

Transforaminal Lumbar Interbody Fusion for Degenerative Disorders of the Lumbar Spine

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ABSTRACT

BACKGROUND: Lumbar spine arthrodesis is a commonly performed surgical procedure for the treatment of spondylosis, trauma, infection, neoplasm, and spinal instability. The transforaminal lumbar interbody fusion (TLIF) technique has become increasingly popular since its introduction by **Harms in 1982**. 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 providing an additional surface for fusion.

OBJECTIVES: The work aims to evaluate TLIF in terms of patient's clinical and radiological outcome.

PATIENTS AND METHODS: A prospective study on twenty operated upon at Neurosurgery Department, Zagazig University Hospitals during a two-year duration (from July 2013 to June 2015). Included in this study were those patients with Grade I/II spondylolithesis, failed back surgery or degenerative disc disease provided that the patient has; low back pain radiating to one or both lower limbs, disability to perform daily activities and failed conservative treatment for 6 months.

RESULTS: In our study, we found a statistically significant difference between pre and postoperative Visual analogue score as well as Oswestry disability index score as the mean preoperative back visual analogue score (VAS) of the studied patients was found to be 8., the mean preoperative visual analogue score leg of was 8.3650 and mean preoperative Oswestry disability index score (ODI) of the studied patients was 64.06. The mean postoperative back visual analogue score of the studied patients was found to be 1.05, the mean postoperative leg visual analogue score of the studied patients was found to be 1.2050 and the mean postoperative ODI score of the studied patients was improved to 18.10.

CONCLUSION: The transforaminal lumbar interbody fusion (TLIF) is an effective method in the management of degenerative disorders of the lumbar Spine.

KEY WORDS: The transforaminal lumbar interbody fusion (TLIF), neurosurgery

Introduction

Lumbar arthrodesis is a commonly performed surgical procedure for the treatment of spondylosis, trauma, infection, neoplasm, and spinal instability (**Vaccaro 2002**).

A posterolateral fusion with autologous on-lay bone graft has traditionally resulted in acceptable clinical results; however, reported fusion rates have been Inconsistent (**Dickman et al, 1992**).

With the addition of internal fixation using pedicle screw instrumentation, fusion rates have improved significantly especially in cases of instability (**Vaccaro 2002**).

Performing an interbody arthrodesis may further improve the clinical results by eliminating the disc as a potential pain generator, improving fusion rates, and restoring intervertebral height and lumbar lordosis (**Vaccaro 2002**).

Technique to achieve anterior column interbody fusion include anterior lumbar interbody fusion (ALIF), posterior lumbar interbody fusion (PLIF) or transforaminal lumbar Interbody fusion (TLIF). (**JavemickKuklo, 2006**).

Over the last decade, TLIF has become a popular technique for achieving interbody fusion. The TLIF approach may reduce the risk of iatrogenic neurologic injury when compared with PLIF and provide a circumferential arthrodesis and avoid anterior spinal exposure and its associated complications (**Mayer, 2006**).

An appropriately sized semilunar polyetheretherketone (PEEK) implant was inserted in the disk space (**Sim et al., 2010**).

Lowe and Tahernia (2005) reported on 40 patients who underwent a TLIF and demonstrated that 85% of the patients had excellent or good results in terms of pain relief, return to work, and improvement in the daily activities. Similarly, **Rosenberg and Mummaneni (2006)** concluded that TLIF is a safe and effective method of achieving lumbar fusion with a nearly 80% rate of patient satisfaction. Hackenberget al.2007 prospectively reviewed 52 patients who underwent an open TLIF with a three-year follow up. Patients had a significant decrease in the Visual Analog Scale (VAS) and the Oswestry Disability Index with an 89% fusion rate (**Hackenberg L, Halm H 2007**).

The TLIF approach may be carried out from the side that was symptomatic (**Paul et al., 2008**).

