

Surgical Outcome of Minimally Invasive Transforaminal Lumbar Interbody Fusion

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Abstract

Back Ground Data: Minimally invasive transforaminal lumbar interbody fusion (MTLIF) has become increasingly popular arthrodesis procedure. It is preferred to treat mechanical back pain due to the advantage of obtaining a circumferential arthrodesis via a unilateral approach with minimal retraction of neural elements.

Purpose: The purpose of this study was to describe this new surgical MTLIF using a single cage with pedicular screws and to assess the surgical outcome regarding safety, efficacy, and possible complications in the management of degenerative disorders or isthmic spondylolisthesis of the lumbar spine.

Study Design: A retrospective descriptive analytic study.

Methods: This retrospective study reviewed 16 consecutive patients who underwent minimally invasive transforaminal lumbar interbody fusion (MTLIF) using a single cage with pedicular screws from January 2008 to August 2011 for the management of degenerative disorders or isthmic spondylolisthesis of the lumbar spine. Demographic characteristics, surgical data, and functional outcome data were recorded.

Results: There were 9 males and 7 females, with a mean age of 41 years, and a mean follow up period of 15 months. Degenerative spondylolisthesis was diagnosed in 6 patients, stenosis with instability in 5, lytic spondylolisthesis in 4, and failed back surgery in 1. Clinical outcomes were assessed using a visual analog scale, patients' subjective satisfaction and the Oswestry Disability Index. The mean preoperative Oswestry Disability Index score was 51, decreasing to a mean of 17 postoperatively. The mean leg and back pain visual analog scale scores were 71 and 57, respectively, improving to means of 7 and 18. Fifteen patients (93.7%) were satisfied with the outcome of the surgery. Fifteen patients (93.7%) showed definite fusion at final follow-up. No significant complications were reported.

Conclusion: Minimally invasive transforaminal lumbar interbody fusion using a single cage with pedicular screws yielded good clinical outcomes with a low complication rate. This new technique is an effective & safe way to achieve interbody fusion. (1012ESJ017)

Key Words: Minimally invasive surgery, transforaminal lumbar interbody fusion, instrumented circumferential fusion.

Introduction

Spinal fusion remains the standard management of low back pain with lumbar segmental instability in patients who failed a comprehensive protocol of conservative treatment. Many reports in the literature stated the surgical results of the variable fusion methods¹⁶, including posterolateral fusion and lumbar interbody fusion (LIF) techniques, such as posterolateral interbody fusion (PLIF), transforaminal lumbar interbody fusion (TLIF), ALIF, and a combined posterior- anterior approach (circumferential fusion, 360° fusion)^{3,4,11,12,14,15,17,21,23,24,26,27}.

Since the introduction of posterior lumbar interbody fusion by Cloward in 1950, there has been a tendency to do circumferential fusion which can theoretically achieve a more complete stability, which in turn could enhance fusion rates^{6,21,31}. Lumbar interbody fusion provides stability to spinal levels with degenerative spondylolisthesis, supports anterior column, increases surface area for fusion leading to enhanced fusion rates over posterolateral fusion, restores disc space height and neuroforaminal area^{7,22}. TLIF was designed by Harms to address some of the disadvantageous characteristics of posterior lumbar interbody fusion such as the excessive nerve root retraction necessary to place the interbody graft, epidural scarring, and arachnoiditis³².

MTLIF has become increasingly popular when arthrodesis is chosen to treat mechanical back pain due to the advantage of obtaining a circumferential arthrodesis via a unilateral approach with minimal retraction of neural elements^{25,28,29}, and when compared to the open procedure, (MTLIF) appears to achieve similar rates of arthrodesis while minimizing iatrogenic soft tissue/muscle injury and blood loss^{9,30}. The Shorter hospital stays and decreased narcotic usage also appears to be advantages of (MTLIF)¹³.

The purpose of this study was to evaluate minimally invasive transforaminal lumbar interbody fusion (MTLIF) using a single cage with pedicular screws and to assess the surgical outcome regarding safety, efficacy, and possible complications in the management of degenerative disorders or isthmic spondylolisthesis of the lumbar spine.

