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Reduction of Lumbar Spondylolisthesis, Surgical Technique and Clinical Outcome.

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Abstract

Background Data: Reduction of the slipped vertebrae as a part of surgical approach is now attempted. In the current literature, the studies have paid attention to the surgical reduction of the slippage or in situ spinal fixation technique. These studies have a lack of comparison between these variable techniques.

Purpose: To define the role and benefits of reduction and stabilization of lumbar spondylolisthesis.

Study Design: A retrospective clinical case study.

Patients and Methods: 24 patients with low grade isthmic lumbar spondylolisthesis between January 2008 and June 2010 were enrolled for this study. Patients were treated by slip reduction, interbody fusion with or without cage and internal pedicle screw fixation. All patients had back pain and radicular pain for at least one year pre-operatively. All patients were examined by plain radiographs, CT scan and MRI. Oswestry Disability Index (ODI) was used for pre and post-operative clinical assessment in all cases. Radiological assessment for bony fusion was done using plain radiography and CT scan. All patients were followed up both clinically and radiologically for at least one and half years.

Results: The overall rate of neurological improvement after our procedures was 91%. Radicular pain improved earlier than back pain. Slip was reduced and satisfactory screw purchase was proved in all patients. Reported fusion rate was 92%. Operative and postoperative complications occurred in five patients but were minor and cured.

Conclusion: Reduction of lumbar spondylolisthesis improved the clinical manifestations, increased the fusion rate and speed the return to normal or near normal life activities. (2013ESJ044)

Key Words: Lumbar spine, spondylolisthesis, reduction

Introduction

Lumbar spondylolisthesis in adults is a frequent pathology that is encountered by spinal surgeon. It affects 5% of populations.[29] Numerous studies have shown that young athletes engaged in strenuous training that incorporate intensive hyperextention and rotation of the lumber spine have a predisposition to spondylolysis and subsequent spondylolisthesis.[10]

Degenerative spondylolisthesis is common in individuals older than 50 years.[25] Clinical presentation is usually variable and ranging from mild to severe symptoms and disability which are related to the neural compression. The symptoms are typically related to the biomechanical spinal instability which leads to disc degeneration and lumber canal stenosis that ends with encroachment of nerve roots and thecal sac at the slide level.[7,20]

Medical treatment is usually the first line on management. Surgical approaches are preserved to cases with failure of conservative treatment or those with overt neurological deficits. However, various surgical techniques have been advocated to deal with symptomatic isthmic spondylolisthesis; the main perception of these surgical techniques focused on spinal fixation and neural decompression.[3,11]

Reduction of the slipped vertebrae as a part of surgical approach is now attempted. In the current literature, the studies have paid attention to the surgical reduction of the slippage or in situ spinal fixation technique. These studies have a lack of comparison between these variable techniques.

Materials and Methods

Twenty four patients with lumbar spondylolisthesis, 18 were females and 6 were males, with age ranging from 18 to 56 years. Clinical symptoms and signs included low back pain and radicular pain in all patients, motor weakness in 4 patients.

Twenty four patients with low grade isthmic spondylolisthesis were treated by reduction, interbody bony fusion with or without cage and internal pedicle screw fixation between January 2008 and June 2010. The inclusion criteria included symptomatic patients with Meyerding grade I and II isthmic spondylolisthesis that evident on plain radiography; patients with a significant neurological deficits or who failed to respond to conservative treatment, at least, for three months. Medical treatment included strong pain killers, physiotherapy, life style modification and body weight reduction. Symptoms are those of severe and chronic low back pain, sciatica pain, sensory disturbances with or without muscle weakness and neurogenic claudication. Exclusionary criteria included; patients with high grade, traumatic, degenerative, or neoplastic spondylolisthesis, patients' infection and congenital malformation.