Patients and Methods

A prospective study of transforaminal lumbar interbody fusion (TLIF) on 20 patients with degenerative lumbar spine disorders operated upon at Neurosurgery Department, Zagazig University Hospitals during two-year duration from July 2013 to June 2015. Patients enrolled in this study were those having Grade I/II spondylolithesis, failed back surgery or degenerative disc disease provided that the patient has; low back pain radiating to one or both lower limbs, disability to perform daily activities and failed conservative treatment for 6 months.

All patients were preoperatively subjected to comprehensive clinical and radiological evaluation. Surgery was performed under general anesthesia in prone position, via a midline approach then transpedicular screw fixation was done followed by ipsilateral facetectomy and discectomy with preparation of the graft site and finally banana cage with the appropriate size was inserted. Patients were followed up clinically and radiologically for six months.

Statistical analysis:

The data were managed through the use of statistical package of social sciences (SPSS) version 19 (SPSS Inc., Chicago, Illinois, USA). Data were expressed as mean for quantitative variable numbers and percentages for categorical variables. Data were presented in the form of tables and graphs when appropriate.

Chi-square, Fisher exact, paired t-test, and Pearson's correlation coefficient were used when appropriate. Probability (P) value < 0.05 was considered statistically significant.

Ethical considerations:

The whole procedure was explained in a simplified manner to the patient, stressing on certain points;

- 1) Advantages and possible disadvantages of the technique.
- 2) That he can refuse to do the examination without any harm on him.
- 3) The outcome of the procedure will be used to help research purposes.

Then, a written informed consent was taken either from the patient or the one who can legally substitute him about the approval of doing the technique.

Results:

The mean age of our patients was 44.5 ± 11.4 years (range from 25 to 62 years). There were 12 males (60%) and 8 females (40%) with male to female ratio of 1.5:1.

Table (1): Age and sex of the studied patients (n= 20)

Variable	Total (n= 20)
Age	
20-30	2 10.0%
31-40	2 10.0%
41-50	10 50.0%
51-60	4 20.0%
> 60	2 10.0%
Mean age ± SD	44.5 ± 11.4 years
Age range	37 (25-62) years
Sex	
(male/female), (%)	12 / 8, 60% / 40 %
Male: female ratio	1.5:1

The mean preoperative back visual analogue score of the studied patients was found to be 8.0450 and the median score was 8. Among

our patients, the majority (15/20, 75%) had a score ranging from 7 to 8 while 2/20 patients (10 %) had scores from 5 to 6, 3/20 patients (15%) had a score from 9 to 10 and no patient had a score from 0 to 4.

Table (2): preoperative back Visual Analogue Scale (VAS) in studied patients (n=20)

Preoperative back VAS scale	Results	
Mean score	8.0450	
Median score	8	
St deviation	0.55581	
Vas score range	No	%
0-2	0	0
2-4	0	0
5-6	2	10
7-8	15	75
9-10	3	15

The mean preoperative leg visual analogue score of the studied patients was found to be 8.3650 and the median score was 8.500. Among our patients, the majority (14/20, 70%) had a score ranging from 7 to 8.

Table (3): preoperative leg Visual Analogue Scale (VAS) in studied patients (n=20)

Preoperative leg VAS scale	Results	
Mean score	8.3650	
Median score	8.500	
St deviation	0.46484	
Vas score range	No	%
0-2	0	0
2-4	0	0
5-6	2	10
7-8	14	70
9-10	4	20

The mean preoperative ODI score of the studied patients was 64.06. Among the studied patients; 11/20 patients (55%) had

severe disability, 7/20 patients (35%) were crippled, 2/20 (10%) patients had moderate disability, while none of our patients had a mild disability or were completely bed ridden.

