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Posterior lumbar interbody fusion (PLIF) Versus Inter-transverse Posterolateral Fusion (PLF) for Treatment of Lumbar Spondylolisthesis: a Comparative Study

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Abstract

Background Data: Lumbar spondylolisthesis is a common condition. Indications for surgery other than failure of conservative treatment include progressive neurological deficits, intractable and symptomatic spinal instability. Surgical options include posterior interbody fusion and posterolateral fusion.

Purpose: To compare the difference in results between lateral inter-transverse fusion (PLF) alone and posterior lumbar interbody fusion (PLIF) regarding clinical outcome and fusion rate.

Study Design: This is a retrospective randomized comparative study.

Patients and Methods: Between May 2009 and April 2014 there were 132 patients with various degrees of lumbar spondylolisthesis. Fifty eight (43.9 %) patients were treated by pedicle screws and PLIF and 74 (56.1%) patients treated with pedicle screws and inter-transverse fusion. This study included 87 female patients (65.9 %) and 45 male patients (34.1 %) with average age 52.2 (age ranged from 43-62). There were 69 patients (52.2 %) had one segment fusion and 63 cases (47.8 %) had 2 segments fusion. All patients were evaluated clinically by Japanese Orthopedic Association Score (JOAS) for preoperative and postoperative and follow-up evaluation. Radiological assessment using plain X-ray and MRI was performed for assessment before and after the procedure. Flexion and extension plain X-ray films were obtained and depended upon for confirmation of fusion/stability. The mean follow up period was 18 months.

Results: There was significant improvement in the final outcome of both groups as there mean improvement rate (IR) for Group A was 89.08±%10.6 (ranged from 60-100 %). However Group B at the final outcome had a mean IR of 81.813.8%± ranged from (45-100). Fusion rate was 82% for group A compared to 89% for group B. Patients satisfaction was 89% for Group A while in Group B 94% of patients were satisfied.

Conclusion: There were no significant differences in results between lateral inter-transverse fusion and PLIF regarding clinical outcome or fusion rate. Cost effectiveness may be considered as an important factor for decision making in treatment of degenerative spondylolisthesis. (2013ESJ063)

Keywords: Posterior lumbar interbody fusion, Posterolateral Fusion, Inter-transverse Fusion, Spondylolisthesis

Introduction

Spondylolisthesis typically occurs in adolescence possibly leading to increased deformity, pain and neurological compromise due to slip of the upper vertebral endplate, and is most commonly seen at the level of L5.[13] Degenerative lumbar spondylolisthesis is a common condition in the elderly, the main cause being disc degeneration and facet joint arthrosis.[9] Spondylolisthesis can also be caused by ligamentous laxity and trauma, and may occur at all ages with a prevalence of up to 5% of general population.[7] Indications for surgery other than failure of conservative treatment include progressive neurological deficits, intractable low-back pain associated with radiculopathy, claudication pain, and symptomatic spinal instability. The goal is to achieve spinal stabilization, fusion, and resolution of symptoms.[17] Use of instrumentation in spinal fusion operations has received increasing attention in the surgical literature, appearing as the treatment of choice because of its association with higher fusion rates as well as better clinical results.[2] Posterior lumbar interbody fusion (PLIF) technique with pedicle screw fixation has shown satisfactory clinical results, and solid fusion had been reported.[18] Interbody cage was designed to improve success rate of fusion by interbody fusion by supporting the mechanical and biologic functions of PLIF and allowing additional bone graft to grow through the cage in between the two adjacent vertebral bodies.[4]

Patients and Methods

Between May 2009 and April 2014 there were 132 patients with various degrees of lumbar spondylolisthesis 87 patients (65.9 %) were females and 45 patients (34.1 %) were males with average age 52.2 (age ranged from 43-62). There were 69 patients (52.2 %) who underwent one segment fusion and 63 cases (47.8 %) that had 2 segments fusion. Before the surgery, all patients had been suffering from disabling low back pain and/or neurological deficits with a limited walking distance caused by spinal claudication. The symptoms persisted for a minimum of 3 months of continuous conservative therapy with muscle strengthening and muscle control training. All patients underwent posterior lumbar spinal decompression and instrumented fusion for a single or multiple levels.

