CLINICAL ARTICLE

Transforaminal lumbar interbody fusion (TLIF): assessment of clinical and radiological outcome

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Abstract

Aim:

To assess the complications and outcome of patients who underwent transforaminal lumbar interbody fusion (TLIF) with an interbody cage.

Methods:

Fifty-two consecutive patients were reviewed retrospectively. Clinical and radiological data were collected and analysed. Thirty-three female and 19 male patients underwent the procedure with a mean age of 45.7 years (12–76 years). Eight cases were revision surgery.

The primary pathology was a lytic listhesis in 20 patients, degenerative disc disease in 17, adjacent segment disease following a previous fusion in eight, degenerative listhesis in four, a congenital abnormality (L5 hemivertebrae and segmentation failure L2-4) in two, and a neuromuscular scoliosis in one patient.

The mean blood loss was 610 ml and mean operative time 170 minutes. Mean stay in ICU or high care was 1 day, and mean hospital stay was 7.8 days.

All patients operated since 2005 were evaluated pre- and post-op using the following scoring systems: EQ 5D, Visual Analogue Scale (VAS), Roland Morris scale and Oswestry Disability Index (ODI).

Results:

There were no intra-operative complications. One patient developed a cauda equina syndrome 48 hours post-operatively when he was mobilised. This resolved completely following evacuation of the haematoma. In one case there was instrumentation failure with a rod screw disarticulation which led to failure of the posterior construct. There were statistically significant improvements in all clinical scores except the EQ 5D.

Fusion could be assessed in 47 patients. Anterior interbody fusion was achieved in 95.3% of cases and posterior lateral fusion was achieved in 83.7%.

Conclusion:

Transforaminal lumbar interbody fusion is a safe and effective option to achieve circumferential fusion. It is technically challenging and the surgeon needs to be proficient in the technique to avoid catastrophic complications. Clinical scoring confirmed that our patients did benefit significantly in terms of pain and overall health status.

Introduction

The transforaminal lumbar interbody fusion (TLIF) technique has become increasingly popular since its introduction by Harms in 1982. Its forerunner, posterior lumbar interbody fusion (PLIF) is limited to levels L3 to S1 since excessive retraction on the thecal sac at higher levels risks damage to the neurological structures. Additionally, TLIF only requires a unilateral approach and thus the contralateral facet joint and lamina can be preserved. This provides an additional surface for fusion.[1] There are only a few studies that specifically assess TLIF in terms of patient's clinical and radiological outcome[2-5] and this is the first to provide local South African data.

Posterior interbody fusion techniques have been criticised due to the additional risks of neural structure mobilisation to facilitate cage insertion. The arguments for include increased fusion rates and the ability to maintain or improve sagittal alignment.

This study aims to provide local data on a consecutive series of patients undergoing the TLIF procedure by a single surgeon, identifying the indications where the technique may usefully employed and noting complications. In addition, outcome in terms of radiological fusion rate and patient completed self-assessment questionnaires are presented.

Materials and methods

A prospective database of all patients operated upon by the senior author (RD) is maintained. This was interrogated for all patients undergoing the TLIF procedure as part of their surgical intervention between January 2004 and December 2007. Fifty-two patients were identified. A retrospective analysis was performed of their case notes and imaging. Demographics, presenting symptoms and signs and affected lumbar spinal level were noted. Radiological indications were also noted by assessment of plain films and MRI imaging. Surgical data analysis included operative time, blood loss, technique, intra-operative complications and instrumentation used. Hospital stay and ICU admission were also documented.

From June 2006 all patients completed pre-operative clinical scores. Visual Analogue Scale, Oswestry Disability Index (ODI), Roland Morris questionnaire (RM), EQ 5D and EQ slider were used. The patients were then scored again at 6 months post-op. Clinical scores pre-operatively and at 6 months post-operatively were compared. Statistical significance was assessed by using the student t test.

Pre-operative lateral lumbar spine X-rays were used to measure sagittal alignment for the specific level involved. This was then compared with post-operative lateral films at 6 months' follow-up. Fusion mass was assessed on anterior posterior (AP) and lateral post-operative films at 6 months. For patients who did not demonstrate union at 6 months continued follow-up at 6 month intervals were performed until fusion was achieved.

