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Posterolateral Fusion versus Transforaminal Lumbar Interbody Fusion in the Surgical Treatment of Low-Grade Isthmic Spondylolisthesis

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Abstract

Background Data: Surgical treatment of isthmic spondylolisthesis includes decompression, fixation and bone fusion. There are different suitable techniques for fusion as (PLF) posterolateral fusion (TLIF) transforaminal lumbar interbody fusion, (PLIF) posterior lumbar interbody fusion, (ALIF) anterior lumbar interbody fusion but still controversy remains about the best technique.

Purpose: To evaluate and compare the surgical results of PLF versus TLIF with pedicle screw fixation in treatment of low-grade isthmic spondylolisthesis.

Study design: A prospective randomized clinical case series.

Patients and methods: This study included 40 patients with low grade isthmic spondylolisthesis. All patients were surgically treated by posterior decompression, transpedicular screw fixation and bone fusion. Patients were divided into two equal groups according to the type of bone fusion. Group A included 20 patients treated with PLF, and Group B included another 20 patients and were treated with TLIF. We used Visual Analogue Scale (VAS) for assess pain and the Oswestry Disability Index (ODI) to evaluate the functional outcome among our patients. Patients have been followed up for at least six months after surgery.

Results: The improvement of VAS of back pain was significantly greater in group B (TLIF) (change 5.25±1.55) than in group A (PLF) (change, 4.4±1.14) ($P<0.05$). There was no significant difference in improvement of ODI in both groups. Patients with BMI≥30 showed that group B experienced more clinical improvement than in group A in the VAS ($P=0.021$). The operative time in group B (185±24.5 min) was significantly longer than in group A (123.3±19.6 min) ($P=0.034$). Intraoperative blood loss in group B (584±192.1 ml) was significantly greater than in group A (417±182.4 ml) ($P=0.008$). The complication rate in group A (30%) was significantly less than in group B (55%) ($P= 0.032$) but broken screws (hardware failure) were more common in group A (20%) than in group B (0.0%) ($P=0.01$). The fusion rate in group B (95%) was higher than in group A (75%).

Conclusion: Our data suggest that although TLIF is better than PLF in achievement of successful bone fusion and improvement of patient's symptoms (back pain and sciatica), PLF still considered simple technique with minimal operative blood loss, less operative time and little complications**.** (2018ESJ162)

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Introduction

Spondylolisthesis is the anterior displacement of a vertebral body over another in the sagittal plane, it is referred to as isthmic spondylolisthesis if the displacement is due to a defect in the pars interarticularis.[7,8] Meyerding grading system described four grades of spondylolisthesis; grade I and II are the low grades, whereas grade III and IV are the high ones.[17] Forward slippage of the vertebra from its proper position leads to narrowing of the intervertebral foramen with pressure on the nerve root, so that low-back pain, leg pain and neurogenic claudication are the most common manifestations in patients with spondylolisthesis.[15]

Surgery for spondylolisthesis includes decompression, bone fusion and instrumentation.[24] Bone fusion can be achieved by using posterolateral fusion (PLF) or interbody fusion which further includes transforaminal lumbar interbody fusion (TLIF), posterior lumbar interbody fusion (PLIF) and anterior lumbar interbody fusion (ALIF).[3,6,9,14]

Posterolateral fusion (PLF) is usually considered simple and applicable technique with little complications, but TLIF which was first described by Harms and Rolinger in 1982,[18] has also many advantages as low risk of dural injury, neural injury and epidural scarring. Additionally, TLIF restores the disc height and lumbar lordosis.

The current study is a randomized prospective study aiming to compare the surgical results of PLF and TLIF in the treatment of low-grade isthmic spondylolisthesis.

Patients and Methods

This study included 40 patients with low grade isthmic single level spondylolisthesis (grade I and II) with a body mass index <40. All patients were surgically treated by posterior decompression, transpedicular screw rod fixation and bone fusion. Patients were admitted and operated at the department of Neurosurgery, Tanta University Hospital in the period between January 2015 and March 2017. According to the type of bone fusion and by using the envelop technique the patients were randomly divided into two equal groups: where in Group A, 20 patients underwent instrumented PLF, while in Group B, 20 patients underwent instrumented TLIF.

