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Posterior Lumbar Interbody Fusion (PLIF) augmented with Pedicle Screw Fixation Versus PLIF augmented with Percutaneous Pedicle Screw Fixation in Low Grade Lumbar Spondylolisthesis

Posterior Lumbar Interbody Fusion (PLIF) augmented with Pedicle Screw Fixation Versus PLIF augmented with Percutaneous Pedicle Screw Fixation in Low Grade Lumbar Spondylolisthesis

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Abstract

Background Data: The optimal treatment for patients with Spondylolisthesis has been the subject of many recent studies which provide some of the best evidence for lumbar spinal fusion.

Purpose: Compare the clinical and radiological outcome of treating low grade lumbar spondylolisthesis patients with PLIF augmented with PSF versus those treated with PLIF augmented with Percutaneous PSF.

Study Design: This is a prospective comparative clinical case study.

Patients and Methods: Seventeen patients with low grade spondylolisthesis who underwent instrumented fixation were retrospectively analyzed from the period of 2011 to 2012. A PLIF and PSF (Group A) was performed in 9 patients, and PLIF and percutaneous PSF (Group B) was performed in 8 patients. Data were collected preoperatively and at 6 months after surgery. A comparative analysis was made between the 2 groups using visual analog pain scale (VAS) before and after surgery, and functional disability was assessed using the Oswestry Disability Index (ODI), by which low back pain, disability were assisted using a questionnaire and radiological (dynamic plain radiographs and CT scans) measures.

Results: Follow-up duration was 6 months. The mean preoperative scores on the VAS for low-back pain in Groups A and B were 55 and 54, respectively, decreasing to 43 and 39, respectively, at 6 months after surgery (P=0.003). The mean preoperative scores on the VAS for leg pain in Groups A and B were 65 and 61, respectively, decreasing at 6 months after surgery to 43 and 40, respectively (P=0.031), The fusion rates in Groups A and B were obtained in all 17 cases with variable rates of fusion in groups A 88.9% and in group B 75% at 6 months after surgery (P=0.008), There was no significant difference in terms of the complication rate between Group A (4.5%) and B (3.9%) (P=0.781).

Conclusion: Patients with PLIF and PSF results were much better than those with PLIF and percutaneous PSF. The postoperative back pain was much less in the percutaneous group and relatively longer time for fusion. These results seem to favor PLIF with SF rather than PLIF with percutaneous PSF in the treatment of low grade spondylolisthesis. (2013ESJ042)

Key Words: Percutaneous, Pedicle Screws fixation, Posterior lumbar interbody Fusion, Spondylolisthesis, Back Pain.

Introduction

Spondylolisthesis is the anterior slippage of one vertebral body relative to the adjacent one. It can be divided into five different types based on etiology, first described by Newman and Stone: congenital, spondylolytic, traumatic, degenerative, and pathologic.[10] The degree of Spondylolisthesis is defined as the percentage of slippage of the vertebral body relative to the adjacent one, with grade 1 indicating only a 0% to 25% slip, grade 2 a 26% to 50% slip, grade 3 a 51% to 75% slip, grade 4 a 76% to 100% slip, and grade 5 greater than 100% slippage (also referred to as spondyloptosis). Grade 1 or 2 Spondylolisthesis is low grade, and grade 3 or higher is high-grade.[11] Degenerative Spondylolisthesis is due to a combination of arthritic and degenerative changes in the disc and facet joints that leads to spinal stenosis and vertebral body displacement. Isthmic Spondylolisthesis results from elongation or traumatic fractures of the pars interarticularis, which lead to dissociation of the anterior and posterior vertebral arches.[12]

The optimal treatment for patients with Spondylolisthesis has been the subject of many recent studies which provide some of the best evidence for lumbar spinal fusion: In appropriate candidates, surgical intervention is superior to nonoperative treatment.[12,13,16,21,22] Pedicle screw systems engage all three columns of the spine and can resist motion in all planes. Several studies suggest that pedicle screw fixation is a safe and effective treatment for many spinal disorders.[12,22] Standard techniques for pedicle screw placement, however, require extensive tissue dissection to expose entry points and to provide a lateromedial orientation for optimal screw trajectory.