Patients were then divided into 2 randomly chosen groups: ***Group A:*** which included 74 patients (56.1%) 56 females (42.4%) and 18 males (13.7%) and who were treated with pedicle screws and lateral inter-transverse fusion (PLF)[7,17] (Figure 1). ***Group B***: included 58 patients (43.9 %) 27 males (20.4 %) and 31 females (23.5 %) who were treated by pedicle screws and PLIF (Figure 2,3). All surgeries were performed in (Ain-Shams University Hospitals, AL-Zahraa University. Hospital, Al-Rahmah Specialized Hospital, Heliopolis Hospital and Greek Community Hospital in Cairo) by the same surgery team. All patients had been treated either by decompression, pedicle screws fixation and intertransverse fusion (PLF) or by posterolateral Interbody fusion (PLIF). PLIF procedures were performed with various pedicle screws systems. Surgery for group B was performed according to the technique described by Brantigan and Steffee.[4]

Routine plain and standardized lateral flexion-extension radiographs and MRI were performed for all patients before surgical interference which was done only in cases with failed conservative treatment.

This study included 69 patients (52.2 %) who had one segment fusion and the 63 (47.8 %) who had 2 segment fusions. According to Myerding's scale we had 64 patients (48.5%) with grade one (GI), 42 patients (31.8%) with grade two (GII) and 26 patients (19.7 %) with GIII spondylolisthesis. All patients were clinically evaluated by the Japanese Orthopedic Association Score (JOAS) for preoperative and postoperative and follow up evaluation.

Group A clinical evaluation according to JOAS showed that the main complaint was low back pain with a mean of 1.40.4±, leg pain had a mean of 1.20.4±. The mean score for gait was 1.3±0.4, sensory disturbance mean score was 1.2±0.4, and motor disturbance had mean 1.50.5±. Regarding objective signs, SLRT had mean score preoperative 1.1±0.3 and Activity Day Living (ADL) had mean score 8.0±1.3 all data of the Group A is detailed in (Table 1)

For group B the main complaint was back pain which was also evaluated by JOAS, the back pain mean score was 1.2±0.6, for the leg pain mean score was 1.1±0.3, gait mean score was 1.2±0.4. SLRT mean score was 1.0±0.2 detailed items for JOAS is seen in Table 1. Group B including post-surgical instability in 12 cases (9.1%), this instability is well defined in the plain x-ray after standing and dynamic views.

Radiological assessment after surgery for placement of the screws and recording the level of fixation, for fusion we relied on Brantigan–Steffee criteria[4] for inter-body fusion as follow up X-rays obtained for all patients were performed at 6 months postoperative and after one year at follow up.

All data regarding blood loss operative time, and intraoperative exposure time were also recorded for both groups and compared.

Results

Clinical outcome JOAS for both groups were compared to the preoperative JOAS. Statistical analysis were calculated by SPSS version 15 software and standard statistic was recorded in addition to ANOVA, Paired T-Test, and Chi square Test were used to compare results pre- and postoperative.

Group A:

Mean JAOS for LBP in group A postoperatively was 2.892-3) 0.31±) compared to mean preoperative score 1.04±0.4 (0–2). By comparing leg pain outcome, it is markedly improved from 1.21-) 0.4± 2) mean score, to mean 2.9± 0.3 (2-3). Gait also improved from mean 1.3±0.5 (1-2) to 2.6±0.4 (2-3). (Table 2 shows all detailed results)

Regarding Improvement Rate (IR), there was significant improvement of the final outcome of the group as there is mean IR for Group A 89.08±10.6 % (60-100 %). Return to previous work and activities were recorded as fifty six patients (75.6 %) out of 74 patients who had been suffering from disabling pain before surgery had returned to their prior work and were functioning normally without needs for any medications. However 15 patients (20.2%) were able to do their previous work with some limitation of activities and sometimes needs for analgesic with excess load. Three patients (4.2%) were able to perform light work with a need for medication at most times.