Clinical and neurological assessments were done in all patients. Oswestry Disability Index (ODI)[13,19] and Visual Analogue Scale (VAS)[23] for back pain were used to evaluate the preoperative functional state and disability. BMI was calculated in all patients before surgery and patients with BMI≥40 (morbid obesity) were excluded from our study.[11]

Preoperative plain lumbosacral radiography (antero-posterior, lateral and dynamic views), CT scan and Magnetic Resonance Imaging (MRI) lumbosacral spine were done for all patients. All patients signed informed consents after the detailed explanation of procedure-related risks. Patients agreed that their data would be used for scientific evaluation.

Operative Technique:

All patients were operated under general anesthesia and in prone position. A midline skin incision was made over the affected level to give a direct and proper exposure. After subcutaneous dissection, a subperiosteal dissection of the lumbar fascia and paraspinal muscles was performed to expose spinous processes, laminae and facet joints. After adequate decompression including laminectomy in group A and unilateral facetectomy in group B, polyaxial transpedicular screws (Egyfix®, Made in ARE) were inserted under fluoroscopic guidance (C-arm).

In group A: A wide lateral dissection was done to expose the transverse processes of the affected levels on both sides. The exposed bony areas were decorticated by an electric drill, then the bone chips obtained by laminectomy and iliac bone grafts were packed over the decorticated transverse processes to form a proper intertransverse process bone grafts on both sides.

In group B: The disc space was exposed on the side of unilateral facetectomy previously performed. Distraction of the disc space was performed using the pedicle screws (Egyfix®, Made in ARE) and complete discectomy was done from one side using rongeurs and disc shavers. The bone chips obtained from iliac graft was inserted to fill the anterior third of the disc space then a kidney-shaped (PEEK) cage

(Egyfix®, Made in ARE) filled with iliac bone graft was placed into the disc space.

After completion of bone fusion in both groups, the screws were tightened to lordotic rod. A closed drainage system was inserted in all patients and wound closure was performed in layers.

Post-operative Evaluation:

VAS and ODI were used to evaluate postoperative back pain as well as the functional outcome and during at least six months follow-up.

We obtained lumbosacral spine plain X-ray, including antero-posterior and lateral views in all patients within 72 hours after surgery (to evaluate the position of screws and the cage) and then repeated at 3, 6, and 12 months after operation during the follow ups (to assess construct-stability and fusion). Early postoperative lumbosacral spine MS-CT scan with sagittal and coronal reconstruction was obtained only in complicated cases. Late MS-CT scan routinely performed in all patients after 6 months.

In group A: Bone fusion was evaluated according to the Lenke classification system20 for posterolateral fusion (Table 1). Definite solid fusion and possible solid fusion were accepted as an adequate arthrodesis. In group B: The presence of osseous continuity between the graft bone and the vertebral bodies was defined as good fusion but the non-union was considered when there was a visible gap.[16]

Statistical Analysis:

Statistical analysis was performed with IBM SPSS Statistics for Windows, Version 21 (IBM Corp, Armonk, NY).

Results

In this study Group A included 20 patients with their age ranged between 28-50 years with a mean of 38.1±6.2 years. Five of these patients were males (25%) and 15 were females (75%). In this group the mean preoperative VAS for back pain was 7±1.5 and the mean preoperative ODI was 35.7±11.1. Ten of these patients (50%) had BMI<30 while the remaining 50% had BMI≥30. Spondylolisthesis grade I was found in 50% of patients and the other 50% was grade II. As regarded the level of spondylolisthesis there were 3 patients (15%) with L3-4, 11 (55%) with L4-5 slip and 6 patients (30%) with L5-S1.

Group B included 20 patients with their age ranged between 27-52 years with a mean of 39.55±6.98 years. Six of these patients were males (30%) and 14 were females (70%). In this group the mean preoperative VAS for back pain was 7.15±1.27 and the mean preoperative ODI was 53.33±9.1. Of this group, ten patients (50%) had BMI <30 while the remaining 50% had BMI≥30. Spondylolisthesis grade I was found in 50% of patients and the other 50% was grade II. As regarded the level of spondylolisthesis there were 4 patients (20%) with L3-4 slip, 10 patients (50%) with L4-5 slip and 6 patients (30%) with L5-S1 slip. (Table 2)

Preoperative data of patients in both groups were fairly homogenous and statistical analysis revealed no significant difference between group A and B in all of the preoperative data except in the ODI which was more significantly in group B (P=0.021) as shown in (Table 2).

