Surgical Management of Low Grade Isthmic Spondylololisthesis with Posterior Fusion and Pedicular Screws Fixation With or Without Reduction (A Comparative Study)

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Abstract

Background: Spondylolisthesis is a condition in which a vertebra slips out of the proper position into the bone below it as a result of pars interarticularis defect. The slipped segment produces abnormal positioning of the vertebrae in relation to each other along the spinal column and causes mechanical back pain with or without radicular pain.

Material and Methods: The current study consisted of 40 patients aged 35-65 years (15 females and 25 males) treated for symptomatic spondylolisthesis between January, 2008 and January, 2010. All patients were randomly distributed into two groups I and II. Twenty patients were in Group I; they underwent reduction of the slipped vertebrae by using Reduction-Screw Technique and posterior lumbar inter-transverse process fusion. Group II consisted of twenty patients who underwent the same technique used in group I but without reduction. All patients in this study had same pre and post operative management.

Results: Only one case had broken screw in group I that required revision. Superficial wound infection was experienced in two patients. The outcome in both groups was variable on the short term but was almost the same on the long term follow-up.

Conclusion: Surgical management of symptomatic low grade spondylolisthesis should include neural decompression and surgical fixation. Reduction of slipped vertebral bodies is unnecessary as the ultimate outcome will be likely similar.

Key Words: Spondylolisthesis – Surgical fixation – Reduction – Outcome – Neural decompression – ODI.

Introduction

LUMBAR isthmic spondylolisthesis in adults is a frequent pathology that is encountered by spinal surgeon. It affects 5% of populations in the USA [1]. Clinical presentation is usually variable and ranging from mild to severe symptoms and disability which are related to the neural compression.

Medical treatment is usually the first line of management. Surgical options are preserved to cases with failure of conservative treatment or those with 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 [8-11].

Reduction of the slipped vertebrae as a part of surgical approach is still debatable. In the current literature, the studies have paid attention to the surgical reduction of the slippage or in situ spinal fixation technique. These studies are lack of comparison between these variable techniques. In this review, we have addressed this subject and designed a prospective randomized controlled study to compare between surgical fixation with or without reduction of the slipped segment.

Material and Methods

This study consisted of 40 patients, who treated for symptomatic isthmic spondylolisthesis at Beni Suef University and Health Insurance Hospitals between January, 2008 and January, 2010. The study was designed for a period of 24 months and a follow-up of 24 months (the last patient was operated in January 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, the 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 grade III and VI, traumatic spondylolisthesis, patients with acute or chronic infection and congenital malformation.

The grade of spondylolisthesis can be expressed as a percentage, according to the Meyerding classification through measurements of the anterior slippage, in millimeters, of the superior vertebrae on the inferior vertebrae. Multiplying the result by 100 yields a percentage indicated below: (Fig. 1).

- Grade 1 is defined ad 0 to 25%.
- Grade 2 is defined as 26-50%.
- Grade 3 is defined as 51-75%.
- Grade 4 is defined as 76-100%.
- Grade 5 is defined as 100% or greater (known as spondyloptosis).

The patient demographics were reviewed and analyzed in a prospective method. Patients who fulfilled the inclusionary criteria were admitted to the hospital for surgical treatment. Pre-operative assessment was carried out on all patients similarly. This included plain and dynamic lumbar spine X-rays, lumbar spine MRI and routine lab work. Oswestry Disability Index (ODI) was used for pre and post operative disability assessment in all cases [12].

Patient distribution in this study group was alternatively and randomly selected. All Patients in either group had same surgical approach. All patients in both groups underwent neural decompression and surgical fixation; those who had undergone surgical reduction of the slipped vertebrae were stratified in group I. The surgical reduction of the slipped vertebrae was achieved by applying Reduction-Screw Technique with posterior lumbar inter-transverse process fusion (Steffe Plate and Screw System) (Fig. 2) and autogenous iliac bone graft. Whereas, patients in group II underwent only surgical fixation and neural decompression. They had no reduction of the slipped vertebra.

