

Unilateral Transforaminal Lumbar Interbody Fusion for High Grade Isthmic Spondylolisthesis

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Abstract

Background Data: Several controversies exist over the most appropriate approach for managing high grade spondylolisthesis; classic interbody fusions (PLIF) are associated with a considerable degree of complications.

Purpose: The aim of this work is to determine the safety and efficacy of unilateral TLIF in managing high grade isthmic spondylolisthesis.

Study Design: Prospective, randomized, between 2000 and 2008. Patient Sample: 44 patients with high grade isthmic spondylolisthesis (Meyerding grades III and IV). The mean age was 24y (range 17-38y). All patients had severe back and radicular symptoms that failed to conservative treatment. Eighteen were at L4/5 and 26 at L5/S1. Outcome measures; total blood loss, operative time and hospital stay were recorded. Clinical outcome was assessed by the ODI and VAS. Fusion was assessed using plain radiographs.

Methods: Limited decompression and indirect instrumented reduction was performed; 21 had additional unilateral TLIF (Group 1) and 23 had posterolateral fusion using autograft bone (Group 2). Patients were followed-up for an average of 4.5y (range 2-7y).

Results: The average Oswestry Disability Index and Visual Analogue Scale showed better improvement in group 1 than group 2. In group 1 anterolisthesis improved from an average of 69% to 16% while in Group 2 it improved from an average of 64% to 19% at final follow up. Other parameters including improvement in disc space height, lumbar lordosis and angle of slip showed better improvement in group 1 than group 2. None in Group 1 had an implant failure and its overall fusion rate was 94%. In Group 2, the average operative time, blood loss and hospital stay were significantly less but two patients had implant failure requiring revision and the overall complications were 6/23 patients.

Conclusion: Direct instrumented reduction and TLIF is an efficient option to treat high grade isthmic spondylolisthesis. It provided immediate stability and superior clinical and radiological outcomes.

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Key words: high grade, spondylolisthesis, transforaminal, interbody fusion

Introduction

Spondylolisthesis was first described in the middle of the 18th century²¹. The most widely accepted classification system for spondylolisthesis is that of Wiltse, et al, (1976)²⁵. Treatment of patients with low to moderate grade lytic spondylolisthesis is usually non-operative²⁴, nonetheless, if conservative measures fail, surgical treatment is an acceptable solution.

Several controversies exist over the most appropriate approach for managing high grade spondylolisthesis. Some authors have recommended fusion in situ, while others recommended decompression and fusion.^{3, 9, 13, 18} Fusion was recommended either with or without instrumentation and more recently in the form of posterior lumbar interbody fusion (PLIF).⁴ PLIF provided solid fusion, mechanical stability and restoration of the original disc height; however, it was associated with significant morbidity and complications.⁷

Transforaminal lumbar interbody fusion (TLIF) was first developed by Harms¹⁰ in 1998 as a simpler technique for unilateral interbody fusion; it avoided the neurological complications which might result from excessive nerve root retraction with classic PLIF.¹⁰⁻¹¹ The aim of this work is to determine the safety and efficacy of unilateral TLIF in managing high grade isthmic spondylolisthesis.

Materials and methods

This prospective, randomized study was conducted between 2000 and 2008 and included 44 patients with high-grade isthmic spondylolisthesis (Meyerding grades III and IV). The study included 30 females and 14 males. The mean age was 24y (range 17 - 38y). All patients had severe back and radicular symptoms that failed to conservative treatment. Patients were examined clinically and investigated radiologically. The clinical examination included a thorough neurological evaluation. Clinical outcome was assessed by the amount of improvement using the ODI and the overall improvement in back and leg pain using a VAS. Hospital notes reviewed included the total operative time, blood loss and hospital stays.

Radiological examination included plain X-ray views of the lumbosacral spine in Anteroposterior, lateral (standing) and both oblique views. Eighteen slips were at L4/5 and 26 at L5/S1. An MRI was performed for all patients. Pre-operative, post-operative and follow-up X-rays were reviewed to assess the change in disc space height, lumbar

lordosis, angle of slip, anterolisthesis and to detect fusion.