All patients were studied radiologically by plain radiography, CT scan and MRI. Pre-operative assessment was carried out on all patients similarly. Oswestry Disability Index (ODI) was used for pre and post-operative disability assessment in all cases.[5] To reduce bias and ensure adequacy of surgical management and outcome; all patients were operated upon by one surgeon.

Reduction Technique:

The procedure entails insertion of pedicular screws in the vertebra below, reduction screws with long lips (reduction screw) in the slipped vertebra and short small caliber screws in the vertebra above the slipped one.

After removing the mobile lamina with both facets, radical discectomy and gentle shaving of the end plate were done. These ensure adequate release of the two adjacent vertebrae. Distraction before reduction is conducted by placing a long flat instrument (such as a shaver, a narrow Cobb elevator, or angled periosteal elevator) in the space and using it as a lever to distract the vertebral bodies (VBs). This distraction maneuver itself may allow partial correction of the forward slippage.

Some surgeons have used Harrington distraction rods for this purpose, but we believe that intervertebral manipulation is simpler and requires less longitudinal soft-tissue dissection. Bilateral rod application over the three screws was done on each side followed by nuts application. While tightening the nuts of the reduction screws simultaneously, these will pull the slipped vertebra backward. Distraction after reduction was applied between the slipped vertebra and the one below followed by interbody fusion using bone grafts from the removed lamina with or without cage insertion. Gentle compression was applied over the lower two screws (one in the slipped vertebra and the other in the vertebra below) on the right side to maintain the reduction followed by untightening the nuts of the left side to remove its rode and replace it by shorter one applied

over the lower two screws only followed by gentle compression and removing the third upper screw. Similarly, the nuts of the right side were untightened and the rod was replaced by shorter one applied over the lower two screws with gentle compression then the third screw was removed. (Figure 1,2)

All patients were followed up both clinically and radiologically for at least one and half years. Spinal rehabilitation was organized for all cases. All patients were clinically evaluated in the outpatient clinic on regular basis by an independent surgeon after 1, 3, 6, 12, 18 months. Lateral, anteroposterior, and dynamic lumbosacral radiographs were performed for all patients for adequate evaluation of screw trajectory, bony fusion, and reported de novo adjacent segment pathology. However, CT-scan was also considered in some patients where more study was needed such as the need to check screws trajectory, to exclude end plate penetration or in cases of pseudoarthrosis.

Data collection and analysis of outcome were completed based on the ODI. The ODI was scored on a 0–100 scale using the Oswestry Low Back Pain Disability Questionnaire of ten items (personal care, lifting, walking, sitting, standing, sleeping, sexlife, social life, travelling and need for medications). Depending on this scale, 0-20 equates to excellent outcome (minor disability), 21-40: very good outcome (minimal disability), 41–60: good outcome (moderate disability), 61–80: fair outcome (sever disability), and 81–100: poor outcome bed-bound or exaggerating.

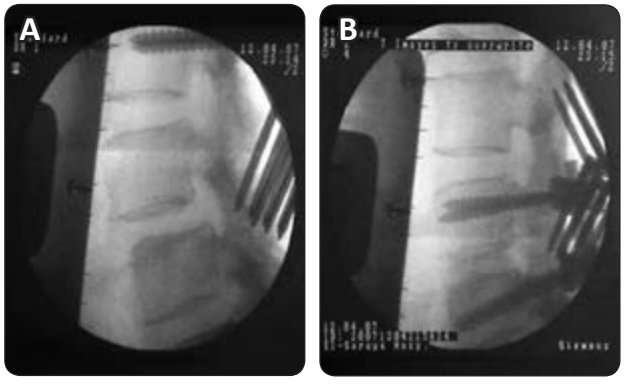

Figure 1. Intraoperative fluoroscopic images before reduction (A) note L3 pedicle screw used as a lever to reduce L4/5 slip, after insertion of L4,5 screws (B) and removal of L3 screw reducing the slip.