Postoperative plain X-rays of the lumbar spine were done to all patients; the site of surgical fixation appeared satisfactory, and they started ambulation with a lumbosacral support on the first or second postoperative day. Spinal rehabilitation was organized for all cases. All patients were evaluated in the outpatient clinic on regular basis as follows 2 weeks, three, six, twelve and twenty four months. Furthermore, lateral and anterior-posterior lumbar sacral spine X-rays were considered on all cases for adequate evaluation of the surgical fixation, progression of spinal fusion, presence of adjacent segment and/or pseudoarthrosis. Lenke et al., radiological criteria was applied on all cases to evaluate their radiological outcome [13] (Table 1).
## Table 1: Lenke posterior fusion grade/score with descriptions.

<table>
<thead>
<tr>
<th>Grades</th>
<th>Descriptions of the grades</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade A</td>
<td>Definitely solid with bilateral trabeculated stout fusion masses present</td>
</tr>
<tr>
<td>Grade B</td>
<td>Possibly solid with a unilateral large fusion mass and a contralateral small fusion mass</td>
</tr>
<tr>
<td>Grade C</td>
<td>Probably not solid with a small fusion mass bilaterally</td>
</tr>
<tr>
<td>Grade D</td>
<td>Definitely not solid with bone graft resorption or obvious pseudarthrosis bilaterally</td>
</tr>
</tbody>
</table>

Data collection and analysis of outcome were based on the Oswestry Disability Index (ODI) as following:

### Scoring instructions:
For each section the total possible score is 5:
If the first statement is marked the section score = 0; if the last statement is marked, it = 5. If all 10 sections are completed the score is calculated as follows:

Example: 16 (total scored).

50 (total possible score) x 100 = 32%

If one section is missed or not applicable the score is calculated:

16 (total scored).

45 (total possible score) x 100 = 35.5%

Minimum detectable change (90% confidence): 10% points (change of less than this may be attributable to error in the measurement) (Table 2).

## Table 2: Sections of ODI.

### Section 1 – Pain intensity:
- I have no pain at the moment
- The pain is very mild at the moment
- The pain is moderate at the moment
- The pain is fairly severe at the moment
- The pain is the worst imaginable at the moment

### Section 2 – Personal care (washing, dressing etc):
- Can look after myself normally without causing extra pain
- I can look after myself normally but it causes extra pain
- It is painful to look after myself and I am slow and careful
- I need some help but manage most of my personal care
- I need help every day in most aspects of self-care
- I do not get dressed, I wash with difficulty and stay in bed

### Section 3 – Lifting:
- I can lift heavy weights without extra pain
- I can lift heavy weights but it gives extra pain
- Pain prevents me from lifting heavy weights off the floor, but I can manage if they are conveniently placed eg. on a table
- Pain prevents me from lifting heavy weights, but I can manage light to medium weights if they are conveniently positioned
- Can lift very light weights
- I cannot lift or carry anything at all

### Section 4 – Walking:
- Pain does not prevent me walking any distance
- Pain prevents me from walking more than 2 kilometres
- Pain prevents me from walking more than 1 kilometre
- Pain prevents me from walking more than 0.5 kilometre
- I can only walk using a stick or crutches
- I am in bed most of the time

### Section 5 – Sitting:
- I can sit in any chair as long as I like
- I can only sit in my favourite chair as long as I like
- Pain prevents me sitting more than one hour
- Pain prevents me from sitting more than 30 minutes
- Pain prevents me from sitting more than 10 minutes
- Pain prevents me from sitting at all

### Section 6 – Standing:
- I can stand as long as I want without extra pain
- I can stand as long as I want but it gives me extra pain
- Pain prevents me from standing for more than 1 hour
- Pain prevents me from standing for more than 30 minutes
- Pain prevents me from standing for more than 10 minutes
- Pain prevents me from standing at all

### Section 7 – Sleeping:
- My sleep is never disturbed by pain
- My sleep is occasionally disturbed by pain
- Because of pain I have less than 6 hours sleep
- Because of pain I have less than 4 hours sleep
- Because of pain I have less than 2 hours sleep
- Pain prevents me from sleeping at all