Open pedicle fixation and spinal fusion have been associated with extensive blood loss, lengthy hospital stays, and significant cost.[21] Minimally invasive placement of pedicle screws can potentially address these issues without compromising the accuracy of placement.[16] Percutaneous fixation of the lumbar spine was first described by Magerl,[9]who used an external fixator. Mathews et al.[15,19] first described and performed a wholly percutaneous lumbar pedicle fixation technique in which they used subcutaneous plates as the longitudinal connectors. Lowery and Kulkarni[19] subsequently described a similar technique in which subcutaneous rods were placed.

Patients and Methods

We reviewed seventeen patients with low grade spondylolisthesis who underwent a PLIF and PSF. A PLIF with PSF was performed in 9 patients (Group A), and PLIF and percutaneous PSF was performed in 8 patients (Group B). The inclusion criteria were as follows: 1-Cases of any age, both sexes with low grade (Grade 1 & 2) degenerative and isthmic lumbar spondylolisthesis. 2-Symptomatic patient with low back pain, radiculopathy and/or neurogenic claudication not responding to at least 3 months of conservative treatment with oral medication and physical therapy. 3-All lumbar levels are to be included. The exclusion criteria were: 1-Patients with general diseases that preclude surgical management (osteoporosis and active infection). 2-Patients with Spondylolisthesis of grades higher than grade 2. 3-Patients with morbid obesity as measured by body mass index >40. 4-Previous lumbar surgery. 5-Pregnancy. 6-Blood coagulation disorder.7-Traumatic conditions. Medical history was reviewed including: sex, age, occupation, smoking, and co morbid medical conditions and data was recorded concerning the presence of low back pain, neurogenic claudication, radiculopathy and its dermatome distribution, parasthesia, motor weakness, sphincter and sexual dysfunction. General, back and locomotor examination for the patient was done and recorded.

Before and after Surgery, radicular pain was assessed using visual analogue scale (VAS),[20] where patients' select a value between pain free (VAS 0) and unbearable pain (VAS 10). Also Before and after surgery, functional disability was assessed using the Oswestry Disability Index (ODI),[7] by using the Oswestry Low Back Pain Disability Questionnaire. (Table 1)

Routine static and dynamic plain lumbosacral spine x-ray antro-posterior and lateral view was used to assess the spine for presence of preoperative instability, and anatomical variants. CT-lumbosacral spine also was used to assess the case preoperatively.

Techniques:

The CD Horizon® Sextant TM spinal system is a minimal access spinal technology (MASTTM), that offer surgeons the ability to treat spinal conditions using less-invasive techniques and minimize the approach related morbidity of traditional lumbar pedicular screw fixation. The instrumentation uses poly axial screws and pre-contoured rods that are inserted percutaneously.

This is possible by the use of geometrically constrained inserter (an innovative mechanical arc device) that passes the rod directly into the screw heads through a small skin incision to stabilize the adjoining vertebrae with minimal injury to muscles near the spine. This minimally invasive technique significantly reduces the size of the incision and resulting scarring to the major muscles in the back.

In addition to the above-described operative technique for using percutaneous pedicle screws, surgical access for interbody fusion was obtained using a tubular retraction system (METRx; Medtronic Sofamor Danek, Minneapolis, MN). The MIS-TLIF approach was carried out on the side that was most symptomatic.

As for the PLIF patients they underwent internal fusion combined with implantation of polyaxial pedicle screws. The decompressive procedure consisted of removal of the spinous process, bilateral laminectomy, and foraminotomy. The disc spaces were carefully assessed for herniated disc material or prominent bulges, and were removed with insertion of an iliac bone graft. Pedicle screws were sized to occupy 70% of pedicle diameter; the pedicles typically accepted 5-6-mm screws, which were inserted and advanced under fluoroscopic guidance in rostrocaudal orientation to the anterior cortex of the vertebral body (VB), maintaining a trajectory that is parallel to the end plate. The rods were bent and attached to the pedicle screws.

Radiographs were obtained postoperatively and at regular follow-up intervals to evaluate situation of spondylolisthesis and to identify the correct placement and stability of the implant system, the mean radiographic follow-up was performed at 6 months. Successful fusion was defined as: 1) absence of motion on flexion–extension radiographs; 2) absence of halo around the implant; and 3) presence of bilateral continuous trabecular bone between the fused segments. Postoperative bone-window computerized tomography (CT) was obtained in all patients to evaluate the results of neural decompression.