Material & methods

The study included 16 patients who underwent

minimally invasive transforaminal lumbar interbody fusion (MTLIF) using a single cage with pedicular screws from January 2008 to August 2011 for the management of degenerative disorders or isthmic spondylolisthesis of the lumbar spine. There were 9 males (56.2%) and 7 females (43.7%), with a mean age of 41 years (range 29–58 years). Preoperative diagnosis was degenerative spondylolisthesis in 6 patients (37.5%), stenosis with instability in 5 patients (31.2%), lytic spondylolisthesis in 4 (25%), and failed back surgery in 1(6.2%). All 16 patients had severe back pain with radicular affection of either side of the leg. Two patients (12.5%) had progressive neurological deficit in the form of unilateral weakness of dorsiflexion. Patients had a trial of conservative treatment for average period of 7 months preoperatively (range 4–11 months) and failed to show satisfactory clinical response, they underwent detailed history taking and neurological examination. The affected levels were L4–5 in 10 cases, L5–S1 in 4 cases and L3–4 in 2 cases. The mean follow up period was 15 months (range 9–28 months). The preoperative characteristics are summarized in Table 1.

Clinical evaluation: The main parameters for the outcome were as follow: A) Pain status (back and leg), B) Functional status, C) Subjective patient satisfaction, D) Neurological outcome. Pre/postoperative clinical data were documented using clinical charts and operative reports.

Preoperative Pain status: The visual analogue scale (VAS) scores were recorded before surgery and again at latest follow-up. On a 100-mm horizontal line with 0 equal to “no pain,” and 100 equal to “very severe pain.” The mean preoperative leg pain using (VAS) score was 71 (range 59–99) and the mean preoperative back pain using (VAS) score was 75 (range 62–99).

Preoperative functional status: The functional status was assessed using the Oswestry Disability Index (ODI) before surgery and at latest follow-up. The ODI was scored on a 0–100 scale using the Oswestry Low Back Pain Disability Questionnaire. On this scale, 0-20 equates to minimal disability, 20-40 moderate disability, 40–60 severe disability, 60–80 crippled, and 80–100 bed-bound. The mean preoperative Oswestry Disability Index score was 51 (range 45-88).

Radiological Evaluation: Preoperative evaluation included standard plain radiographs; AP and lateral standing films, oblique (right and left) and lateral flexion/extension films of the lumbar spine and an

MRI scan. Postoperatively, all patients had standard plain radiographs AP and lateral films, radiographic evaluation was done at each follow up visit.

Table 1. Patients demographic and preoperative clinical characteristics

Variable		Value
Number of patient		16
Mean age (range)		41 (29–58 years)
Sex	male	9 (56.2%)
	female	7 (43.7%)
Preoperative diagnosis	degenerative spondylolisthesis	6
	stenosis with instability	5
	lytic spondylolisthesis	4
	failed back surgery	1
Conservative treatment period preoperatively		Average 7 months (range 4–11 months)
Spinal level	L3-4	2 cases
	L4-5	10 cases
	L5-S1	4 cases
Mean preop leg pain VAS score (range)		71 (range 59–99)
Mean preop back pain VAS score (range)		75 (range 62–99)
Mean preop ODI score (range)		51 (range 45-88)
Mean follow up period		15 months (range 9–28 months).

Operative technique: Under general endotracheal anesthesia and full muscle relaxation, all patients had the surgery done in the prone position on a Mayfield frame and on a radiolucent table. In some cases, positioning alone resulted in some degree of postural reduction. The back was prepped and draped in the usual manner. Using the image intensifier (C-arm), the target levels were identified and marked with a skin marker; a standard midline posterior exposure was performed far laterally at the tips of the transverse processes of the desired levels while working through an illuminated specific tubular retractor.