The operative time in group A ranged between 100-165 minutes with a mean of 123.25±19.6 minutes while in group B it ranged between 150-240 min with a mean of 185±24.5 min and statistical analysis revealed significant increase in the operative time in group B than in group A (P=0.034) (Table 3). Intra-operative blood loss in group A ranged between 150-750 ml with a mean of 417±182.4 ml while in group B it ranged between 250-1000 ml with a mean of 584±192.1 ml and statistical analysis revealed significant blood loss in group B than in group A (P=0.008) (Table 3).

Assessment of the clinical outcome by using VAS for back pain was showed that in group A the mean postoperative VAS was 2.6±1.7 with a mean change of 4.4±1.14 in relation to the preoperative value while in group B the mean postoperative VAS was 1.9±1.21 with a mean change of 5.25±1.55 in relation to the preoperative value and the statistical analysis revealed that there was a significant statistical difference between the mean change of the VAS between both groups denoting more improvement in group B than in group A (P=0.05), (Table 4).

In group A the mean postoperative ODI was 19.5±9.31 with a mean change of 34.7±11.38 in relation to the preoperative value while in group B the mean postoperative ODI was 16.5±6.68 with a mean change of 37.05±10.1 in relation to the preoperative value and the statistical analysis revealed that there was no significant statistical difference between the mean change of the ODI between both groups (P=0.4), (Table 4).

Patients with BMI≥30, in group A the mean preoperative VAS for back pain was 7.2±1.55 and the postoperative was 3±2 with a mean change of 4.2±1.32; while in group B the mean preoperative VAS was 7.2±1.4 and the postoperative was 1.6±0.7 with a mean change of 5.6±1.17. There was statistically significant difference between both groups in the mean change denoting more clinical improvement in the VAS in group B than group A (P=0.021), (Table 5).

Regarding ODI in patients with BMI≥30, in group A the mean preoperative ODI was 55.2±12.8 and the postoperative was 22.8±11.01 with a mean change of 32.4±12.37 while in group B the mean preoperative ODI was 54.1±10.39 and the postoperative was 15.6±3.97 with a mean change of 38.5±8.62 without significant statistical difference between both groups regarding the change in ODI score (P=0.219), (Table 5).

Patients with BMI<30, in group A the mean preoperative VAS for back pain was 6.8±1.4 and the postoperative was 2.2±1.32 with a mean change of 4.6±0.97; while in group B the mean preoperative VAS was 7.1±1.2 and the postoperative was 2.2±1.32 with a mean change of 4.9±1.85. There was no statistically significant difference between both groups regarding the mean change in VAS (P=0.657), (Table 5).

Regarding ODI in patients with BMI<30, in group A the mean preoperative ODI was 52.2±9.4 and the postoperative was 16.2±5.9 with a mean change of 37±10.44 while in group B the mean preoperative ODI was 53±8.14 and the postoperative was 17.4±8.75 with a mean change of 35.6±11.68 without significant statistical difference between both groups regarding the mean change in ODI score (P=0.781), (Table 5).

Plain lumbosacral radiographs revealed that in group B: satisfactory fusion was reported in 19/20 (95%) of patients while non-union found in one patient (1/20, 5%). No broken screws were noticed in patients of this group. In group A: satisfactory fusion (definite solid fusion or possible solid fusion) occurred in 15/20 (75%) of patients, and definite lack of fusion in 5/20 (25%) of patients. This was associated with broken screws in 4 patients of them (4/5, 80%) and redo surgery was done in these four patients. In all patients with broken screws, calculated BMI was≥30. (Table 6)

Dural tear was reported in one patient (1/20, 5%) of group A and it was treated by primary sutures and tight closure of the wound without post-operative CSF leakage. In group B, dural tear was reported in four patients (4/20, 20%), two of them repaired intra-operatively by primary sutures without post-operative CSF leakage. In the other two patients the tear was extremely lateral and it was not amenable for intra-operative closure, so we used only fat graft to cover the tear. Post-operative CSF leakage was noticed in these two patients of group B and managed conservatively by bed rest and medical treatment.

Wound infection was reported in one patient (1/20, 5%) of group A and two patients (2/20, 10%) of group B which was managed by using proper antibiotics according to the result of culture and sensitivity test. In group B, three patients (3/20, 15%) of transient foot drop were reported and improved within 2 months after surgery by using medical treatment and physiotherapy.