Segmental kyphosis was measured as the angle between the posterior borders of the two vertebral bodies on the lateral radiograph. If the difference of the interbody angle on the flexion and extension radiographs was not greater than 2 degrees, non-union was assumed.[8] Operative blood loss was calculated for both groups and operative time.

Statistical Data Analysis

Statistical data analysis was accomplished using the chi-square test and the Student t test for continuous data (slippage percentage and nonunion and hardware failure rates). The Mann–Whitney u test was used to compare categorical data (functional outcome).

Table 1: Score Interpretation of the Oswestry Disability Questionaire[7]

0-20% (minimal disability)	The patient can cope with most living activity.
21-40% (moderate disability)	The patient experiences more pain and difficulty with sitting, lifting and standing. Travel and social life are more difficult and they may be disabled from work.
41-60% (severe disability)	Pain remains the main problem in this group but activities of daily living are affected.
61-80% (crippled)	Back pain impinges on all aspects of the patient's life.
81-100%	Bed-bound patient or exaggerating their symptoms.

Results

Seventeen patients with spondylolisthesis, in which 9 treated with PLIF and PSF (group A) and 8 with PLIF and percutaneous PSF (group B) with a follow-up period of 6 months. There were 12 males (70.5%) and 5 females (29.5%) (Figure 1), age ranged from 35 to 52 with a mean age of 43.5. Twelve patients had degenerative Spondylolisthesis, and five had isthmic spondylolisthesis. The majority of cases occurred at L4-L5 (N=11), others occurred at L5-S1 (N=5), and L3-L4 (N=1) (Figure 2). VAS and ODI data were prospectively collected. Thin cut CT with reconstructions was used to assess for fusion. Reduction of spondylolisthesis was measured by comparing plain lateral radiographs preoperatively and after 6 months. Postoperative follow-up Leg pain VAS decreased from a preoperative mean of 65 to a postoperative mean of 45 (P=0.031), group A from 65 to 43 while group B from 61 to 40. Back pain VAS decreased from a preoperative mean of 52 to a postoperative mean of 40 (P=0.003), group A from 55 to 43 while group B from 54 to 39. ODI decreased

from a preoperative mean of 56 to a postoperative mean of 23 (Figure 3, 4). Lateral radiographs obtained 6 months after surgery demonstrated partial reduction of spondylolisthesis in 13 cases (76.4%), marked in group A: 8 cases (47%), and in 5 cases in group B (29.4%), (Figure 5). Fusion was performed at one vertebral level in 17 patients. Radiographic evidence of bone fusion, defined as the presence of bilateral trabecular bone between fused segments, was achieved in all cases with variable rates of fusion; in groups A 88.9% and in group B 75% at 6 months after surgery (P=0.008). No major surgery-related complications occurred, in terms of wound infection, additional neurological dysfunction, or screw placement–related vascular injuries due to screw placement. The reported minor complications rates were; group A (4.5%) and group B (3.9%), with no significant difference (P=0.781). No patient died or required reoperation or hardware removal after fusion.On sensory examination, significant improvement was demonstrated in six (66.7%) of nine patients of group (A) who presented with sensory deficits and in 6 (75%) of 8 patients of group (B). Motor disturbances improved in 7 (77.8%) of 9 cases group A, and in 5 (62.5%) in group B (Figure 6). Reflex responses were not changed postoperatively.

Blood loss was calculated for both groups and was found to be much less for group B (300 to 500ml mean 370 ml) than group A (500 to 1100ml mean 800ml).(Figure 7) Operative time for both groups revealed no significant difference.

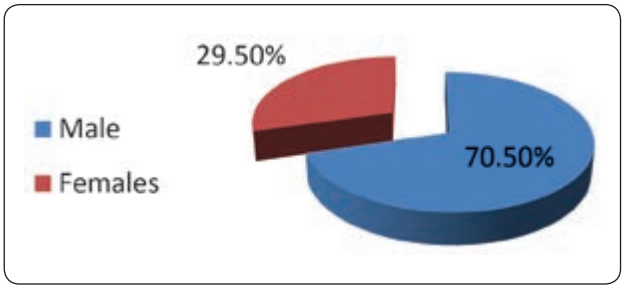

Figure 1. Gender distribution in our study.