Surgical Procedure:

Limited decompression and indirect-instrumented reduction was performed; 21 had additional unilateral TLIF (Group 1) and 23 had posterolateral fusion using autograft bone (Group 2).

Technique:

The patient was placed in the prone position on a Wilson frame and the abdomen was assured to be free of any compression. The spine was exposed through a vertical midline incision and the posterolateral gutters were carefully prepared exposing the transverse processes to their tips on either side or the ala of the sacrum when needed. On either side, the pars interarticularis was removed and a hemifacetotomy of the superior and inferior facets at the level to be fused was done. The pseudarthrosis was meticulously debrided and the exiting nerve root was carefully decompressed. Pedicle screws were then placed, their insertion was greatly facilitated by "feeling" the inferior and medial walls of the pedicle by a dissector. Indirect reduction was achieved by gentle distraction across the spinous processes or the pedicle screws.

In Group 1:

The side of the spine selected for TLIF was chosen on the basis of preoperative radicular symptoms; the most symptomatic side was selected, if symptoms were bilaterally equal, the left side was usually used. The intervertebral disc was removed with the traversing nerve root protected by a blunt dissector and the exiting nerve root visualized hugging its respective pedicle. Endplate decortication with special curettes and shavers was carefully performed. More distraction was gently applied across the pedicle screws or by use of a laminar spreader and the intervertebral space was packed anteriorly with autogenous bone graft obtained during the decompression. Finally an appropriately sized cage packed with autograft bone was inserted; distraction was gradually released to allow the endplates to gently compress the cage, further compression was applied after application of the longitudinal members.

In Group 2:

The posterolateral gutter was filled with morselized autograft bone that was placed after thorough decortication of the transverse processes on either side.

In Groups 1 and 2:

The longitudinal members (either plates or rods)

were then firmly tightened. Aggressive debridement was performed, the wound was thoroughly irrigated, suction drains were inserted and the wound was then closed in layers. Patients were fully ambulant by the second postoperative day. At that time, the suction drains and urinary catheters were removed. All patients were instructed to wear a lumbosacral brace postoperatively; the brace was worn for 6-8 weeks.

Results

Patients were followed up for an average of 4.5y (range 2-7y). All patients were viewed at 6, 12, 18, 24, 36 weeks and 1 year postoperatively and afterwards were followed up at yearly intervals; clinical evaluation and plain X-rays were individually scheduled at each visit (Figure 1, 2).

Hospital Notes: (Table 1)

The total operative time was significantly more in Group 1 with an average of 3 h (range 2.5-4 hours) than Group 2 with an average of 2.15 hours (range 1.45-3.15 hours) ($P < 0.001$). The total blood loss had an average of 580 cc in Group 1 (range 450-910 cc) and 450 cc in Group 2 (range 380-800 cc) ($P < 0.001$). The average postoperative hospital stay was 4.5 (range 3-7) days in Group 1 and an average of 3.5 (range 2-5) days in Group 2 ($P < 0.001$).

Clinically: (Table 2)

The average Oswestry Disability Index and Visual Analogue Scale showed better improvement

Group 1 than in group 2.

Radiologically: (Table 3)

Plain X-rays obtained preoperatively, immediate postoperatively and at the last follow up were analyzed by an independent radiologist. In Group 1, anterolisthesis improved from an average of 69% to 16% while in Group 2, it improved from an average of 64% to 19% at final follow up. Other parameters including improvement in disc space height, lumbar lordosis and angle of slip showed better improvement in Group 1 than group 2. Radiographic fusion was confirmed based on the presence of at least 4 of the following criteria: trabecular bone crossing the disc space from one vertebral end plate to the other, complete obliteration of the disc space, continuous trabecular bone throughout the intertransverse fusion mass, the absence of radiolucent lines around the pedicle screws, no loosening or breakage of implants. The overall fusion rate was 94% in Group 1 and 88% in Group 2.