Group B:

Group B, treated by PLIF, their postoperative results had been improved according to JOAS were improved regarding LBP from preoperative mean 1.2±0.6 (0-2) to postoperative mean 2.7±0.4 (2-3). Leg pain improved for all patients from mean 1.12–0) 0.3±) into mean 2.8±0.3 (2-3). Gait improved from mean 1.2±0.4 (1-3), Straight Leg Raising Test also improved from mean 1.0±0.2 (1-2) improved to mean 2.9±0.2 (2-3). Neurological deficit were improved as sensory disturbance were improved from mean 1.11-) 0.3± 2) into mean 1.81-2) 0.3±), and Motor disturbance improved from mean 1.4±0.5 (1-2) into mean 1.8±0.3 (1-2). Activity Day Living (ADL) mean was 7.34-11) 1.7±) and improved into mean 12.3±1.2 (10-14).

Table 3 has detailed postoperative data and Total score with Improvement Rate (IR).There is Improvement Rate (IR) at the final follow up of all patients which was 81.845-100) 13.8%±). Thirty eight patients (65.6 %) out of 58 patients who had been incapacitated before surgery had returned to their prior occupation and were functioning normally without pain. However 12 patients (20.6%) were able to do their previous work with some limitation of activities and sometimes a need for analgesic with excess load. Eight patients (13.8%) modified their work and their necessity for medication increased with excess work.

There is no statistical significant difference in blood loss for both groups as shown in Table *4*. Difference in operative time ranged from 40-90 min with mean 70 minutes.

Radiological Outcome:

Fusion was assessed simply by standing lateral flexion and extension films. Posterolateral fusion also was assessed and the arthrodesis was considered successful if there is bone contact in the inter-transverse space. Fused segment was considered radiographically fused if there was bone bridging over the involved disc space and no radiolucency around the cages (Table 5). There was a 82 % fusion rate in group A in comparison to 89 % in group B. Complications were recorded in both groups, pseudoarthrosis in Group A was 28 % radiologically without clinical symptoms, while Group B showed less incidence of pseudoarthrosis in 11 %. Adjacent segment stenosis occurred in 5 cases (6.7%) in Group A, while Group B had 3 cases (5.1 %) of adjacent segment stenosis. Those cases with adjacent segment stenosis were in need for additional surgical decompression and extension of fusion for more than one level. Broken rods and screws were recorded, Group A recorded 3 cases with broken rod, while Group B had 2 cases with broken rod and screws. Intraoperative dural tear occurred in 6 cases that had revision back surgery which was repaired at the time of surgery without neurological complications.

Table 1: Mean Score for Group A and B, JOAS Preoperative.

	Group A	Mean	SD	Group B	Mean	SD
LBP	74	1.0	0.4	58	1.2	0.6
Leg pain	74	1.2	0.4	58	1.1	0.3
Gait	74	1.3	04	58	1.2	0.4
SLRT	74	1.1	0.4	58	1.0	0.2
Sensory dist.	74	1.1	0.3	58	1.1	0.3
Motor dist.	74	1.5	0.5	58	1.4	0.5
ADL	74	8.0	1.3	58	7.3	1.7
Urinary dist.	74	-2.0	0.9	58	-2.0	0.8
Total Score	74	15.4	2.0	58	14.0	2.7

Table 2. Mean Postoperative JOAS Item and IR for Group A (N=74)

JOAS	Min	Max	Mean	SD
LBP post	2	3	2.9	0.3
Leg pain	1	2	1.2	0.4
Gait	2	3	2.9	0.1
SLRT	2	2	2.0	0.0
Sensory dist.	1	2	1.9	0.1
Motor dist.	1	2	1.9	0.1
ADL	11	14	12.9	1.1
Urinary dist.	-3	0	-0.8	0.4
Total Score	23	29	27.5	1.3
Improvement Rate (IR)	60	100	89.0	10.6

Table 3. Group B, Mean JOAS Postoperative Data and IR (N=58).

JOAS	Min	Max	Mean	SD
LBP post	2	3	2.7	0.4
Leg pain	2	3	2.8	0.3
Gait	2	3	2.9	0.2
SLRT	1	2	1.9	0.1
Sensory dist.	1	2	1.8	0.3
Motor dist.	1	2	1.8	0.3
ADL	10	14	12.3	1.2
Urinary dist.	-3	0	-0.2	0.7
Total Score	22	29	26.3	1.9
Improvement Rate (IR)	45	100	81.8	13.8

Table 4. Blood Loss in Both Groups.