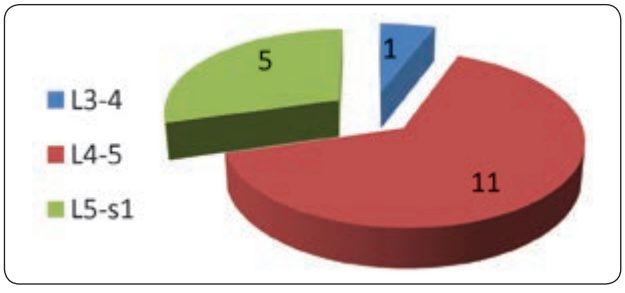

Figure 2. Operated levels in our study.

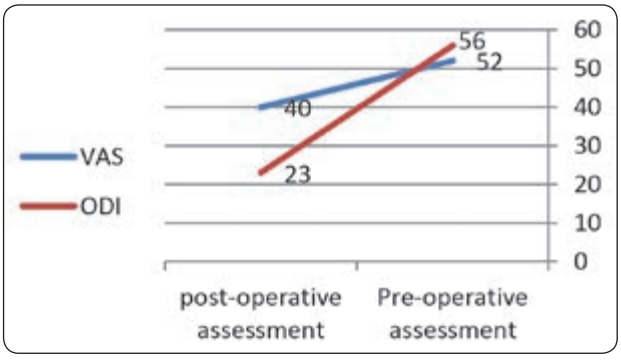

Figure 3. Pre- and Postoperative assessment of VAS and ODI (N=17)

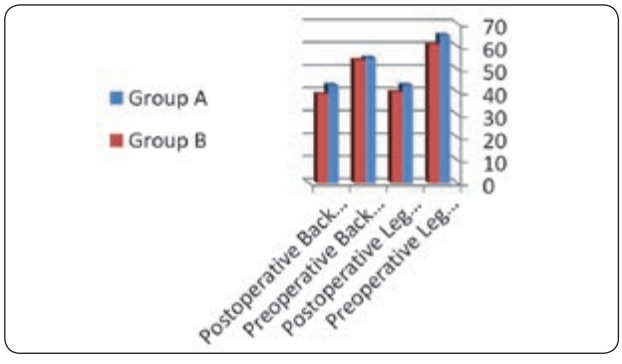

Figure 4. Pre- and Postoperative Leg Pain and Back Pain for both groups.

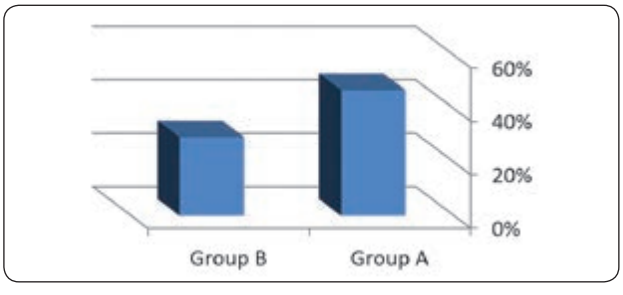

Figure 5. Slip reduction in our patients.

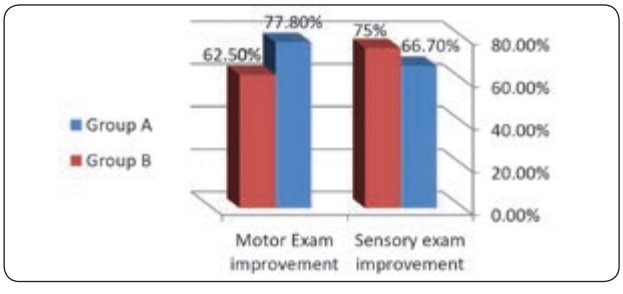

Figure 6. Postoperative sensory and motor exam improvement percentage in both groups.