Complications:

In group 1, one patient had a dural tear that was successfully repaired. One patient experienced a transient weakness in the left ankle; it fully recovered within 4 months. Where in group 2, two patients had implant failure requiring revision. One patient had deep infection which required a formal debridement. One patient experienced weakness in the right ankle.

Table 1. Hospital notes

Hospital Notes	Group (1) (TLIF)	Group (2) (PSF)
Operative time (average)	3 h	2.15 h
Blood loss (average)	580 cc	450 cc
Hospital Stay (average)	4.5 d	3.5 d

Table 2. Clinical Outcome

Clinically	Group (1) (TLIF)	Group (2) (PSF)
ODI (average improvement)	69%	64%
VAS (average improvement)	78%	72%

Table 3. Radiological Outcome

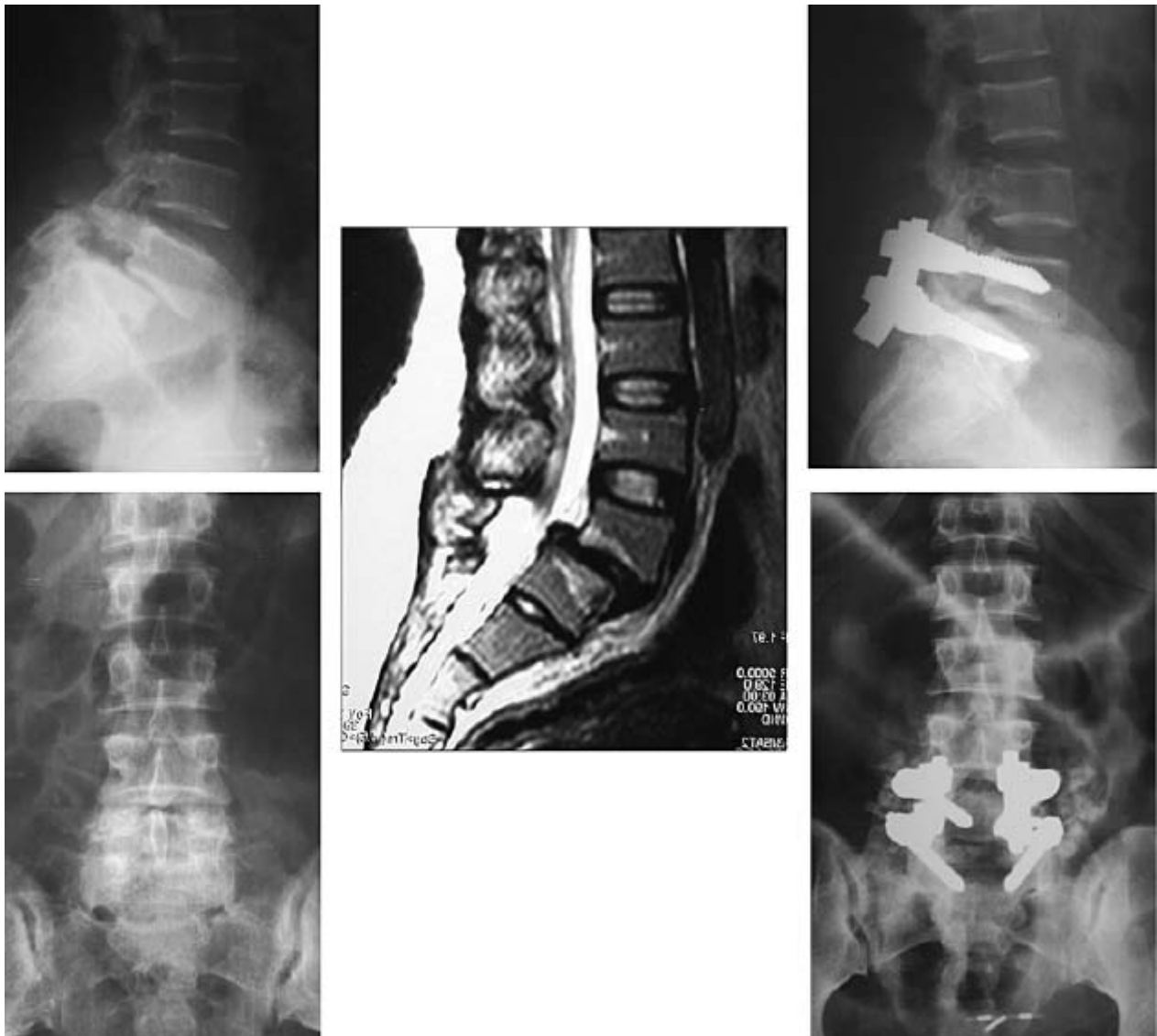
Radiologically	Group (1) (TLIF)	Group (2) (PSF)
Anterolisthesis (average improvement)	53%	45%
Disc space height (average improvement)	23%	18%
Lumbar lordosis (average improvement)	17%	12%
Angle of slip (average improvement)	19%	14%
Fusion Rate	94%	88%