	No.	Min	Max	Mean	SD
Group A	74	600	1600	927.9	193.7
Group B	58	800	1400	995.6	118.9

Table 5. Final Clinical and Radiological Outcome.

Evaluation points	Group A (N=74)	Group B (N=58)	P* value
Fusion rate	82%	89%	0.049
Patient satisfaction	89 %	94%	0.051
Radiculopathy Improvement	85%	89 %	0.541

*P value=analysis of difference among groups with chi square test

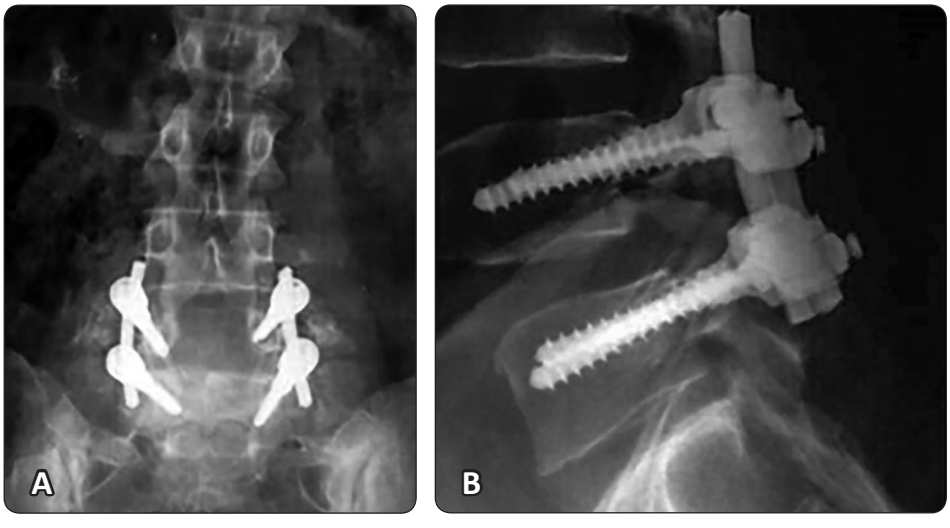

Figure 1. Plain radiographs lumbar spine (A) AP and (B) Lateral at final follow up showing spondylolisthesis L4-5 treated by wide neural decompression, posterolateral fusion and transpedicular screws fixation.