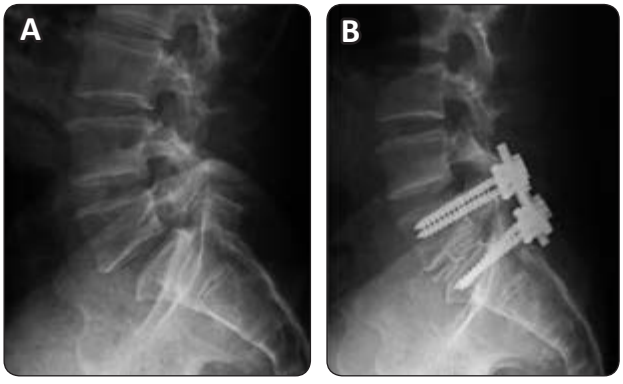

Figure 2. Pre-operative Plain lumbosacral lateral radiograph showing (A) preoperative L5/S1 isthmic spondylolisthesis and (B) post-operative plain lateral radiograph after reduction, interbody fusion and pedicle screw fixation.

Results

The mean hospital stay in this study was 3 days. Postoperative radiographs of the lumbar spine were done for all patients according the follow-up protocol. Radiographs appeared satisfactory regarding screw trajectory, maintained slip reduction, and position and volume of the interbody bony graft. Patients started ambulation with a Lumbosacral support on the first or second postoperative day.

According to ODI questionnaire, no patient had poor outcome, two patients had fair outcome (still need strong analgesics), 5 had good outcome (had mild pain and mild analgesics were needed), 12 patient had very good outcome, and 5 patients had excellent outcome. Through a period of 18 months of radiological follow up, sound bony fusion was reported in 22 patients (92%). Only 2 patients had pseudoarthrosis and were revised using iliac crest packed cage for interbody fusion. Summary of the patients' data was shown in Table (1).

Minor intra operative complications were reported in the form of unintended durotomy in 2 patients that were sutured directly with no post-operative CSF leakage, superficial wound infection in 3 diabetic patients that were treated by antibiotics and twice daily dressings, and transient post-operative sciatica in 6 patients as a result of intraoperative nerve root manipulation and all were cleared with time (average one week).

Table 1. Summery of Patients' Data.

Pt.	Gender/age	Grade	Level	Preop ODI	Postop ODI	Outcome	Cage
1	F /32	2	L4-5	65	37	very good	-
2	F/44	2	L4-5	54	33	very good	-
3	F/18	1	L4-5	61	14	excellent	-
4	F/56	2	L4-5	85	69	fair	-
5	M/38	2	L5-S1	47	11	excellent	-
6	F/23	1	L4-5	56	31	very good	-
7	F/33	1	L4-5	67	34	very good	-
8	F/40	2	L4-5	77	51	good	-
9	F/21	1	L5-S1	59	36	very good	-
10	M/28	2	L4-5	63	9	excellent	-
11	M/52	1	L4-5	70	59	good	-
12	F/48	1	L4-5	75	44	good	-
13	M/44	2	L4-5	53	29	very good	-
14	M/25	2	L4-5	49	26	very good	-
15	F/30	1	L4-5	54	16	excellent	-
16	F/39	1	L4-5	66	39	very good	-
17	F/27	2	L5-S1	63	30	very good	-
18	F/35	2	L4-5	69	44	good	+
19	F/43	2	L5-S1	76	49	good	+
20	M/30	1	L4-5	51	11	excellent	+
21	F/50	2	L4-5	90	77	fair	+
22	F/33	1	L5-S1	55	38	very good	+
23	F/37	2	L5-S1	69	50	good	+
24	F/29	1	L4-5	53	34	very good	+