Figure Legends

Figure 1. A 23 year old female who underwent TLIF for a L5/S1 grade 3 spondylolisthesis; including pre-op X-rays, MRI and X-rays at final follow-up.



Figure 2. A 31 year old female from group 2; including pre-op X-rays, MRI and X-rays at final follow-up.



Discussion

Spondylolisthesis was first described in the middle of the 18th century; later in the nineteenth century, this condition was related to a defect in the pars interarticularis, a condition that is referred to as spondylolysis. Isthmic spondylolisthesis is further subdivided into three subtypes: A, B and C.⁸ Type A is defined as a lytic stress fracture that results from repetitive stress to the region of pars interarticularis. Type B is characterized by elongation of the pars interarticularis, while type C is usually due to acute pars fracture.

Patients with isthmic spondylolisthesis usually present with back pain which may be referred to the buttocks and sometimes radiating to below the knee. Patients with low grade slips (I or II) are usually treated conservatively, while most of those with high grade slips (III or IV) are treated

operatively. A number of different approaches have been advocated, from in-situ posterolateral fusion with or without instrumentation, anterior-posterior fusion, decompression and posterior interbody fusion, posterior reduction or combined anterior and posterior reduction for high grade slips.

Posterolateral fusion in situ has been the gold standard treatment.⁵⁻⁶ The technique is associated with increased risk of postoperative slip progression even in the face of solid fusion especially with high grade isthmic spondylolisthesis due to shear forces and tension on the fusion mass.¹⁻²

Posterior Lumbar Interbody Fusion (PLIF) provides 360° spinal fusion via a single posterior approach, thus decreasing the operative time and avoiding the complications associated with simultaneous front and back approaches.^{20,22}

Nevertheless, the standard PLIF requires significant bilateral retraction on the thecal sac and nerve roots. As a result, it is associated with higher risks of CSF leak, nerve root injury, and epidural fibrosis.¹⁶

Harms described the TLIF technique, in which bone graft and titanium cage are placed via a posterolateral transforaminal route into a distracted disc space¹¹, it involves exposing only the ipsilateral neural foramen and, since a complete facetectomy is performed, less neural retraction is required, leading to a lower incidence of neurologic injury.¹⁹

There is now growing evidence supporting the efficacy of TLIF in the treatment of spondylolisthesis, however the technique has one potential disadvantage is that by performing a total facetectomy unilaterally, the spine is significantly destabilized.^{12,14} Most authors reported on the use of TLIF in the treatment of lumbar spinal instability, however, their studies included both degenerative and lytic spondylolisthesis. Lowe and Tahermia¹⁷ evaluated the results of patients operated by the TLIF technique; 23 patients had degenerative instability while 13 had pars defects. Radiological fusion was demonstrated in 95% of the cases. The clinical result was good to excellent in 88% of the patients. Two patients had pseudo-arthrodesis and one had transitory neuropraxia.