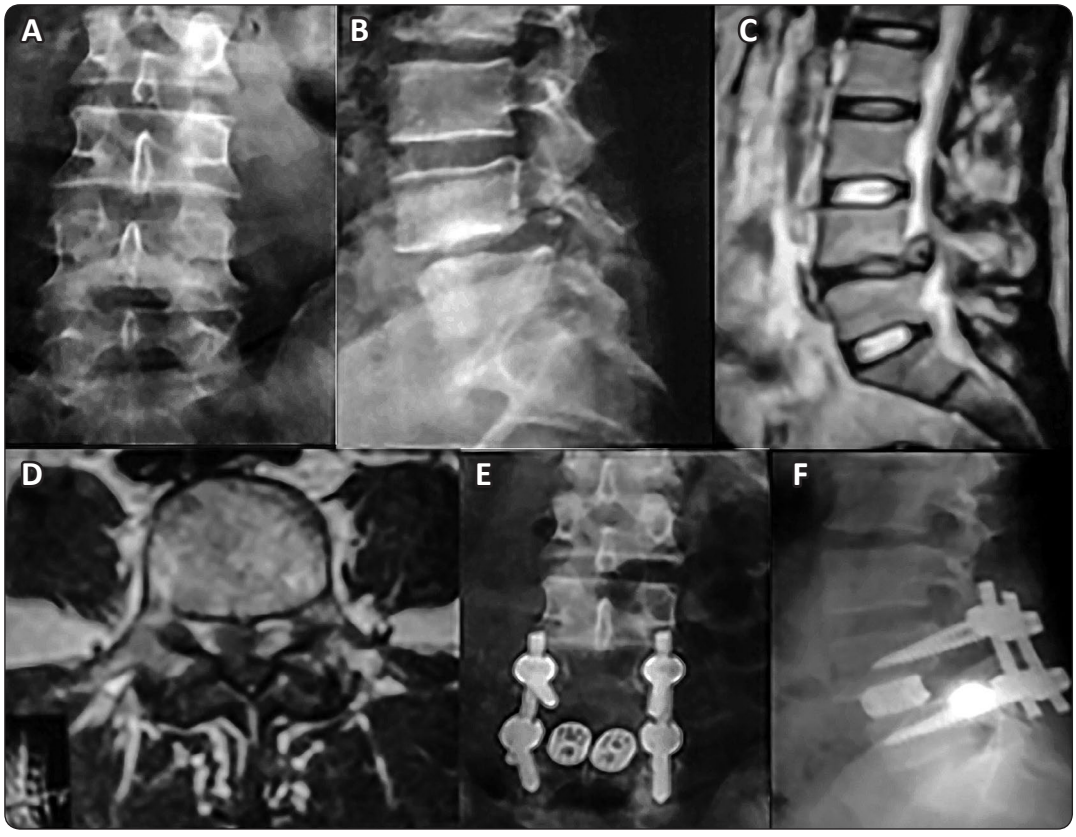

Figure 2. (A,B) standing AP and lateral plain radiographs showing spondylolisthesis L4-5 with huge degenerative disc prolapse shown at (C,D) T2 MRI sagittal (C) and axial (D) images treated by PLIF and transpedicular screws fixation as shown on AP and lateral postoperative plain radiographs (E,F).