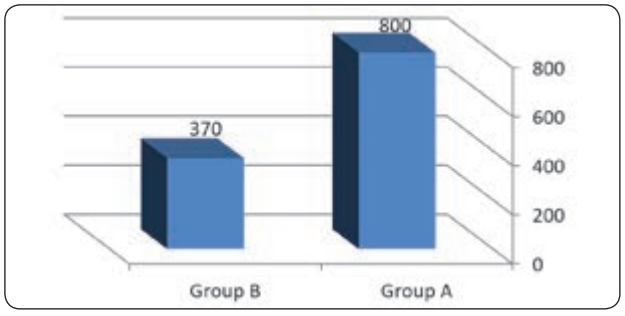

Figure 7. Operative blood loss in both groups.

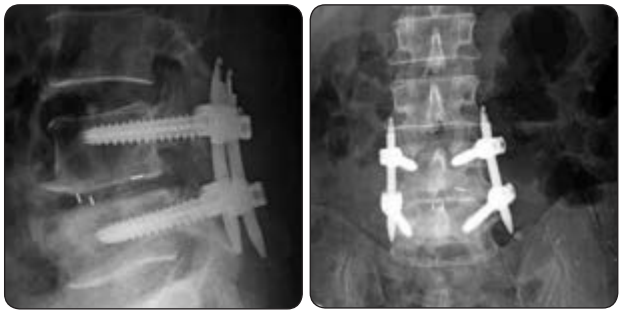

Figure 8. AP and Lat views X-Ray of percutaneous screws fixation.

Discussion

Spondylolisthesis is a condition characterized by a failure of the three-column support in which there is severe complex instability that requires reconstruction of the altered supporting structures. The segmental use of posterior lumbar pedicle screw devices is currently the standard for this reconstructive surgery; the widespread dissemination of these screws began this era of segmental spinal fixation.[2,6,14]

Biomechanically, pedicle screw systems allow three-column stabilization in which grip force is stronger than in othevr posterior fixation systems; do not require intact posterior elements; preserve adjacent normal motion segments; prevent deformity progression; and reduce mechanical pain syndromes, thereby encouraging immediate ambulation.[1,2,6,17]

Fusion of the posterior elements of the lumbar spine combined with placement of instrumentation represents a valid solution for spinal instability and may result in a solid fusion in up to 95% of cases.[5,6,18]

The physiological axial load is 80% through the anterior column and 20% through the posterior elements. In fused segments, the absence of anterior support makes the whole axial load pass through the system, reducing, as a result, its endurance. Additionally it must be remembered that the transpedicular systems work through posteriorly attached screws with a large lever arm, and thus flexion movements may result in placing extreme stress on the screw body fusion hardware should not be used as a stand-alone device to treat lumbar spondylolisthesis.[3,4]

Percutaneous fixation of the lumbar spine was first described by Magerl,[16] who used an external fixator. Mathews and Long[19] first described and performed a wholly percutaneous lumbar pedicle fixation technique in which they used plates as the longitudinal connectors. Lowery and Kulkarni[15] subsequently described a similar technique in which rods were placed. Although the latter authors reported a high success rate, Mathews and Long noted a significant rate of nonunion (HH Mathews, personal communication, 2001). In all cases, the longitudinal connectors were placed either externally[16] or superficially, just beneath the skin. [15,19]

The minimally invasive surgical treatment of spinal disorders is increasingly being recognized as safe and effective, with the opportunity for a reduction in pain and postoperative complications. The advantages of minimally invasive surgery have been disputed in the treatment of localized pathologies that are well managed using traditional methods, as evidenced by a recent randomized study of minimally invasive surgery versus open lumbar discectomy.[10]

The radiological and clinical results demonstrated in this study agree with those reported by a number of authors and support the view that a rigid segmental fixation combined with interbody fusion is the treatment of choice for segmental lumbar instabilities. In fact, a solid fusion was achieved in all patients, and there were no graft-related complications or serious neurological complication in the PLIF group or the percutaneous group. The post-operative back pain was much less in group B which might be due to less tissue destruction and manipulation. Also operative blood loss in group B was much less than group A as there is neither muscle distraction nor excessive tissue manipulation as per group B. the improvement in symptoms motor and sensory was almost equal as well as the surgery time was almost the same.

The advantages of a minimally invasive approach are likely to be increased over open surgery. It should be noted that these procedures and corrections have been made possible only because

of the recent confluence of commercially available devices, advanced surgeon training, and modern intraoperative imaging techniques. Our clinical and radiographic results for these 17 patients demonstrate that a posterior minimally invasive surgical approach and interbody fusion followed by percutaneous pedicle screw fixation was safe and effective with less blood loss, less postoperative back pain and leg pain, and a good fusion rate.