Technique

A midline approach was used with fluoroscopic confirmation of the level prior to incision. Patients received pre- and post-operative intravenous Cefazolin 1 gram eight hourly for 24 hours. Sub-periosteal dissection was performed and the dissection extended lateral to the transverse processes. Pedicle screws were placed with lateral fluoroscopic control prior to the decompression in order to minimise risk of neurological damage. Laminectomy and facetectomy on the symptomatic side were performed. This bone was later morsalised and used as graft. The nerve roots were identified and retracted. An annulotomy was performed and the disc removed. To aid the decompression, distracters were placed on the heads of the screws. The endplates were prepared, and morsalised auto graft was placed in the anterior disc space prior to insertion of the interbody cage. The cage was packed with morsalised graft or demineralised bone matrix depending on graft availability. On introducing the cage the distracters were released prior to rotation and anterior cage placement. The position of the cage was confirmed with fluoroscopy. The transverse processes and lateral structures were decorticated. Allograft mixed with the patient's blood was packed between and covering the transverse processes. One-eighth of an inch drain was placed and a routine closure of tissue was done. Pressure dressings were applied and the patients remained supine for 6 hours post-op to prevent a wound hematoma. Patients were mobilised on day 1 within pain limits without a brace.

Results

A total of 56 levels were operated in 52 patients. Thirty-three female and 19 male patients underwent the procedure with a mean age of 45.7 years (12–76 years). Eight cases were revision surgery. Six cases were complicated and underwent osteotomies, multiple level fusions and prolonged operative time and blood loss. In three patients L4/5 and L5/S1 were fused and one patient L2/3 and L5/S1 were fused.

The most common indication for the TLIF procedure was degenerative disc disease with a lytic listhesis (20 patients), degenerative disc disease (17 patients), degenerative listhesis (4 patients), adjacent segment disease (8 patients) and two cases of congenital hemivertebrae. In one case of a neuromuscular scoliosis that needed a long thoraco-lumbar fusion an interbody cage was placed at L5/S1 to achieve secure lumbosacral arthrodesis and prevent sacral screw pullout.

The mean blood loss was 610 ml (200–1 500; SD 291) and mean operative time 170 min (105–240; SD 35). The six complicated cases were excluded from this calculation because they involved pedicle subtraction osteotomies and multilevel fusions. Blood loss in these cases ranged between 1 500 and 7 000 ml and operative times between 240 minutes and 360 minutes.

Table I: Changes in sagittal profile

LEVEL L4/5

Patient no.	Pre-op	Post-op	Change
1	-16	-3	13
2	9	9	0
3	20	19	1
4	11	14	3
5	15	7	-8
6	15	17	2
7	18	28	10
8	18	37	19
9	21	26	5
10	22	29	7
11	30	36	6
12	30	28	-2
13	31	25	-6
Average	17.23	20.92	3.76

LEVEL L5/S1

Patient no.	Pre-op	Post-op	Change
1	20	20	0
2	18	14	-4
3	20	22	2
4	26	20	-6
5	19	14	-5
6	20	14	-6
7	15	14	-1
8	11	28	7
9	30	20	-10
10	25	21	-4
11	18	18	0
12	15	15	0
13	35	30	-5
14	25	21	-4
15	30	24	-6
16	21	30	9
Average	**21.75**	**20.31**	**1.44**

Overall, anterior interbody fusion was achieved in 95.3% of cases and posterior lateral fusion was achieved in 83.7%

Table II: Oswestry Disability Index

Domain	Pre-op	Post-op	Percentage change	p-value
Pain	2.4	1.5	33	0.02
Standing	2.9	1.6	45	0.0003
Sleep	2.2	0.9	60	0.001
Care	1.4	1.2	15	0.7
Lift	2.9	2.5	17	0.12
Walk	2.4	1.7	30	0.15
Sit	2.2	1.6	23	0.23
Social	2.1	1.5	28	0.13
Employment	2	1.7	15	0.35
Travel	1.8	1.5	17	0.23

Hospital stay on average was 7.8 days (4 to 41 days) including complicated cases. All patients spent at least the first day in ICU or high care.

There were no intra-operative complications. One patient developed a cauda equina syndrome 48 hrs post-operatively when he was mobilised. This patient was on a low molecular weight heparin at the time. This resolved completely following evacuation of the haematoma. One patient developed a wound infection subsequent to a wound haematoma. She was on low molecular weight heparin peri-operatively. The infection was treated with surgical debridement and prolonged intravenous antibiotics. This patient was admitted for 41 days.

There was one of instrumentation failure with a rod-screw disarticulation that led to failure of the posterior construct. This was particular to the instrumentation used and its use was subsequently discontinued.