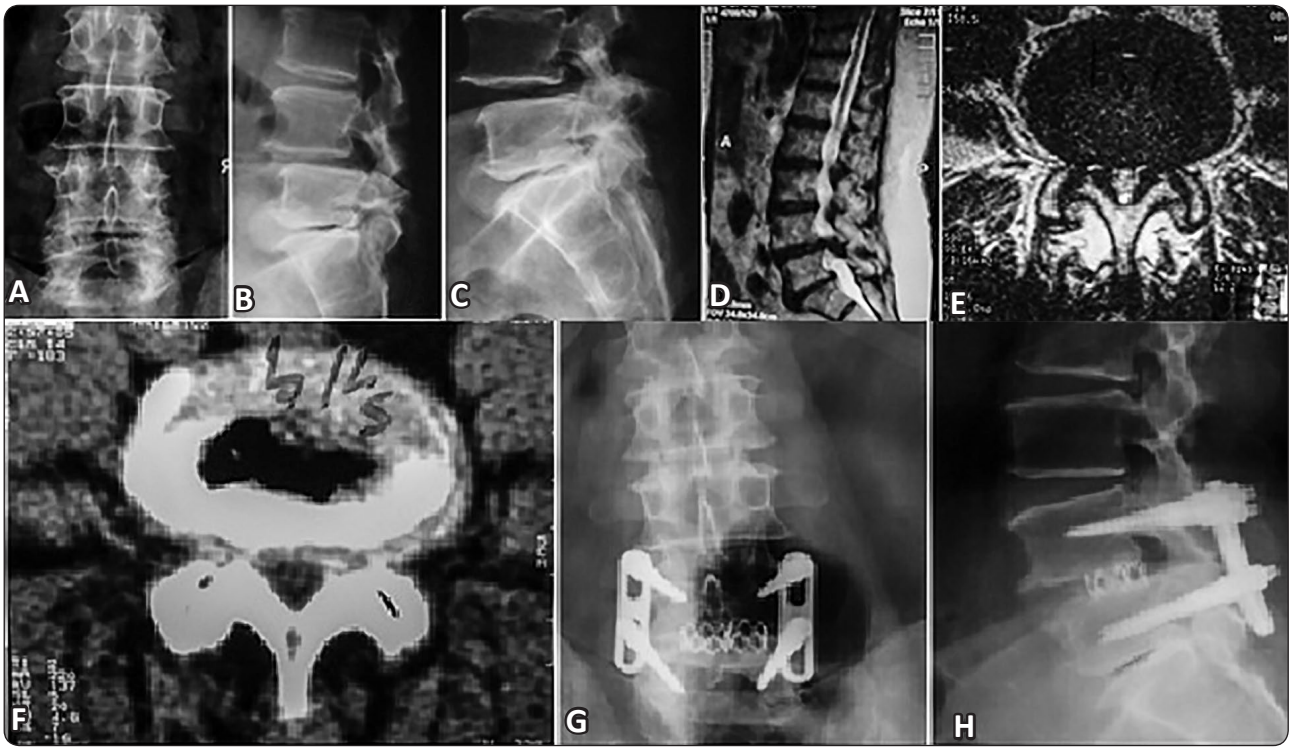

Figure 3. L4-5 degenerative spondylolisthesis treated by PLIF and transpedicular screws. (A,B,C) plain X-ray with dynamic films. (D,E) MRI T2WI sagittal and axial cuts. (F) C-T scan showing double egg shadows. (G,H) postoperative X ray with PLIF single Pyramish cage.

Discussion

Spinal fusion is a generally accepted procedure for the management of patients with a variety of spinal disorders. The success of every spine fusion procedure depends on bone healing. Bone healing process depends on many factors, including the type of graft, host factors, technique, and the rigidity of the particular surgical construct.[8]

Complete neural decompression, solid fusion and restoration of normal inter-segmental alignment in addition to preservation of normal spinal function are the goals of PLIF in the treatment of spinal instability.[10] During the last decades, PLIF has been widely used in arthrodesis for segmental instability of the lumbar spine.[5]

Most of cases Group A (74 patients) in our study with lateral inter-transverse fusion were treated by this technique as cost for PLIF may exceed the fund provided for PLIF. Cost effectiveness is an important factor for treatment of patients in the developing countries. Lee et al, 2011 stated that traditional posterolateral inter-transverse fusion still remains a useful procedure with acceptable fusion rates for most degenerative conditions.[15]

We have mean improvement rate according to JOAS for group A 81% and for group B 89.8%. There is no significant difference between results of both groups. This result is comparable to the results of posterolateral fusion reported by Agazzi et al,[1] who had reported clinical outcome 67% for 71 patients treated by PLIF, patient satisfaction 76 % and fusion rate 90%.

Although we relied on standing lateral dynamic films to evaluate fusion there is several studies to assess fusion rate in different techniques of spinal fusion.[6,11,14,15] Several investigators[16] believe that flexion-extension radiographs are a reliable indicator of fusion, but there is no consensus concerning the critical value of segmental motion for fusion failure. The pitfall of dynamic radiographs lies in the fact that the absence of any movement does not necessarily correspond with solid fusion.[14]

Kim et al,[12] reported approximately 35% of patients who have fusion after a PLIF have some bony bridging forming around the cage after 12 months. They reported also 82% of these patients have bone fusion mass in posterior vertebral cortical margin four years follow up. Patients who do not experienced fusion, bony mass can only be observed inside the cage.[12] In both groups the outcomes of the studies shows that there is no evidence of the superiority of one approach over another one in terms of the fusion rate. As the fusion rates in Group A, were82%, however Group B had 89% fusion rate.

Fogel GR et al,[6] executed their study for fusion assessment of posterior lumbar interbody fusion using radiolucent cages: X-ray films and helical computed tomography scans compared with surgical exploration of fusion. They concluded that evaluation of fusion rate either by surgical exploration, conventional X-ray, or CT methods performed after PLIF or posterolateral fusion was very similarly and there were no significant differences in accuracy between the two methods. They had results indicating that when plain films show strong evidence of fusion or pseudarthrosis the helical CT is unlikely to provide useful new information.[6]

Barbagello et al,[3] compared the effectiveness and safety of lumbar lateral interbody fusion (LLIF), with PLIF and transforaminal lumbar interbody fusion (TLIF). They found that lumbar lateral interbody fusion (LLIF) group experienced less estimated blood loss and lower mortality risk compared with PLIF group. They also concluded that there is insufficient evidence of the comparative effectiveness of LLIF versus PLIF/TLIF surgery.

Autogenous bone grafts were used for all patients in this study obtained from posterior iliac crest from the same incision. Lee et al,[15] found that there is moderate evidence suggesting no difference in fusion rate between posterolateral fusion and PLIF. They also suggested more studies to compare each single approach with circumferential fusion to determine whether a combined approach is necessary to improve the clinical results and fusion rate.