The complication rate in group B was higher than in group A and the statistical analysis revealed a significant increase in the complication rate in group B than in group A (P=0.032) but broken screws (hardware failure) were more common in group A (P=0.01). The complication rate in patients of BMI≥30 (in group A: 5/20, 25% and in group B: 9/20, 45%) was significantly higher than in patients of BMI<30 (in group A: 1/20, 5% and in group B: 2/20, 10%). (Table 7)

Table 1. Lenke Classification System for Posterolateral Fusion Evaluation

Grade of Fusion	Radiographic fusion pattern
Definite solid fusion	Big, bilateral, solid, trabeculated fusion masses
Possible solid fusion	Large, unilateral fusion mass with small contralateral one
Lack of solid fusion	Bilateral, small and thin fusion masses
Definite lack of Fusion	Absorption of bilateral fusion mass or obvious pseudarthrosis

Table 2. Patients Characteristics

Parameters	Group A	Group B	P
Age (years)			
Range	28-50	27-52	0.251
Mean±SD	38.1±6.2	39.55±6.98	
Gender			
Male	5(25%)	6(30%)	0.333
Female	15(75%)	14(70%)	
VAS (Preoperative)	7±1.5	7.15±1.27	0.310
ODI (Preoperative)	35.7±11.01	53.33±9.1	0.021*
BMI (kg/m2)			
<30	10 cases (50%)	10 cases (50%)	0.321
≥30	10 cases (50%)	10 cases (50%)	0.321
Grade of spondylolisthesis			
Grade I	10 cases (50%)	10 cases (50%)	0.321
Grade II	10 cases (50%)	10 cases (50%)	0.321
Affected level			
L3-L4	3(15%)	4(20%)	0.212
L4-L5	11(55%)	10(50%)	0.218
L5-S1	6(30%)	6(30%)	0.321

Differences are considered to be statistically significant (*) if p value ≤0.05

Table 3. Surgical Time and Blood Loss in both Groups

Parameters	Group A	Group B	P value
Surgical time (min)	123.25±19.6 (100-165)	185±24.5 (150-240)	0.034
Blood loss (ml)	417±182.4 (150-750)	584±192.1 (250-1000)	0.008

Table 4. Assessment of the Clinical Outcome by Using VAS and ODI

Parameters		Group A	Group B	P value
VAS	Preoperative	7±1.5	7.15±1.27	
	Post-operative	2.6±1.7	1.9±1.21	
	Change	4.4±1.14	5.25±1.55	0.05
ODI	Pre-operative	35.7±11.01	53.33±9.1	
	Post-operative	19.5±9.31	16.5±6.68	
	Change	34.7±11.38	37.05±10.1	0.4

Differences are considered statistically significant if P value ≤0.05

Table 5. Impact of BMI on the Outcome

BMI ≥30				
Parameters		Group A	Group B	P value
VAS	Preoperative	7.2±1.55	7.2±1.4	
	Postoperative	3±2	1.6±0.7	
	Change	4.2±1.32	5.6±1.17	0.021
ODI	Preoperative	55.2±12.8	54.1±10.39	
	Postoperative	22.8±11.01	15.6±3.97	
	Change	32.4±12.37	38.5±8.62	0.219
Complications rate		5 (25%)	9 (45%)	0.001
BMI <30				
VAS	Preoperative	6.8±1.4	7.1±1.2	
	Postoperative	2.2±1.32	2.2±1.32	
	Change	4.6±0.97	4.9±1.85	0.657
ODI	Preoperative	52.2±9.4	53±8.14	
	Postoperative	16.2±5.9	17.4±8.75	
	Change	37±10.44	35.6±11.68	0.781
Complications rate		1 (5%)	2 (10%)	0.001

Differences are considered to be statistically significant if p value ≤0.05

Table 6. Fusion Rate in Both Groups

Parameters	Group A	Group B	p value
Accepted fusion	15(75%)	19(95%)	0.001
Lack of fusion	5(25%)	1 (5%)	0.001

Differences are considered to be statistically significant if p value is ≤0.05

Table 7. Complications in both groups

Parameters	Group A	Group B	p value
Dural tear	1 (5%)	4 (20%)	0.025
Wound infection	1 (5%)	2 (10%)	0.037
CSF leakage	0 (0.0%)	2 (10%)	0.01
Transient foot drop	0 (0.0%)	3 (15%)	0.01
Broken screws (hardware failure)	4 (20%)	0 (0.0%)	0.01
Total	6 (30%)	11 (55%)	0.032