Radiological follow-up was possible in 47 patients at the pre-operative and 6 months' mark. In five patients no suitable follow-up X-rays could be located. A change in sagittal profile was assessed for single levels L4/5 and L5/S1 undergoing primary surgery. This sub-group comprised 29 patients. In the complicated cases, multilevel surgery was excluded as confounding factors would be responsible for changes in the sagittal profile. At L4/5 (13) the mean gain in lordosis was 3.76 degrees (17.2 to 20.4) and at L5/S (16 patients) there was a mean loss of lordosis of 1.44 degrees (21.75 to 20.31) *(Table I)*.

Overall, anterior interbody fusion was achieved in 95.3% of cases and posterior lateral fusion was achieved in 83.7%. Non-union was noted in four patients at 6 months. Two of these patients were only followed up at 6 months before defaulting further follow-up. The other two patients were followed up for 2 years but failed to unite.

Pre- and post-operative scores were available in 25 patients from the time formal scoring was started in June 2005. The EQ 5D assesses a patient in five domains (pain, depression/anxiety, usual activities, mobility and self care) with a total possible score of 15. EQ 5D improved to 8.3 from 9.1 which was not statistically significant. The Oswestry Disability Score (ODI) assesses a patient in 10 domains (pain, standing, sleeping, sitting, socially, employment, lifting, care, walking, travelling) with a total possible score of 50. ODI improved from 44 to 32. A minimum change of 6 points are required to be of clinical significance. The 10 domains of the ODI were individually analysed and improvements in all of these were recorded *(Table II)*. On the Visual Analogue Scale (VAS) for average pain, improvement from 5.9 to 4.15. (p=0.015) were seen. On the Roland Morris questionnaire (RM) scores improved from 11.35 to 8.2 (p=0.01). The EQ slider is a sliding scale where patients can score their overall health status, where 100 would be their best overall health state and 0 their worst imaginable health state. This improved from 49 to 67 (p=0.01).

Discussion

An ongoing debate on the clinical and biomechanical advantages of an instrumented fusion continues in the wake of rising costs and an ageing population. In the UK, it is estimated that 8 000 spinal fusions were performed annually between 1997 and 2002. Similarly in the US there was a 350% increase in spinal fusions from 9 000 p.a. in 1996 to 36 000 in 2002.[6] Opponents to instrumented fusion advocate financial incentives for the rise in use of instrumentation. Zdeblick[7] showed in a prospective study that patients who underwent instrumented fusion did significantly better than in uninstrumented cases in terms of fusion and clinical outcomes. France *et al*[8] looked at instrumented vs uninstrumented fusion in a prospective study and found that instrumentation improved the fusion rate but it did not correlate with clinical outcome. Kanyana[9] *et al* assessed instrumented and uninstrumented lumbar fusion and found that instrumentation resulted in higher fusion rates at 8 weeks compared to the uninstrumented group but at 16 weeks the fusion rates were the same in both groups.

The argument in favour of a circumferential fusion lies primarily in the achievement of higher fusion rate since the interbody space allows 90% more surface area. Biomechanically interbody fusion utilises the anterior and middle column which is more important with regard to load-bearing. Additional advantages include an improved sagittal profile and restoration of foraminal height.[10,11] There are in essence three techniques available for interbody fusion: anterior lumbar interbody fusion (ALIF), posterior lumbar interbody fusion (PLIF) and transforaminal lumbar interbody fusion (TLIF).

Madan *et al*[12] found better clinical and radiological outcomes in patients with PLIF as compared to posterolateral fusions only. Humphreys *et al*[1] alluded to the advantages of TLIF vs PLIF: TLIF could be performed at all lumbar levels, and there was less thecal retraction, operative time and blood loss in TLIF cases compared to PLIF. ALIF is an alternative to TLIF but is associated with great vessel injuries as high as 1.7% and injury to retroperitoneal structures.[13] In addition, from a cost perspective, ALIF was found to be more expensive.[14]

Our results are similar to recent studies in terms of surgical data and hospital stay.[2,4]

An excellent radiological fusion rate was recorded. At the interbody level this was 95.3% and posterolaterally this was 83.7%, with only two patients who failed to unite both posterolaterally and at an anterior interbody level. Potter *et al*[2] recorded post lateral fusion rate of 93% and interbody fusion in 94% with seven patients out of 100 patients.

