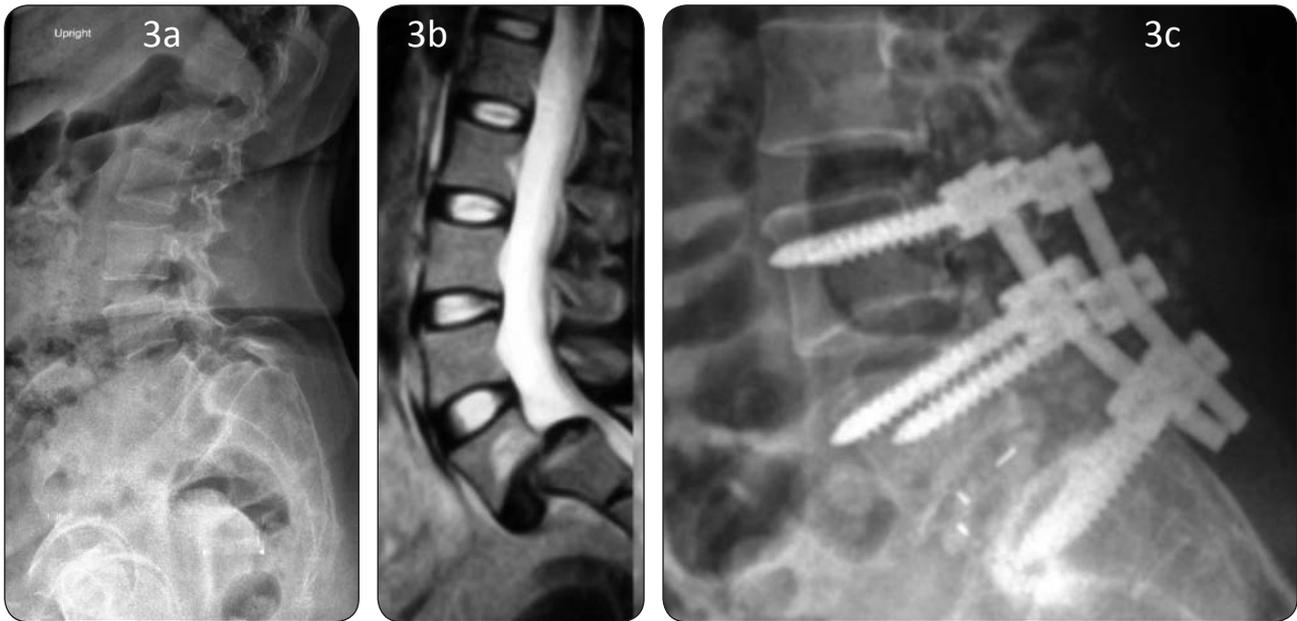


Figure 3. GA, 40 year old female. **3a.** Preoperative lateral view with 78% slip, LSA 12, SS 48, PT 30 and PI 78. **3b.** Preoperative sagittal T2 MRI. **3c.** Postoperative lateral view with 13 % slip, LSA -12, SS 54, PT 25 and PI 79. At her latest follow up she experiences occasional low back pain but no leg pain. Takes occasional NSAIDs. Satisfied with her surgery and continues with her regular work as a school teacher.

Table 1 shows the mean postoperative radiological measurements in comparison to the preoperative ones.

Table 1.
Mean Preoperative and Postoperative Radiological Parameters.

	Mean Preoperative	Mean Postoperative
Percentage of slip (Slip%)	81.5%	21.3%
(Sacral slope (SS	42.5	55
Pelvic tilt (PT)	30.5	23.5%
Pelvic Incidence (PI)	73	78.5
Lumbosacral angle (LSA)	21.5	-3.5

Discussion

The fusion rates have been variably reported for high grade spondylolisthesis, with higher fusion rates reported for interbody fusion varying from 88.9% to 100%^{5,14,15,16,19}. This series reported a definite case of pseudoarthrosis with implant breakage (8.3%). Another two cases (16.7%) showed a stable construct without definite bridging bony trabeculae on X-rays. We suspect that the development of delayed union in these two patients will eventually heal into solid fusion especially as they are asymptomatic. Local bone autograft augmented with bicalcium phosphate was used in this series. No iliac bone graft was harvested. Whether this contributed as

well is an open question. We achieved solid bony fusion as detected on plain X-rays & CT scans in 9 patients (75 %).

The patient that developed S1 screws fracture may suggest the need to augment the sacral fixation by a method of pelvic fixation. Most patients did not develop implant failures possibly due to the fact that this cohort of patients was of young adults with good bone stock. Also the getting of a bi-cortical purchase for the sacral screws may have contributed to this⁶.