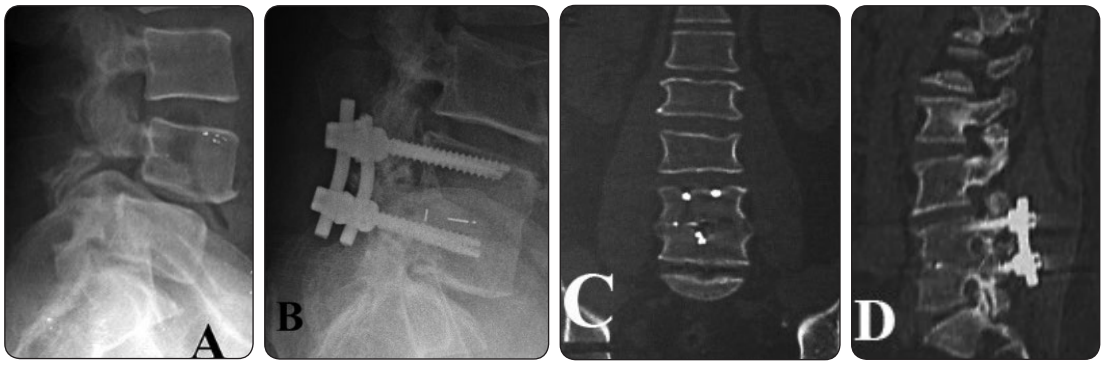

Figure 1. (TLIF Case) (A) Pre-operative plain lateral radiographs showing L4-5 isthmic slip. (B) postoperative lateral radiographs 12-month follow-up showing solid fusion. (C, D) MS-CT scan 12 months follow up showing solid fusion.

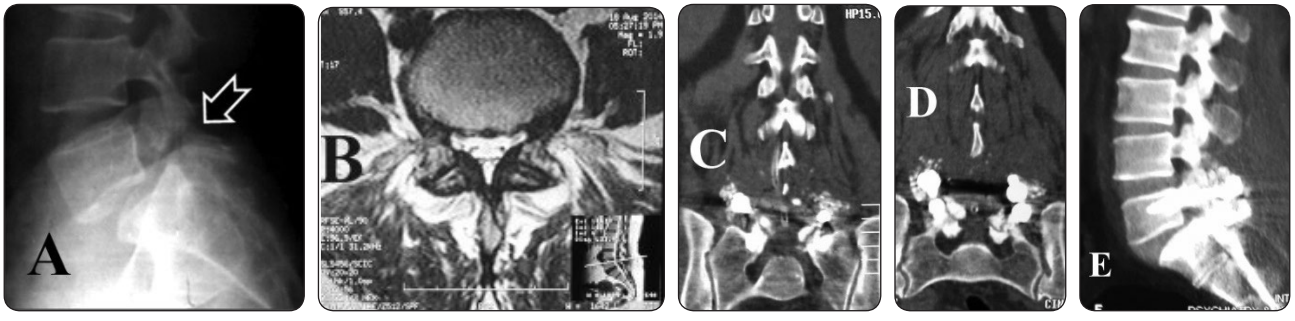

Figure 2. (PLF Case) (A) Pre-operative plain radiograph showing L5-S1 isthmic spondylolisthesis. (B) Preoperative T2 weighted axial MR images. (C, D) Post-operative coronal CT and (E) sagittal CT showing pedicle screw fixation and sound PLF.

Discussion

Fujimori et al,[16] compared the clinical and radiological results of TLIF and PLF in the treatment of spondylolisthesis and they found significant improvement in VAS for back pain in TLIF group than in PLF group, but there was no significant difference in the improvement of ODI between both groups.

In our study there was no significant difference between both groups in ODI score but the VAS for back pain was significantly improved in group B than in group A. The fusion rate was higher and successful in group B than in group A so we agree with the results of Nayak and Raghavendra,[21] as they concluded that a successful fusion usually associated with improvement in back and lower limb symptoms with better patient satisfaction.

Durate et al,[11] evaluated the impact of BMI on the clinical outcome in their study and they reported that there were no significant differences in ODI score (functional state) after surgery between the two groups (BMI≥30&BMI<30). Djurasovic et al,[10] studied the effect of BMI on outcomes of lumbar fusion and they reported that there were more common complications with high BMI.