Percutaneous pedicle screw fixation technique is minimally invasive with potential benefits of less damage to muscle and skin, less blood loss, less post-operative pain, quicker return to normal activities, easier rehabilitation and smaller scars. It is safe and efficacious in the management of low grade spondylolisthesis. Complex biomechanics of instrumentation, lack of adequate fusion and steep learning curve with increased radiation exposure limits its application in all cases.

Conclusion

Patients with PLIF and PSF results were much better than those with PLIF and percutaneous PSF. The postoperative back pain was much less in the percutaneous group and relatively longer time for fusion. These results seem to favor PLIF with SF rather than PLIF with percutaneous PSF in the treatment of low grade spondylolisthesis.

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الملخص العربي

اللحام الخلفي القطني بين الفقرات مدعم بتثبيت المسمار العنيقى مقابل اللحام الخلفي القطني بين الفقرات مدعم بتثبيت المسمار العنيقى عن طريق الجلد في الانزلاق الفقاري القطني منخفض الدرجة.

خلفية البيانات: يتمثل العلاج الأمثل لمرضى الانزلاق الفقاري وهوموضوع العديد من الدراسات الحديثة التي توفر بعض أفضل الأدلة على اللحام في العمود الفقري القطني.

الغرض: والغرض من هذه الدراسة لمقارنة النتائج السريرية والإشعاعية لعلاج درجة الانزلاق الفقاري القطني المنخفض فى المرضى جراحيا مع التثبيت بمسامير عنيقية ولحام عظمى بين الفقرات مقابل تثبيت المسمار العنيقى عن طريق الجلد مع لحام عظمى بين الفقرات القطنية.

تصميم الدراسة: هذه دراسة حالة المقارنة السريرية بأثر رجعي. وقد تم تحليل سبعة عشر المرضى الذين يعانون من الانزلاق الفقاري منخفض الدرجة الذي خضع للتثبيت بأثر رجعي عن الفترة من ٢٠١١-٢٠١٢

المرضى والأساليب: أجري تثبيت بجراحة مفتوحة (مجموعه أ) في ٩ مرضى ، وأجريت عن طريق الجلد تثبيت المسامير (المجموعة ب) مع اللحام بين الفقرتين في ٨ مرضى . وقد تم جمع البيانات قبل الجراحة وبعد ٦ أشهر بعد الجراحة. وقدم تحليل مقارن بين المجموعتين باستخدام (مقياس الألم التناظري البصري (VAS) قبل وبعد الجراحة ، وجرى تقييم الإعاقة الوظيفية باستخدام مؤشر العجز أوسويستري (ODI) ، وتقييم آلام أسفل الظهر والعجز وقدمت المساعدة باستخدام استبيان، والتدابير الإشعاعية (صور الأشعة عادي ديناميكية والأشعة المقطعية).

النتائج: مدة المتابعة التي بلغت٦ أشهر . مؤشر الالم قبل الجراحة على VAS لألم أسفل الظهر في المجموعات أ وب كان ٥٥ و٥٤ ، على التوالي ، وخفض إلى ٤٣ و٣٩، على التوالي بعد الجراحة، في ٦ أشهر بعد الجراحة (P=0.003) .اما مؤشر الالم قبل الجراحة على VAS لألم الساق في مجموعات أ وب ٦٥ و٦١ ، على التوالي ، وخفض في ٦ أشهر بعد الجراحة ل٤٣ و٤٠ ، على التوالي (P=0.031) ، وكانت معدلات اللحام العظمى في المجموعات أ وب فى ١٧ حالة متقاربه ولكن لصالح المجموعة أ ، في ٦ أشهر بعد الجراحة ولم يكن هناك اختلاف كبير من حيث نسبة المضاعفات بين المجموعة أ وب.

والخلاصة: كان المرضى الذين يمثلون المجموعة أ افضل من المجموعة ب فى نتائج اللحام العظمى. وكانت آلام الظهر بعد العملية الجراحية أقل بكثير في المجموعة ب عن طريق الجلد وو قتا أطول نسبيا للحام.