Table (4):preoperative Oswestry disability index (ODI) in studied patients (n=20)

Preoperative Oswestry disability index	Results	
Mean	64.06	
Median	59.500	
St deviation	4.48	
ODI score	No	%
Mild disability (0-20)	0	0
Moderate disability	2	10
Severe disability (41-	11	55
Crippled (61-80%)	7	35
Bed-bound (81-100%)	0	0

Radiological investigation of our patients showed that 15/20 patients (75%) had lytic spondylolithesis, 3/20 patients (15%) had recurrent disc herniation, 1 patient (5%) had degenerative spondylolithesis and 1 patient (5%) had canal stenosis & recurrent disc. Single level pathology was found in (18/20, 90%) patients while double level pathology was found in (2/20, 10%) patients. A highly significant statistical difference was found between pre and postoperative visual analogue and Oswestry disability index (ODI) scores

Table (5): Comparison between pre and postoperative visual analogue (VAS) score

VAS Score	Mean	Std. Deviation	T-test	P-Value
Pre VAS back	8.04	0.55	67.264	0.0001**
Post VAS back	1.05	0.502		
Pre VAS leg	8.36	0.46	65.737	0.0001**

Post VAS leg	1.20	0.342		
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** = highly significant p value

Table (6): Comparison between pre and postoperative ODI score

ODI Score	Mean	Std. Deviation	T-test	P-Value
Preop ODI	64.06	5.61	17.328	0.00**
Postop ODI	18.1	1.524		

** = highly significant p value

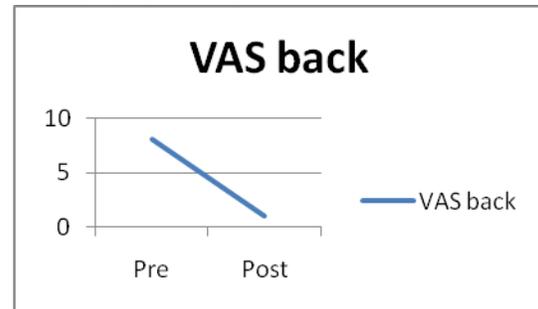


Figure (1): comparison between pre and postoperative VAS back score

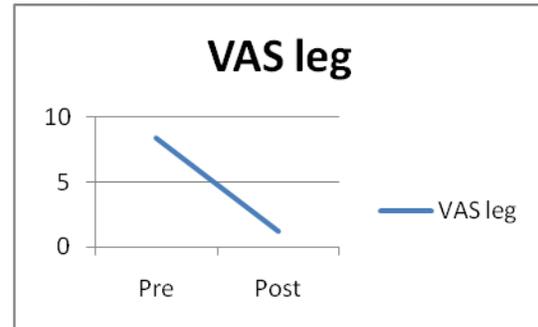


Figure (2): comparison between pre and postoperative VAS back score

Discussion:

Lumbar spine arthrodesis is a commonly performed surgical procedure for the treatment of spondylosis, trauma, infection, neoplasm, and spinal instability. The transforaminal lumbar interbody fusion

(TLIF) technique has become increasingly popular since its introduction by **Harms in 1982**. 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 providing an additional surface for fusion.

Because there are only few studies that specifically assess TLIF in terms of patient's clinical and radiological outcome, this prospective study was performed. Twenty patients were recruited for this evaluation and operated upon at Neurosurgery Department, Zagazig University Hospitals during a two-year duration (from July 2013 to June 2015). Included in this study were those patients with Grade I/II spondylolithesis, failed back surgery or degenerative disc disease provided that the patient has; low back pain radiating to one or both lower limbs, disability to perform daily activities and failed conservative treatment for 6 months. The mean age of our patients was 44.5 ± 11.4 years (range from 25 to 62 years). There were 12 males (60%) and 8 females (40%) with male to female ratio of 1.5:1.

All patients were preoperatively subjected to comprehensive clinical and radiological evaluation. Surgery was performed under general anesthesia in prone position, via a midline approach then transpedicular screw fixation was done followed by ipsilateral facetectomy and discectomy with preparation of the graft site and finally banana cage with the appropriate size was inserted. Patients were followed up clinically and radiologically for six months.

In our study, we found that the mean preoperative back visual analogue score

(VAS) of the studied patients was found to be 8.0450 and the median score was 8. Among our patients, the majority 15 patients (75%) had a score ranging from 7 to 8 while 2 patients (10 %) had scores from 5 to 6, 3 patients (15%) had a score from 9 to 10 and none of our patients had a score from 0 to 4.