### Section 8 – Sex life (if applicable):
- My sex life is normal and causes no extra pain
- My sex life is normal but causes some extra pain
- My sex life is nearly normal but is very painful
- My sex life is severely restricted by pain
- My sex life is nearly absent because of pain
- Pain prevents any sex life at all

### Section 9 – Social life:
- My social life is normal and gives me no extra pain
- My social life is normal but increases the degree of pain
- Pain has no significant effect on my social life apart from limiting my more energetic interests eg. sport
- Pain has restricted my social life and I do not go out as often
- Pain has restricted my social life to my home
- I have no social life because of pain

### Section 10 – Travelling:
- I can travel anywhere without pain
- I can travel anywhere but it gives me extra pain
- Pain is bad but I manage journeys over two hours
- Pain restricts me to journeys of less than one hour
- Pain restricts me to short necessary journeys under 30 minutes
- Pain prevents me from travelling except to receive treatment
**Poor outcome:**
 Patients who experienced same preoperative symptoms or the symptoms had worsened up after surgery and there were a significant restriction of their daily life activities.

**Fair outcome:**
 Pain had improved up to 50% compared with the preoperative status but still requiring strong analgesics; mild improvement in sensory and motor symptoms was evident but the patient still had some difficulty with his daily life activities. Patient’s satisfaction was around 50-60%.

**Good:**
 When the patient had a significant improvement in the back pain and sciatica, occasional analgesics were required and they experienced less numbness and paraesthesia with a noticeable improvement in weakness. No constraint in daily activities any more. Patient’s satisfaction was 60-80%.

**Excellent:**
 This group included cases with no more pain or neurological deficits. Normal daily life activities and patient’s satisfaction was more than 80%.

**Results**
 A total of 20 patients in group I (15 males and 5 females) ages 35-65 years (average 48.2 years) were treated with surgical fixation, neural decompression and reduction of spondylolisthesis. There were 20 patients in group II (10 males and 10 females) ages 39-62 years (average 49.1 years) were treated only with neural decompression and fixation in situ without reduction of the slipped vertebrae. There was no significant difference between two groups in regards to the clinical presentation, clinical findings and preoperative co-morbidities. (Table 3) shows the demographic distribution and characteristics of each group.

<table>
<thead>
<tr>
<th>Table (3): The demographic distribution and clinical presentation of both subgroups.</th>
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</thead>
<tbody>
<tr>
<td><strong>Reduction Group I</strong></td>
</tr>
<tr>
<td>N=20</td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>Average</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Severe low back pain</td>
</tr>
<tr>
<td>Radiating or claudicating pain:</td>
</tr>
<tr>
<td>Unilateral</td>
</tr>
<tr>
<td>Bilateral/cramps</td>
</tr>
<tr>
<td>Sensory disturbance</td>
</tr>
<tr>
<td>Muscle weakness</td>
</tr>
<tr>
<td>History of medical co-morbidities (DM, HTN)</td>
</tr>
</tbody>
</table>

There were no difference in the operative and post operative co-morbidities in both group and that included; pedicle fracture, minor dural tear which was repaired instantly and none of them experienced post operative CSF collection or leak, (6% vs. 5.8% respectively). However, a few early post-operative complications were encountered such as; superficial wound infection, post operative transient sciatica pain, as a result of intra-operative nerve root manipulation was seen frequently; pain almost improved with time (frequency in group I and II 22% vs. 25.0% respectively). A broken screw had only occurred in one case in group I.

The hospitalization stay was between two and four days for all patients. The real time of operation was estimated at average of 2 hours in each group.

On the long term follow-up, there was only a patient from group II who developed pseudoarthrosis which required surgical intervention. Adjacent segment disease was not evident on any case in both groups.

Preoperatively, there was no significant difference in mean ODI between patients of group I (mean=0.52) and group II (mean=0.50). Over time, the mean ODI decreased significantly and linearly in both groups with the mean ODI being significantly lower in group I at all period of follow-up (Fig. 3). At the last follow-up evaluation, the mean ODI had decreased from the preoperative value of 0.50 to 0.04) in group I and from 0.52 to 0.15 in group II.
Further improvement was achieved on the two years’ follow-up, over the ensuing time; patients in both groups displayed a significant improvement and ended with good to excellent condition (Table 4).