Pedicle screws were inserted at the desired levels through the retractor on one side and percutaneously on the contralateral side. The targeted site for decompression is sought by total excision of the pars interarticularis & inferior facet process using a small sized sharp osteotome and diamond tipped high speed drill. By excising the distal part of the superior facet above the level of the pedicle and the lateral part of the ligamentum flavum, the intervertebral foramen was clearly exposed. The exiting nerve root was then identified and protected.

Once adequate decompression was obtained, a

complete discectomy was performed; discectomy and endplate preparation were carried out until the disk space has been totally cleared of disk material down to the bony end plates which were thoroughly curetted. Bone graft was harvested from the posterior iliac crest, fashioned into small pieces and mixed with bone obtained from the posterior elements; it was then inserted into the disk space using a specially designed graft delivery tube. The bone graft was carefully impacted into the disk space along the anterior & lateral aspects of the annulus fibrosus. A cage of appropriate size was mounted on the introducer & impacted into the disk space with a trajectory of 30 - 45 degrees. The position of the ramp as well as the pedicle screws is was finally checked with the image intensifier. The pedicle screws were then compressed over the cage & firmly tightened. Intertransverse grafting was also performed. Closure was performed in layers in the routine fashion over a suction drain, Figure (1).

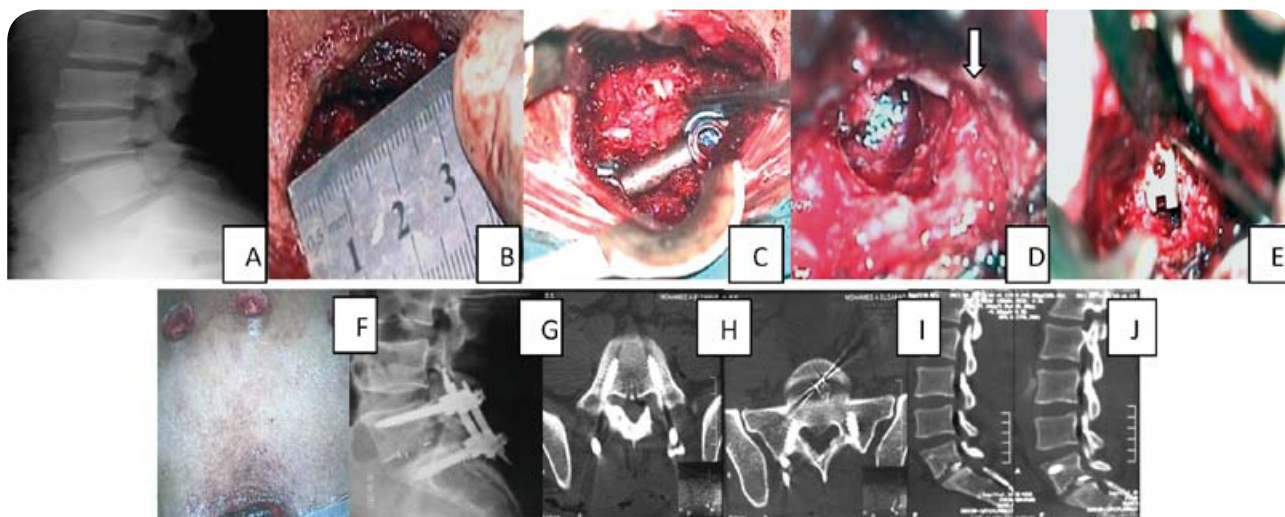
In selected cases To minimize incision size and consequent adjacent tissue injury we have made a variation by introducing percutaneous transpedicular screws on one side, while performing a small 3 cm incision of the midline to carry on with the same

above mentioned technique in applying (TLIF) cage and posterolateral screws on one side without violating the exposure of the contralateral side.

Prior to closure of the wound all the patients had intraoperative final plain X-ray films anteroposterior

and lateral views to ensure proper final position of the cage and screws. The patients were instructed to walk within the first 48hours while having a lumbosacral orthosis.