Sagittal alignment was also assessed pre- and post-op in a sub-group of 29 patients. At L4/5 there was a gain of 3.76 degrees of lordosis to 20.4 degrees, and at L5/S1 there was a loss of 1.44 degrees of lordosis to 20.31 degrees *(Table I)*. Neither of these were statistically significant due to a wide range; however there is clearly no loss of sagittal balance as they match the normal values of 24 degrees (range of 0 to 44 degrees) at L4/5 and 24 degrees (range of 6 to 39 degrees) at L5/S1as published.[15] Hsieh *et al*[11] compared ALIF and TLIF by looking at sagittal profile and found that ALIF is of more value than TLIF with an increase in foraminal height of 18.5% vs 0.4%, increased gain in lordosis of the disc angle (8.3 degrees vs 0.1degrees), and an increase in lumbar lordosis of 6.2 degrees vs 2.1 degrees. Loss of sagittal balance can be expected when performing a posterior fusion alone especially when distracting to increase foraminal height inducing kyphosis. Placing an interbody cage allows the surgeon to open up the foramen without sacrificing sagittal balance. As the disc space needs to accommodate the height of the cage, an extremely narrow disc space may preclude the use of this technique.

The complication rate in this study was low. There were no intra-operative complications and specifically no unintentional durotomies which is common in PLIF. This is reflected in similar studies[4,5] In a recent MRC study[6] a peri-operative complication rate of up to 36% is reported. Transient neuritis due to excessive nerve root retraction has been reported to be as high as 7%; however this has not been our experience. There have been anecdotal reports of catastrophic vascular injuries to the great vessels during decompression[16] or cage placement. Complications reported in ALIF relates primarily to great vessel injury (1.7%) with venous injury as high as 15.6%. Retroperitoneal damage can result in dyspareunia in female patients and retrograde ejaculation in male patients. These complications place TLIF favourably as the alternative option to a circumferential fusion.

The low rate of pedicle construct failure may be due to the cage shouldering the enormous shear stress on the posterior construct in cases of a high grade lytic listhesis. TLIF has also been utilised to obtain a biomechanically stronger

construct at the lumbosacral junction in correction of a neuromuscular scoliosis where forces as high as 100 Nm have been reported.[17,18]

Weiner *et al*[3] found a clinical success rate (excellent and good outcomes) in 41% (11 of 27 patients) by using the system of Macnab and later modified by McCulloch and An. Their highest success rate (50%) was in lytic listhesis. Potter *et al*[2] used the Six Item Core Set, modified North American Spine Society Lumbar Spine Outcome Instrument, RM questionnaire and VAS. They found a greater than 50% decrease in pre-operative back pain in 81% of patients and 71% of patients narcotic-free post-operatively. In contrast to Potter et al patients with degenerative listhesis had better outcomes than the lytic listhesis group. Clinical scoring was performed in a sub-group of 29 patients after June 2005. On analysis of EQ 5D there was only marginal improvement of 0.9 points (9.2 to 8.3 out of a total of 15 points). This was not significant (p=0.223). We believe the reason for this was that in each of the domains there are only three stark options and patients tend to choose the middle option (2 points) that would add up to 10 points in total. In our experience the EQ 5D did not differentiate patient outcomes. The ODI was found to be of more value. This tested 10 domains. Overall improvement was 12 points (p=0.03). A change of 6 points is required for it to be of clinical significance. Further analysis of each of the 10 domains is reflected in *Table II*. Statistically significant improvements were recorded in pain, standing and sleeping. There were statistically non-significant improvements in the other domains. VAS for general pain experienced improved by 1.75 points (p=0.015) and RM scores improved by 3.15 (p=0.01). The EQ slider improved by 36% with a p-value of 0.01.

The debate whether clinical outcome and fusion rate correlate have been raging in the literature for years.[7,8,18,19] The majority of our patients were operated for lytic listhesis and degenerative disc disease and our clinical outcomes can be regarded as good to excellent with significant improvement in all of the scoring systems that were applied. If one considers that our union rate was 95% it is clear that clinical results correlate with fusion rate.

Figure 2:
Pre-operative sagittal MRI in same patient. Note the narrow intervertebral foramen caused by the slip, and collapsed L5/S1 disc space compressing exiting L5 nerve root

Figure 1:
Pre-operative lateral lumbar spine X-ray indicating grade II lytic listhesis

Figure 3:
Post-operative view at 6 months of the same patient. Note good interbody fusion mass, improved sagittal alignment and restoration of foraminal height

Figure 4:
Patient with grade IV lytic spondylolisthesis

Figure 5:
Same patient 6 months post-operatively. The interbody cage reduces the deformity and thus protects against pedicle screw failure by reducing the shear stress

Conclusion

Transforaminal lumbar interbody fusion is a safe and effective option to achieve circumferential fusion. It is technically challenging and the surgeon needs to be proficient in the technique to avoid catastrophic complications. Clinical scoring proved that our patients did benefit significantly when looking at pain and overall state of health.

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