In the study of **ZhangKai et al (2014)** on 34 patients, they reported a mean preoperative VAS back of 8.1 ± 0.7 . Similarly, **Guangfei et al., (2014)** reported a score of 7.4 ± 1.0 which are close to our figures.

In our study, the mean preoperative visual analogue score leg of the studied patients was found to be 8.3650 and the median score was 8.500. Among our patients, the majority of patients (70%) had a score ranging from 7 to 8 while 2 patients (10 %) had scores from 5 to 6, 4 patients (20%) had a score from 9 to 10 and none of our patients had a score from 0 to 4.

In agreement with our results, **Zhang Kai and coworkers (2014)** found the mean preoperative VAS leg to be 7.1 ± 1.3 . Also **Guangfei et al., (2014)** reported a mean preoperative VAS leg of 7.7 ± 0.9 .

In our study we found that the mean preoperative Oswestry disability index score (ODI) of the studied patients was 64.06. Among the studied patients; 11 patients (55%) had severe disability, 7 patients (35%) were crippled, 2 (10%) patients had moderate disability, while none of our patients had a mild disability or were completely bed ridden.

In 2008, **Paul and coworkers** performed their study on transforaminal lumbar interbody fusion in 40 patients with mean preoperative ODI score of 49.4 ± 15.2 . **Sim et al (2010)** found in their study that the mean preoperative ODI score was 61.7 ± 13.2 . In literature, the mean preoperative ODI score ranged from 37 to 66 as reported by numerous authors (**Humphreys et al., 2001; Salehi et al., 2004; Potter et al., 2005; Weiner et al., 2006; Hsieh et al., 2007;**

Wu et al., 2008; Shunwu et al.,2010; Villavicencio et al., 2010; Lau et al., 2011; Young et al., 2014 and Zhang Kai et al., 2014)

Radiological investigation of our patients showed that 15 patients (75%) had lytic spondylolithesis, 3 patients (15%) had recurrent disc herniation, 1 patient (5%) had degenerative spondylolithesis and 1 patient (5%) had canal stenosis & recurrent disc. Single level pathology was found in 18 patients (90%) patients while double level pathology was found in 2 patients (10%) patients.

In agreement with our results, **Paul et al (2008)** performed their study of TLIF on 40 patients; 30 patients carried a diagnosis of degenerative spondylolisthesis and the remaining 10 had isthmic spondylolisthesis. Thirty-two patients had a Meyerding Grade I spondylolisthesis, whereas 8 had a Grade II slippage. Single level pathology was found in 38 patients (95%) patients while double level pathology was found in 2 patients (5 %) patients.

Also, **Jacobsohn(2009)** studied TLIF on 52 patients; the primary pathology was a lytic listhesis in 20 patients, degenerative disc disease in 17, adjacent segment disease following a previous fusion in 11, degenerative listhesis in 4 patients.

In our study the mean operative time of the studied patients was found to be 174.5 minutes and the median was 180 minutes. The longest operative time was 220 minutes and the shortest was 140 minutes.

In agreement with our study, **Guangfei et al., (2014)** who reported operative time 186.6 ± 23.4 , **Young Seok Lee et al (2014)** who reported operative time 128.83 ± 33.23 min and **Zhang Kai et al (2014)** who reported operative time 257 min.

The mean operative blood loss of our studied patients was found to be 280.5 cc and the median was found 250 cc. The maximum amount of blood loss was 700 cc and the minimum was 180 cc.

Similarly, **YoungSeokLee et al (2014)** had a mean blood loss of 253.83 ± 104.75 mL, **Guangfei et al (2014)** had a mean blood loss of 476.3 ± 176.2 and **Zhang Kai et al (2014)** had a mean blood loss of 546 which is within our range.

To avoid the excessive blood loss we should use hypotensive anesthesia. Also, the excessive preoperative use of Non-steroidal anti-inflammatory drugs which should be stopped a week before surgery.