Figure 1: A) Plain X ray (lateral view) showing spondylolysis at L5/S1. B) Skin incision size (3cm) on the mini open surgery side. C) Microscopic view after one side pedicular screw insertion. D) Microscopic view of the disc space after being prepared for the implant, note the pink nerve root traversing at the upper part of the image marked by white arrow. E) Microscopic view after the cage being placed in the disc space. F) Final skin incision (3cm) on one side and the stabs for percutaneous screws on the other side (0.5 cm each). G) Plain X- ray lateral view showing the implants. H,I,J) Postoperative CT scan bone window cuts – axial and sagittal views- showing proper trajectory of the implants.



Results

The mean operating time was 151 minutes (range 110– 264 minutes). The mean estimated blood loss was 222 ml (range 135–490 ml). There was no need for blood or plasma transfusion for any case. The mean hospital stay was 5 days (range 3–8 days). All 16 patients experienced improvement of symptoms

related to radiculopathy immediately after surgery.

Pain status: The mean preoperative leg pain on (VAS) was 71 (range 59–99), improving to a mean of 7 postoperatively (range 0–28). The mean preoperative back pain on (VAS) was 75 (range 62–99), improving to a mean of 18 postoperatively (range 0–35) Figure (2).

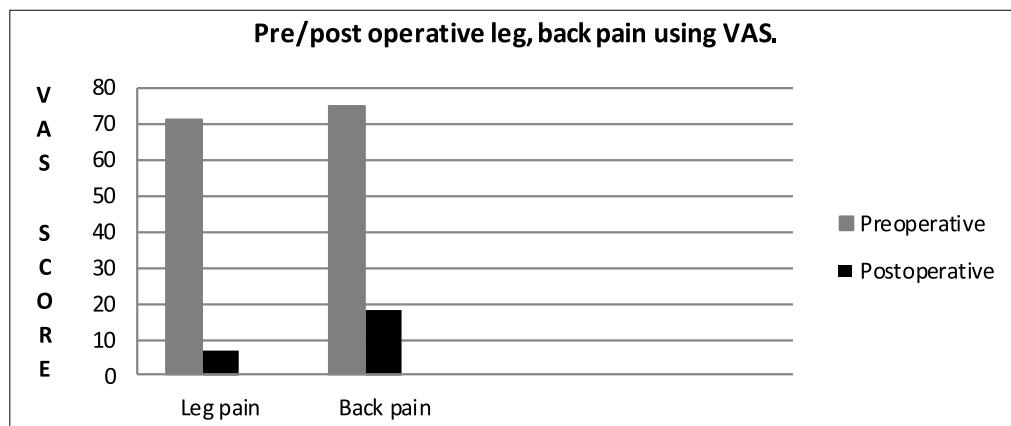


Figure 2. Comparison between pre/post operative leg and back pain using VAS.

Functional status: The mean preoperative Oswestry Disability Index score was 51 (range 45-88), denoting severe disability, while the postoperative Oswestry Disability Index score was 17 (range 3-32), denoting minimal disability.

Subjective patient satisfaction: Depending on the patients' subjective satisfaction with the overall results of the procedure and whether they would go for the same surgery again knowing the current results, nineteen patients (94%) were satisfied with the outcome of the procedure.

Neurological Status: Preoperatively, two patients (12.5%) had progressive neurological deficit in the form of weakness of dorsiflexion on one side; one patient showed complete recovery after 2 months and the other patient had partial recovery on the most recent follow up visit.

Radiological status: On their latest follow up visit, fifteen patients (93.7%) showed radiographic evidence of solid fusion evidenced by osseous continuity more dense and mature than originally achieved at surgery at the interface between the grafted bone and the vertebral end plate. One case (6.2%) showed radiographic evidence of pseudoarthrosis on the latest follow up visit evidenced by resorption of the bone graft, and a gap visible in the fusion area (2 mm or more around the entire periphery of the graft or cage).

Complications: Two patients (12.5%) had postoperative superficial wound infection. They had culture and sensitivity based antibiotics with frequent dressing and healed properly without residual deficit after 9 days from infection detection date. One patient had transient foot drop attributed to neuropraxia from manipulation on the L5 root and the condition improved completely in 21 days.