In our study, we evaluated the effect of BMI on the functional outcome and there was no significant change in ODI after surgery for both categories of BMI (BMI≥30&BMI<30) between both groups but the rate of complications was high in patients with BMI ≥30. We found difficulty in positioning these patients on the operating table which usually associated with congestion and excessive epidural bleeding, the paraspinal dissection was not easy and deep resulting in uncomfortable surgical field. We also reported significant improvement in VAS for back pain in group B (TLIF) than in group A (PLF) in patients with BMI ≥30 and we attributed these to the advantages of interbody fusion as it usually restores the load-bearing capacity of the vertebral column, maintains the disc height, provides immediate stabilization and gives wide fusion bed to achieve proper bone fusion.[15]

In this work, the mean operative time in group A was significantly lower than in group B and the mean intra-operative blood loss in group A was also less than in group B. These findings were related to the technical aspect of TLIF as it included facetectomy with excision of the fibrocartilaginous tissue which usually adherent to the dura, evacuation of the disc space, curettage of the end-plates and proper insertion of TLIF; all of these factors resulted in prolonged surgery with more blood loss than in PLF. These results were coinciding with results of Zaater et al,[25] and Coe and Vaccaro.[5]

In the study by Bozkurt et al,[2] they did radiological and clinical comparison between PLF and TLIF techniques and they found no significant difference in the fusion rate between both techniques but this study has some limitations as lack of true randomization and relatively low number of patients in each group. Different studies reported that interbody fusion had a higher fusion rate than PLF and it was the same to our study.[1,12,16,25]

Inamdar et al,[19] compared the results of PLF (intertransverse fusion) and interbody fusion in treatment of lumbar spondylolisthesis and they reported that PLF is simple procedure with a lower complication rate. Complications related to hardware and implants (screws fractures and loosening of the implants) are more common in PLF technique.[4,22]

In our study, the complication rate in group A was less than in group B but the rate of complications related to hardware and implants (broken screws) was higher in group A than in group B.

We reported some precautions to avoid complications and to achieve good outcome in future patients include; patients should be advised for weight reduction before surgery (BMI≤30), proper patient positioning on the operating table especially patients with BMI≥30 is essential to avoid congestion and excessive epidural bleeding in addition to meticulous decompression, facetectomy and excision of the fibrocartilaginous tissue with minimal manipulation or retraction on the nerve root are useful to avoid neural injury.

Conclusion

Our data suggest that although TLIF is better than PLF in achievement of successful bone fusion and improvement of patient's symptoms (back pain and sciatica), PLF still considered simple technique with minimal operative blood loss, less operative time and little complications.

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الملخص العربي

دراسة مقارنة بين اللحام العظم الخلفى الجانبى واللحام العظمى بين الجسم الفقارى فى علاج التزحزح الفقارى البرزخى منخفض الدرجة

البيانات الخلفية: يشمل العلاج الجراحي للتزحزح الفقاري البرزخي ازلة الانضغاط والتثبيت واللحام العظمي ، لكن لا يزال هناك جدل حول أفضل تقنية للحام العظام.

الغرض: تقييم ومقارنة النتائج الجراحية للحام العظمي الخلفي الجانبي مقابل اللحام بين الجسم الفقاري في علاج الثزحزح الفقاري منخفض الدرجة

تصميم الدراسة: دراسة سريرية إستباقية لسلسلة من الحالات

المرضى والطرق: تم علاج أربعين مريضا يعانون من التزحزح الفقاري البرزخي عن طريق ازالة الانضغاط والثبيت الخلفي بالمسامير والقضبان المعدنية. تم تقسيمهم إلى مجموعتين من 20 مريض الاولي (أ) اجري لها اللحام العضمي الخلفي والثانية (ب) باستخدام اللحام بين الجسم الفقاري. تم استخدام مقياس التماثلية البصرية(VAS) ومؤشر العجز (ODI) لتقييم النتائج الوظيفية بين المرضى. تمت متابعة المرضى لمدة تصل إلى ستة أشهر بعد الجراحة.

النتائج: كان تحسن الألم أعلى بكثير في المجموعة ب حتى في تلك مع مؤشر كتلة الجسم اكبر من 30 وكان كل من وقت العملية وفقدان الدم أعلى بشكل ملحوظ في المجموعة ب .كان معدل المضاعفات أقل بشكل ملحوظ في المجموعة أ . ومع ذلك كان معدل المسامير المكسورة أكثر شيوعًا في المجموعة أ. وكان معدل الاندماج العظمي أعلى بشكل ملحوظ في المجموعة ب.

الاستنتاج: على الرغم من أن اللحام بين الجسم الفقاري أفضل من اللحام الخلفي في تحقيق اندماج العظام بنجاح وتحسين أعراض المريض ، لا يزال يعتبر اللحام الخلفي تقنية بسيطة مع الحد الأدنى من فقدان الدم ، وأقل وقتا وأقل في المضاعفات.