Discussion

Lumbosacral spondylolisthesis presents a challenge for the spine surgeons. Management of spondylolisthesis is variable and depends on the underlying pathology. For asymptomatic cases surveillance is the treatment of choice while medical treatment is the first line of management for symptomatic cases. However, surgical treatment is reserved for cases who have failed medical treatment or to patients with neurological deficits and is traditionally treated by either open anterior or posterior approaches. The surgical goals are to decompress the neural structures and to provide the appropriate environment for a solid fusion. The decompression can be performed directly by removal of the lamina and pars interarticularis or indirectly by distraction of the spinal interspace or reduction of spondylolisthesis or both.[3,11,16]

Pedicle screw fixation of spinal column in patients with various spinal disorders had become increasingly popular over the past years particularly for treatment of spondylolisthesis. Various surgical techniques have been used to deal with lumber spine spondylotic spondylolisthesis; basically focused on the concept of spinal fusion. Many have advocated the use of instrumentations with or without neural decompression or only neural decompression without surgical fixation with claim of variable results though.[20,23]

Furthermore, many authors have advocated that correction of sagittal spinal deformity by reduction in conjunction with arthrodesis will enhance the spinal biomechanics and results in a nerve root decompression. Besides that, it provides a mechanical protection for the spinal fusion from tensile and shearing forces that may be applied to the adjacent segments and this could prevent an early adjacent segment disease. What makes the slippage reduction in adults amenable and easy is the fact that the slip angle is usually small, and there are no dysplastic changes of adolescent high-grade slips, such as a rounded sacrum or trapezoidal L5 shape.

However, these facts have been challenged by many authors.[24,26,27]

Adjacent segment disease still a problem that may occur in a high rate on the long term follow up after lumbar spine fixation and estimated at in 36.1% of cases. This may be related to the pre-operative abnormal sagittal configuration of the spine rather than to the surgical technique utilized or extension of the spinal fixation or even the existence of degenerative disease. Conversely, it seems that normal sacral inclination is the most important factor for having lower adjacent segment degeneration and retrolisthesis is the most frequent degenerative type of adjacent segment disease seen.[28]

Functional outcome following instrumental spinal surgery for spondylolisthesis in physically energetic patients is crucial. Molinari et al,[17] had reviewed the functional outcome following instrumental surgery and concluded that patients with symptomatic low grade spondylolisthesis could return to high functional life with less back pain following a limited surgical intervention.

As a result, there is lack of studies in the literature that compares surgical outcome between patients with low grade spondylolisthesis who underwent surgical fixation with reduction of the vertebral shift and those who underwent only fixation in situ without having the step reduced. There is no strong clinical evidence (no randomized clinical trials) for spondylolisthesis reduction *versus* fusion "*in situ*" but a lot of arguments support it. Surgery including reduction of the slip is becoming popular. During the interval 1996-2002, the percentage of patients with lytic spondylolisthesis in whom reduction of the slip was performed doubled (from 22% to 44%).[18] Though comparison studies between variable surgical techniques utilized to deal with symptomatic spondylolisthesis have been carried out by many authors. Apparently, the surgical outcome of various techniques used for spinal decompression and instrumental fixation seems to be almost the alike with trivial differences between these techniques in terms of surgical complications, rate of spinal fusion and satisfactory outcome in the short and long term follow up.[12,14]

To correct or leave as the defect is the central controversial issue yet to be resolved in the surgical management of such lesions. Future studies should be directed to performing sophisticated real-time continuous neural monitoring intraoperatively, objective intraoperative assessment of tension/ stretch in the cauda equina nerve root, and any other test that will establish the cause of neural impairment.

Spinal deformity may induce abnormal compensatory postural changes, slowly evolving neurological deficit from stretching or compression of neural elements, and chronic pain. One of the central goals of reduction surgery is to correct spinal deformity and restore sagittal balance, reduce the slip angle to alleviate all these symptoms, decrease postoperative pain and immediate mobilization of the patient. Satisfactory listhesis reduction and disc height restoration lead to increased neuroforaminal height have been shown following these procedures.[2,4,6,8,13,22,21]

The quality of fusion construct is optimized when the deformity is corrected. When reduction surgery is not performed, if lumbar interbody fusion (posterior or anterior) is considered, there is a smaller surface area of endplate cooptation for the placement of the graft. When the slippage is corrected, the surface area is restored leading to successful arthrodesis.[1,9] In cases in which conventional posterolateral fusion is considered, the transverse process of L-5 is small and hypoplastic. After removal of the L-5 posterior arch, including inferior articular facet, there is very little surface area left for a fusion bed. Additionally, without reduction, the graft is placed under tension if the transverse process continues its forward migration, a condition not conducive to fusion. This explains the low fusion rates with in situ arthrodesis.