Discussion

Although (MTLIF) is a relatively new technical advancement, recent studies suggest that the procedure is as effective as open TLIF in the treatment of degenerative disc disease and/or spondylolisthesis²⁸. The decrease on the (ODI) from 51 preoperatively to 17 postoperatively denoting minimal disability, decrease in the mean preoperative leg and back pain on (VAS) from 71, 75 to 7, 18 postoperatively, (95.2%) patient satisfaction with the outcome of the procedure, (95.2) fusion rate and with a very few accepted complication rate,

all make our results comparable to the favorable outcomes reported in the literature. Schwender et al.³⁰ reported a 100% fusion rate and significantly improved outcomes in 49 patients at 1 year, with the VAS and ODI scores decreasing to 2.2 and 18, respectively, from preoperative values of 7.2 and 46. Rosenberg & Mummaneni²⁹ have reported on a series of 22 patients with a good & excellent outcome in 21 with minimal complications. Brisling & Vaccaro¹ have commented upon the lower risk of nerve tethering in TLIF compared to the more traditional PLIF.

Compared to conventional lumbar arthrodesis, the main benefit of (MTLIF) is significant reduction of muscle injury and systemic inflammatory reactions during the acute postoperative period, which has been credited with playing an important role in preventing morbidity after lumbar fusion surgery²⁰. In a meta analysis published by Wu et al.³⁴, the fusion rates for both open and (MTLIF) are relatively high and in similar ranges, while complication rates are also similar, with a trend toward (MTLIF) having a lower rate.

Karikari et al.¹⁸ reported that (MTLIF) generally show comparable or improved clinical outcomes when compared with those following open posterior lumbar interbody fusion (PLIF) techniques. Additionally, significantly less blood loss, hospital stay, and complications were generally reported, despite slightly longer duration of surgery, especially during early cases in a surgeon's experience, which again supports this new surgical technique.

Deng et al.⁸ in 2008 concluded after comparison between, lumbar interbody fusion with (PLIF) technique and (TLIF) that both provide good outcomes in the treatment of adult degenerative spondylolisthesis. Moreover, the (TLIF) procedure is simpler, safer, and as effective as the (PLIF) technique. Chad et al.² reported that the chief advantages of the (TLIF) procedure compared with the (PLIF) procedure included a decrease in potential neurological injury, improvement in lordotic alignment given graft placement within the anterior column, and preservation of posterior column integrity through minimizing lamina, facet, and pars dissection. Kim et al.¹⁹ in 2009 in a retrospective clinical data analysis comparing the (MTLIF) versus anterior lumbar interbody fusion augmented by percutaneous pedicle screw fixation did not demonstrate

significant differences in the clinical and functional outcomes between both groups. Other authors^{10,33} compared the results of (TLIF) with combined anterior and posterior fusion, and reported that TLIF had a shorter operative time, less blood loss, lower need for blood transfusion, lower need for postoperative intensive care stay, shorter hospital stay & lower hospital cost compared to single stage anterior & posterior fusion. This novel technique leaves the spine surgeon a good safe chance for a version midline structures whenever a revision surgery is needed, decreasing the complications rate related to midline exposures, also leaves a one side version if compared with (PLIF).

From our study we found the main advantages unique to the (MTLIF) using a single cage with pedicular screws are the maximization of fusion and solid spinal stability; in addition this technique preserves the posterior elements and hence reduces spinal destabilization. The manipulations and retractions on the nerve roots are minimal while accessing the neural foramina using this technique, with a less chance for scar formation. (MTLIF) has a significant shorter operative time and less blood loss compared to other interbody fusion methods. This technique gives the surgeon a chance to visualize the neural elements while gaining complete access to the disc space. There is a better chance and view angle to curette the disc space (cartilaginous end plate) to enhance fusion rate. (MTLIF) restores interbody height and proper spinal curvature, which are essential to stabilize the spine.