TLIF is a safe and effective method to treat high-grade spondylolisthesis, which can theoretically prevent typical complications of anterior and posterior lumbar interbody fusion. Clearance of the disk space facilitates reduction and insertion

of appropriate cage size enables opening up the foramen, indirectly decompressing the neural elements and restoring the sagittal profile of the patient.

Using reduction screws (extended screw heads) in listhetic vertebrae is of great benefit. It facilitates insertion of the rods without too much manipulation. Also gradual tightening of the nuts allows gradual reduction of the slipped vertebra. Similarly, the use of a side loading system, where the manipulation of the screw connector, can have the same effect of the reduction screws.

Some authors have reported the use of a sacral dome osteotomy^{14,15}. This was not used in this series. A thorough preparation of the disk space with shavers and different angled curettes can achieve a relatively flat surface of the sacral dome. The sacral dome osteotomy has the theoretical added benefit of shortening the spine. This may in turn decrease the stretch across the neural structures. In this case series, gradual distraction and translational reduction with continuous monitoring of the tension along the neural structures were used without developing any neurological deficits postoperatively.

Our radiological measurements have confirmed the ability of this surgical technique to improve lumbo-sacral kyphosis and spino-pelvic alignment. This has contributed to the correction of the patients' clinical deformity and therefore the overall spinal balance which in turn may decrease adjacent level disease in the future. These improvements follow other published data^{7,13}.

In this case series the fusion was always extended to LV4 vertebra. It was our feeling that the correction of the lumbo-sacral kyphosis and the translational slip was better obtained this way. Also the presence of an extra point of anchor at L4 gave a sense of safety and confidence particularly with the often small and dysplastic pedicle of LV5. Others have used the stable zone to determine the extension or otherwise to LV4. This measurement was not used in this small case series.

Conclusion

This study shows that instrumented reduction and TLIF for treatment of grade VI adult isthmic spondylolisthesis can provide a safe way of reduction to restore the sagittal alignment of the spine and the spino-pelvic alignment, allows direct and indirect

decompression of neurological structures, and provides an environment for successful fusion.

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Address reprint
request to:

AdHossam Salah Eldin Taha, M.D., FRCS (Eng).
10 Hoda Shaarawy street, Bab Elluk, Cairo, Egypt.
e-mail: hossammeister@gmail.com

الملخص العربي

الرد الجراحي باستخدام المثبتات والالتحام ما بين أجسام الفقرات القطنية للانزلاق الفقاري البرزخي من الدرجة الرابعة لدى الكبار

مقدمة: علاج الانزلاق الفقاري ذات الدرجة العالية لا يزال مثيرا للجدل، ما بين المدافعين عن الالتحام في الموقع وآخرون مؤيدون لرد الانزلاق.

الغرض: تقديم تقرير عن النتائج السريرية والإشعاعية وتقنية الجراحة من سلسلة حالات من الانزلاق الفقاري البرزخي من الدرجة الرابعة لدى الكبار والتي خضعت للرد الجراحي.

تصميم الدراسة: تقييم سلسلة من الحالات بأثر رجعي من الناحية السريرية والإشعاعية.

مواد وطرق: جرى استعراض بأثر رجعي ١٢ مريضا من الانزلاق الفقاري البرزخي من الدرجة الرابعة. جميع المرضى يعانون من آلام الظهر، ٨٣٪ من ألم في الساق، في حين ٦٦٪ جاثم المشي وقدم ١٦،٥٪ يعانون من متلازمة ذيل الفرس. جميع المرضى خضعوا لجراحة تخفيف الضغط من الخلف، مع رد للانزلاق بواسطة مسامير عنق الفقرة والالتحام بين أجسام الفقرات القطنية بواسطة فقص جانبي.

النتائج: انخفض متوسط VAS قبل الجراحة لآلام الظهر من ٧،٣ حتى ٢،٢ ومن ٨ حتى ١،٩ في آلام الساق بعد الجراحة. انخفض متوسط ODI قبل الجراحة من ٤١ إلى ١٢ في أحدث متابعة. تم الحصول على الالتحام الصلب في ٧٥٪ مع ١٦،٧٪ بنيات أخرى مستقرة دون سد الالتحام العظمي.

الخلاصة: الرد الجراحي يوفر وسيلة آمنة وفعالة لعلاج الانزلاق الفقاري ذات الدرجة العالية للبالغين.