Table (4): Outcome on the short and long term follow-up by using ODI.

<table>
<thead>
<tr>
<th>Follow-up</th>
<th>Reduction Group I</th>
<th>Fusion in situ Group II</th>
</tr>
</thead>
<tbody>
<tr>
<td>On 3 months:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bad</td>
<td>0 (0.0)</td>
<td>5 (25)</td>
</tr>
<tr>
<td>Fair</td>
<td>2 (10)</td>
<td>6 (30)</td>
</tr>
<tr>
<td>Good</td>
<td>3 (15)</td>
<td>8 (40)</td>
</tr>
<tr>
<td>Excellent</td>
<td>16 (80)</td>
<td>1 (5)</td>
</tr>
<tr>
<td>At 1 year:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bad</td>
<td>0 (0.0)</td>
<td>1 (5)</td>
</tr>
<tr>
<td>Fair</td>
<td>0 (0)</td>
<td>2 (10)</td>
</tr>
<tr>
<td>Good</td>
<td>3 (15)</td>
<td>11 (55)</td>
</tr>
<tr>
<td>Excellent</td>
<td>18 (90)</td>
<td>6 (30)</td>
</tr>
<tr>
<td>At 1.5 years:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bad</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Fair</td>
<td>0 (0)</td>
<td>1 (5.0)</td>
</tr>
<tr>
<td>Good</td>
<td>2 (10)</td>
<td>2 (10)</td>
</tr>
<tr>
<td>Excellent</td>
<td>19 (95)</td>
<td>17 (85)</td>
</tr>
<tr>
<td>At 2 years:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bad</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Fair</td>
<td>0 (0.0)</td>
<td>1 (5.0)</td>
</tr>
<tr>
<td>Good</td>
<td>4 (20)</td>
<td>3 (15)</td>
</tr>
<tr>
<td>Excellent</td>
<td>17 (85)</td>
<td>16 (80)</td>
</tr>
</tbody>
</table>

Radiologically, all patients had no fusion evident on the X-rays after 6 months of surgery. However, around 50% of patients, in each group, had a solid fusion after one year (Figs. 5,6). Most of the patients, 17 from group I and 19 from subgroup II had solid fusion at two years but one case who developed pseudoarthrosis and required revision.

Discussion

Pedicle screw fixation of spinal column in patients with various spinal disorders has become increasingly popular over the past years particularly for treatment of spondylolisthesis. 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 the medical treatment or to patients with neurological deficits. Various surgical techniques have been used to deal with lumbar 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 [6,7].
The reduction of vertebral step is still a matter of debate. In his study, Mikko et al., concluded that patients who had surgical fixation without reduction ended with better outcome compared with patient who underwent surgical reduction and fixation. Yet, this conclusion was drawn on adolescent patients who had severe spondylolisthesis; the other face it might not be applicable on older patients or those with lower grade of spondylolisthesis [14]. The results we concluded in our study have proved that the outcome is almost similar in patients who underwent instrumental fixation along side with neural decompression whether they had reduction of the spondylolisthetic segment or not. This draw a challenge to the results of Mikko et al., when his conclusion is being applied on adult patients with low grade spondylolisthesis.

Furthermore, many authors have advocated that correction of sagittal spinal deformity 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 [15-18].

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 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 [19].

Functional outcome following instrumental spinal surgery for spondylolisthesis in physically energetic patients is crucial. Molinari et al., 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 [20].

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. 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 same 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 [21,22].

Conclusion:
Surgical treatment of isthmic spondylolisthesis is reserved to the symptomatic patient who failed conservative treatment or developed neurological deficits. The gold standard treatment is surgical fixation of the slipped segments with neural decompression. Surgical reduction of spondylolisthesis is a matter of controversy. In this review we concentrated on this uncertainty and concluded that on the short and long term follow-up the outcome between patients who underwent surgical fixation and neural decompression with or without correction of the slippage is almost approximated there is no significant difference between these two approaches.

References