Conclusion

Instrumented lateral inter-transverse fusion is an effective method for treatment of spinal instability. There are no significant differences in results between patients treated by pedicle screws and lateral inter-transverse fusion and those treated with pedicle screws and PLIF regarding clinical outcome or fusion rate. Cost effectiveness for lateral inter-transverse fusion, time of surgery and blood

loss may be considered as an important factor when decision making for treating degenerative spondylolisthesis.

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الملخص العربي

اللحام الخلفي القطني ما بين جسمين الفقرات مقابل اللحام الخلفي الجانبي ما بين النتوء العرضي ما بين الفقرات لعلاج حالات التزحلق الفقاري القطني: دراسة مقارنة

مقدمة: التزحلق الفقاري القطني يحدث عادة في مرحلة المراهقة وقد يؤدي إلى إختلال في التركيب التشريحي الطبيعي للعمود الفقري وآلام أسفل الظهر وأعراض أخرى مرتبطة بالضغط على الأعصاب القطنية، وهو أكثر شيوعا عند مستوى الفقرة القطنية الخامسة.

الهدف: الغرض من الدراسة هو مقارنة الفرق في النتائج بين اللحام الخلفي الجانبي بين النتوء العرضي وحده، وعندما يكون مصحوب ذلك باللحام الخلفي القطني بين جسمين الفقرات وذلك بخصوص النتائج الإكلينيكية ومعدل حدوث الإنصهار المطلوب ما بين الفقرات القطنية.

الطرق: بين مايو ٢٠٠٩ وأبريل ٢٠١٤ تم عمل دراسة تشمل ١٣٢ من المرضى الذين يعانون من درجات متفاوتة من التزحلق الفقاري القطني. وقد تم معالجة ٥٨ من إجمالي عدد المرضى (٤٣,٩٪) بواسطة المسامير العنيقية مع اللحام بين النتوء العرضي و أيضا اللحام الخلفي القطني بين جسمين الفقرات و ٧٤ (٥٦,١٪) من المرضى عولجوا بمسامير عنيقية فقط مع اللحام بين النتوء العرضي. وقد شملت هذه الدراسة ٨٧ مريضا من الإناث (٦٥,٩٪) و ٤٥ مرضى من الذكور (٣٤,١٪) وكان متوسط العمر ٥٢,٢ (عمر يتراوح بين ٤٣-٦٢). كان هناك ٦٩ مريضا (٥٢,٢٪) تم لهم عمل إلتحام في مستوى قطني واحد و٦٣ حالة (٤٧,٨٪) في ٢ مستوى. وقد تم تقييم جميع المرضى إكلنيكيا بواسطة مقياس تقييم جمعية جراحة العظام اليابانية (JOAS) وذلك لقبل الجراحة وبعدها وفي أثناء والتقييم والمتابعة. بالإضافه لأنه قد تم إجراء تقييم إشعاعي بإستخدام الآشعة السينية والتصوير بالرنين المغناطيسي قبل وبعد الجراحة. وقد تم عمل الآشعة السينية في الوضعين المنثني للأمام والخلف وذلك لتأكيد الإنصهار/الإستقرار. وكانت فترة المتابعة في هذه الدراسة ١٨ شهرا.

النتائج: حدث تحسن كبير في النتيجة النهائية للمجموعتين، فقد كان معدل التحسن في المجموعة A ٨٨,٨٪ (تراوح بين ٦٠-١٠٠٪) ±١٠,٦ ولكن كان معدل التحسن النهائي في المجموعة B ٨١,٨٪ (تراوح من ٤٥-١٠٠٪) ± SD ١٣,٨. كان معدل الإنصهار ٨٢٪ للمجموعة A مقارنة مع ٨٩٪ للمجموعة B. وكان معرل رضا المرضى ٨٩٪ في المجموعة A بينما وصل إلى ٩٤٪ في المجموعة B.

الإستنتاج: لا توجد فروق كبيرة في النتائج بين اللحام الخلفي الجانبي بين النتوء العرضي وحده، وعندما يكون مصحوب ذلك باللحام الخلفي القطني بين جسمين الفقرات بشأن النتائج الإكلينيكية أو معدل الإنصهار. ويمكن أيضا إعتبار فارق الكلفة المادية عامل إضافي عند أخذ القرار الخاص بنوع الجراحة التي سيجريها المريض.