Lauber et al¹⁵ evaluated the results of TLIF in degenerative and isthmic lower grade spondylolisthesis; the medium of ODI in all patients decreased from 23.5 to 13.5 points, the radiographic fusion rate was 94.8%, sagittal translation was reduced from 23% to 15%.

It is important to emphasize that the previously mentioned studies included low grade slips; to the best of our knowledge, the use of TLIF in high grade slips was seldom reported. In our study, a significant improvement in pain and function was observed in our patients who all had high grade spondylolisthesis treated with TLIF, these patients also showed a higher rate of fusion. Complications in the TLIF group were also significantly less which coincides with the literature; Humphreys et al¹² made a comparative study of 34 PLIF with 40 TLIF cases. There were no complications with the TLIF patients, however, with PLIF, there were 4 cases of radiculitis, 1 case of broken hardware, 1 case of screw loosening, 2 cases of screw removal, 1 nonunion requiring additional fusion, and 1 superficial wound infection; Rosenberg and Praveen²³ had 1 major complication in 22 patients treated with TLIF.

Conclusion

Direct-instrumented reduction and TLIF is an efficient option to treat high-grade isthmic spondylolisthesis. It provided immediate stability and superior clinical and radiological outcomes.

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الملخص العربي

مقدمة: توجد اختلافات حول تحديد أكثر النهج ملائمة لعلاج الانزلاق الفقاري مرتفع الدرجة، ويرتبط الاندماج بين الفقرات الكلاسيكي مع درجة كبيرة من المضاعفات.

الغرض: إن الهدف من هذا العمل هو تحديد سلامة وفعالية الاندماج بين الفقرات من جانب واحد في علاج الانزلاق الفقاري البرزخي مرتفع الدرجة.

تصميم الدراسة: مستقبلية عشوائية بين عامي ٢٠٠٠ و ٢٠٠٨

عينة المرضى: ٤٤ مريض يعانون من الانزلاق الفقاري البرزخي عالي الدرجة (النوع الثالث والرابع). كان متوسط العمر ٢٤ عام وكان جميع المرضى يعانون من الام شديدة في الظهر والأطراف فشلت فيها العلاج التحفظي.

النتائج المقيمة: إجمالي فقدان الدم، الوقت المستغرق في الجراحة، البقاء في المستشفى. تم تقييم النتائج السريرية وجرى تقييم الالتئام باستخدام الأشعة العادية.

الوسائل: تم عمل توسيع محدود للقناة العصبية والتثبيت الخلفي. في المجموعة الاولى تم عمل اندماج بين الفقرات من جانب واحد أما في المجموعة الثانية تم عمل ترقيع خلفي. تم متابعة الحالات لمدة متوسطها ٤,٥ عام .

النتائج: تحسن متوسط مؤشر العجز أوسويستري ومقياس التناظرية البصرية بشكل ملحوظ في المجموعة ١. في المجموعة ١ تحسن الانزلاق الفقاري من متوسط قدره ٦٩ % إلى ١٦ % بينما في المجموعة ٢ تحسنت من متوسط قدره ٦٤ % إلى ١٩ % في المتابعة النهائية. المعلمات الأخرى بما في ذلك تحسين ارتفاع مساحة القرص القطني وزاوية الانزلاق كانت أفضل بكثير في المجموعة ١. لم يكن في المجموعة ١ فشل في المفروسات ومعدل الاندمج الكلي كان ٩٤%. في المجموعة ٢ كان متوسط الوقت الجراحي، وفقدان الدم والبقاء في المستشفى أقل بكثير ولكن اثنين من المرضى عانوا من فشل في المفروسات تطلب المراجعة والمضاعفات عموما كانت في ٦/٢٣ مرضى.

الاستنتاج: الاندماج بين الفقرات من جانب واحد هو خيار فعال لعلاج الانزلاق الفقاري البرزخي مرتفع الدرجة وأظهر تفوق في النتائج السريرية والإشعاعية.