There are some limitations to our study that should be mentioned; the study was a retrospective, relatively small number of patients, uncontrolled review of the clinical outcomes achieved without consideration of psychosocial factors. A longer follow- up period might be necessary to prove that the parameters we used are effective factors in judging clinical outcomes. The overall outcome is encouraging, and can provide clear benchmarks for spine surgeons to adapt this technique.

Conclusion

Minimally invasive transforaminal lumbar interbody fusion (MTLIF) using a single cage with pedicular screws produced good clinical and radiological outcomes with a low rate of complications. This technique is safe and effective

in achieving good clinical and radiological outcomes. (MTLIF) has many advantages compared to other fusion techniques moreover it allows for future revision surgeries without difficulties

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الملخص العربي

الالتحام بين الأجسام القطنية بطريقة قليلة الغور عن طريق الثقب وباستخدام قفص واحد مع مسامير عنيقية: التقنية الجراحية والنتائج

الهدف: كان الهدف من هذه الدراسة لوصف الالتحام بين الأجسام القطنية بطريقة قليلة الغور عن طريق الثقب وباستخدام قفص واحد مع مسامير عنيقية لتقييم نتائج الجراحة بشأن مدى السلامة والفاعلية، والمضاعفات المحتملة في علاج الاضطرابات التآكلية أو الانزلاق الفقاري البرزخي في الفقرات القطنية. المرضى والطرق: هذه دراسة الاستعادية استعرضت ١٦ مريضاً على التوالي الذي خضعوا لعملية الالتحام بين الأجسام القطنية بطريقة قليلة الغور عن طريق الثقب وباستخدام قفص واحد مع مسامير عنيقية في مستشفى جامعة القاهرة ومستشفى ناصر المعهد خلال الفترة من يناير ٢٠٠٨ إلى أغسطس ٢٠١١ لإدارة الاضطرابات التآكلية أو الانزلاق الفقاري البرزخي في الفقرات القطنية. وسجلت الخصائص الديموغرافية، وبيانات العمليات الجراحية، والنتائج الوظيفية.

النتائج: من بين المرضى ١٦ الذين لعملية الالتحام بين الأجسام القطنية بطريقة قليلة الغور عن طريق الثقب وباستخدام قفص واحد مع مسامير عنيقية كان هناك ٩ من الذكور و٧ من الإناث، مع متوسط عمر من ٤١ سنة، ومع متوسط متابعة فترة ١٥ شهراً. تم تشخيص الانزلاق الفقاري الانحلالي في ٦ المرضى، وضيق في الفقرات مع عدم الاستقرار في ٥، والانزلاق الفقاري التحليلي في ٤، وعملية جراحية مرتجعة لعدد ١ مريض. تم تقييم النتائج السريرية باستخدام مقياس البصرية التناظرية، ورضا المرضى الذاتي ومؤشر العجز أوسويستري. وكان متوسط العجز أوسويستري قبل الجراحة ٥١ درجة، وتتناقص إلى ١٧ بعد العمل الجراحي. كان ألم في الساق والظهر باستخدام مقياس البصرية التناظرية، قبل الجراحة ٧١ و٥٧، على التوالي، وتحسن إلى ٧ و١٨. كانوا ١٥ مريضاً (٩٣.٧٪) راضين على نتائج الجراحة. وأظهر ١٥ مريضاً (٩٣.٧٪) انصهار واضح في متابعة الزيارة النهائية. لم يوجد حالات احتاجت إلى تدخل جراحي لعدم الالتحام. مضاعفات قليلة تم تسجيلها في الدراسة.

الخلاصة: أسفرت عملية الالتحام بين الأجسام القطنية بطريقة قليلة الغور عن طريق الثقب وباستخدام قفص واحد مع مسامير عنيقية نتائج سريرية جيدة مع انخفاض نسبة المضاعفات. هذه التقنية الجديدة هي وسيلة فعالة وآمنة للوصول إلى الالتحام بين جسم الفقرات.