Our mean postoperative hospital stay of the studied patients was found to be 3.35 days and the median was found 3 days. The maximum time of hospital stay was 5 days and the minimum was 2 days which was in agreement with **Guangfei et al (2014)** which was 7.1 days and **Zhang Kai et al (2014)** which was 3.7days.

The mean postoperative back visual analogue score of the studied patients was found to be 1.05 and the median score was 1. Among our patients, the majority 18 patients (90%) had a score ranging from 0 to 2 while 2 patients (10 %) had scores from 2 to 4 and none of our patients had a score from 5 to 10.

Our mean postoperative back VAS was in agreement with , **Zhang Kai et al (2014)** the mean postoperative back VAS was 2.3 ± 0.7 and **Guangfei et al., (2014)** was 1.8 ± 0.6

The mean postoperative leg visual analogue score of the studied patients was found to be 1.2050 and the median score was 1.2000. Among our patients, the majority 19 patients (95%) had a score ranging from 0 to 2 while

1 patients (5%) had scores from 2 to 4 and none of our patients had a score from 5 to 10.

In agreement with our study, **Zhang Kai et al (2014)** the mean postoperative leg VAS was 2.2 ± 0.9 and **Guangfei et al., (2014)** was 1.8 ± 0.7

In our study, the mean postoperative ODI score of the studied patients was improved to 18.10. All patients had mild disability.

The mean postoperative ODI of our study was compared to **Guangfei et al (2014)** which was improved to 15.9, **Lee et al (2014)** which was improved to 11.85 and **Zhang Kai et al (2014)** which was 21.8

In our study all patients were followed up for 12 months to assess the fusion rate where we found that 95% of our patients attained a solid fusion

In the study of Kai et al., (2010), they reported a solid fusion in 65.2% (20 patient out of 21). Also, **McAfee et al., (2005)** reported a solid fusion in 82% and **Zhang Kai et al (2014)** reported a solid fusion in 90.29% which are comparable to our result.

In our study intraoperative complications occurred in one patient in the form of dural tear which was repaired intraoperatively

Rosenberg and Mummaeni (2001) reported incidental dural tear in one patient, repaired but followed by cerebrospinal fluid leak that necessitated a second operation for dural repair and reinforcement by fibrin glue. **Zhou et al., (2011)** reported two cases of dural tear that needed no further surgery after repair. **Ould-Sliman et al., (2011)** reported 3 cases (7%) of dural tears. **Wang et al., (2011)** reported 5 cases of dural tears. **McAfee et al., (2005)** reported 7 dural tears (of 120 patients) during cage insertion and nerve root decompression.

One patient was complicated with partial weakness in L 5 myotome which is improved within 3 months.

Rosenberg and Mummaneni (2001) reported one case of postoperative L5 motor weakness that resolved spontaneously within 6 months. Two patients were complicated with tingling and numbness. **Chen et al., (2009)** reported 3 cases of transient radiculopathy that resolved spontaneously.

In this study, we found a statistically significant moderate positive correlation between patient age and the postoperative ODI index where younger patients had lower ODI scores and better results. Also, a statistically significant difference in postoperative ODI score was found between smokers and non-smokers where non-smokers had lower scores with better improvement after surgery. Similar statistical findings were also reported by **Guangfei et al., (2014)**, **Zhang Kai et al (2014)** and **YoungSeokLee et al (2014)** in their studies.

In our study, we found a statistically significant difference in postoperative ODI score was found between patients having Spondylolisthesis and those having Canal stenosis and recurrent disc herniation as lower scores were found in the canal stenosis and recurrent disc herniation patients. Our results in this regard agree with numerous previous studies including **Wu et al., 2008**; **Jacobsohn(2009)**, **Shunwu et al.,2010**; **Lau et al., 2011**; **Young et al., 2014** and **Zhang Kai et al., 2014**

Conclusion

In this study we have evaluated the clinical and radiological results of twenty patients who underwent TLIF. At 12 months follow up, (19) patients (95%) have attained solid fusion, (18) patients (90 %) had excellent clinical outcome and (2) patients (10 %) had good clinical outcome.