In situ fusions do not generally result in stable constructs. Even if osseous fusion is documented on x-ray film studies, the fusion mass may elongate under abnormal tensile forces and may result in progression of the vertebral slippage. Such a scenario is never known to occur in cases in which fusion is performed after reduction surgery. In in situ fusion, the floating posterior arch of L-5 is generally not removed so as to provide a larger surface area for the fusion bed. Such a maneuver results in persistent and often worsening neurological deficit.[15,19] Spine surgeons who practice in situ fusion tend to include higher segments (namely L-4 and possibly L-3) to allow for a larger graft contact area. This practice is more likely lead to junctional syndromes. Based on the fore mentioned details, it is apparent that there

are stronger arguments to correct such deformities if the surgical technique can be improved to minimize or avoid neurological deficits.

Conclusion

Spondylolisthesis reduction leads to indirect neural decompression, normalization of the shear forces by realignment of the sagittal contour, and increases fusion rate by increasing the surface area for bony fusion. All these lead to improving the clinical manifestations and speed the return to normal or near normal life.

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الملخص العربي

استرجاع تزحلق الفقرات القطنية؛ طرق العلاج الجراحى والنتائج الاكلينيكية

المقدمة: محاولة استرجاع الفقرات القطنية المنزلقة كجزء رئيسى فى تقنية العلاج الجراحى تخضع الآن للعديد من الدراسات والتجارب فى محاولة للمقارنة بين التقنيات المختلفة للعلاج الجراحى وقد اهتمت الدراسات الحديثة باسترجاع تزحلق الفقرات القطنية بتثبيت الفقرات كما هى دون استرجاع ولكن المقارنة بينهما لم تزل غير كاملة.

الهدف من الدراسة: هو تحديد دور وفوائد الاسترجاع وتثبيت تزحلق الفقرات القطنية.

تصميم الدراسة: دراسه بأثر رجعي لحالات سريرية.

الطرق: تم إجراء هذه الدراسة بأثر رجعى على ٢٤ مريض يعانون تزحلق الفقرات القطنية وقد تم علاجهم طريقتين مختلفتين لاسترجاع وتثبيت تزحلق الفقرات القطنية وعمل التحام عظمي بداية من يناير ٢٠٠٨ حتى يونيو ٢٠١٠ وكل المرضى كانوا يعانون من آلام اسفل الظهر وآلام بالساقين لمدة عام على الأقل قبل الجراحة وقد تم إجراء فحوصات بالأشعة لجميع المرضى قبل وبعد الجراحة. وقد استخدمنا معامل اوسوسترى لتقييم المرضى قبل وبعد العمليات الجراحية وأيضا متابعة المرضى إكلينيكيا وبالأشعة لمدة عام ونصف على الأقل.

النتائج: وقد أظهرت النتائج ان هناك تحسن إجمالي في ٩١٪ من المرضى وأن تحسن آلام الساق كان اسرع من تحسن آلام الظهر وأن مضاعفات الجراحة حدثت فى خمسة من المرضى وكانت محدودة وتم السيطرة عليها مما يدعم الاستنتاج.

الاستنتاج: أن استرجاع تزحلق الفقرات القطنية يزيد من اللحام العظمي ويحسن الحالة الإكلينيكية للمريض ويسرع عودة المريض لحياته الطبيعية او شبه الطبيعية.