Improved functional outcome is more difficult to assess. However, functional outcome is more related to patient selection and decompression.

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التئام اجسام فقرات العمود الفقري القطنية باستخدام دعامة من خلال الثقب الفقاري لعلاج اضطرابات الفقرات العمود الفقري القطنية

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إن عملية سمكرة ما بين جسم الفقرات من خلال الثقب الفقاري القطني عملية آمنة وبديل جيد لعلاج حالات
الأم أسفل الظهر نتيجة التآكل بين الفقرات والتي تشمل حالات الإنزلاق الغضروفي وحالات الضيق في القناة
العصبية وحالات التزحزح بين الفقرات وحالات فشل الجراحة السابقه في العمود الفقري وتعطي نتائج رائعة
في حالات التزحزح بين الفقرات حتي الدرجة الثانية من التزحزح . ويحدث رجوع للفقرات الي وضعها
الطبيعي بعد هذه العملية بالمقارنة بالطرق الجراحية الأخرى ومن خلال دراستنا اظهرت ان النتائج
الإكلينيكية لم تتأثر بدرجة رجوع الفقرات إلي الوضع الطبيعي وان النتائج أفضل في الحالات الأصغر سنا
ما بين ٢٥- ٤٥ سنة وأيضا في حالات عدم حدوث تآل في الغضاريف في الفقرات المجاورة
تجري هذه الجراحة بدرجة مقبولة من المخاطرة وتعطي نتائج جيدة عن طريق عملية واحدة ويعد هذا البحث
وسيلة لاثبات أن هذه الطريقة الجراحية من أهم وأمن الطرق لإجراء عملية السمكرة الكلية بين جسم الفقرات
وبالتالي من أهم الطرق لعلاج حالات التآكل بين جسم الفقرات القطنية وخاصة الحالات التي تعاني من ألم
أسفل الظهر لفترات مزمته مع وجود أو عدم وجود ضغط علي الأعصاب مع فشل كل طرق العلاج
التحفظي.

لا بد من رؤية العصب المار من خلال الثقب الفقاري القطني بوضوح وأيضا لا بد من الاستئصال الكلي
للغضروف وبالتالي تجهيز المكان الملائم للسمكرة وتركيب القفص بالوضع الصحيح وبالطبع يتم هذا ويكون
أفضل باستخدام الآلات المخصصة لهذه الجراحة. هناك خطورة من حدوث إصابات بالعصب المار من خلال
الثقب الفقاري أو حدوث إنزلاق للغضروف من الجهة المقابلة إذا لم يتم إستئصال كلي للغضروف

تعد هذه الطريقة الجراحية من السهل إتقانها بالتدرج مع إجراء الحالات ومن خلال خبرتنا في هذه الجراحة
. لم نواجهه اية صعوبات أو مشاكل في استخدام المسامير الفقارية او وسيلة للمباعدة بين الفقرات
تظهر فوائد هذه الطريقة بوضوح بالمقارنة بالطرق الأخرى للسمكرة بين جسم الفقرات في حالات التآكل بين
الفقرات عن طريق عملية واحدة وبأقل المضاعفات بشرط الإختيار الدقيق للمرضي حتي تعطي أفضل
النتائج . ومن خلال هذه الجراحة يمكن أيضا توسيع القناة العصبية وتسليك الممر العصبي وعن طريق الإستئصال
الجزئي لمفصل الفقرات ونصف الصفيحة تكون نتائج السمكرة أفضل من الطرق الأخرى وبأقل
المضاعفات وعدم الاضرار بالأعصاب أو الشد الزائد علي الضفيرة العصبية او اصابة الأم الجافية ولذلك لا بد من
إتقان هذه العملية الجراحية لكل جراحي العمود الفقري.
وخلاصة حتي تتمكن من الإستفادة من هذه الطريقة لا بد من الإختيار الصحيح للمرضي مع الأخذ في
الإعتبار الحالة المرضية و درجة العجز الوظيفي.