Case Report

A study of clinical, radiological and functional outcome following surgical management of spondylolisthesis by posterior instrumentation and posterolateral fusion

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Abstract

Background: Spondylolisthesis is one of the most common causes of low back pain and sciatica in adolescents and adults. Most of acute symptoms settle with conservative line of treatment. The purpose of surgical treatment is to reduce low-back pain and radiating pain, to relieve the neurological symptoms, and to improve the posture and gait. The purpose of this study was to evaluate the pain relief, functional improvement and improvement in radiological grading of spondylolisthesis after posterior instrumentation. Methods: 34 patients of spondylolisthesis of varied etiology are operated with posterior instrumentation with pedicle screw fixation, posterior loose fragment excision, decompression and posterolateral fusion.

Results: Clinical evaluation was based on Kim and Kim criteria. 73.6% patients had achieved clinically successful results (Excellent 5.9%, Good 67.7%, Fair 23.5% and Poor 2.9%). Conclusion: Posterior instrumentation with pedicle screws, posterolateral fusion with posterior loose fragment excision and decompression yields satisfactory results in symptomatic spondylolisthesis in adults, with low back pain and radicular pain and without major neurological deficit.

Key words:

Introduction

Spondylolisthesis is derived from the Greek word spondyl, meaning “vertebra,” and lithenein, meaning “to slip.” It is defined as anterior or posterior slipping of one segment of the spine on the next lower segment. Spondylolisthesis is one of the most common causes of low back pain and sciatica in adolescents and adults. There are six types of spondylolisthesis: dysplastic, isthmic, degenerative, traumatic, pathological and iatrogenic. Several possible sources of pain in spondylolisthesis include instability at the defect (isthmic spondylolisthesis) causing lumbar strain and osteoarthritis (degenerative spondylolisthesis), foraminal entrapment of a nerve root (chronic root traction, irritation and compression), disc herniation or disc degeneration at, above or below the slip, and hyperlordosis. Also the late progression of slip in adults may turn an asymptomatic lesion into a symptomatic one.

In most cases symptoms are mild and respond to non-surgical options like activity modification, bracing, physical therapy, and intervention in the form of medications and injections and use of muscle relaxants and narcotics may be appropriate for managing initial acute pain.

The purpose of surgical treatment is to reduce low-back pain and radiating pain, to relieve the neurological symptoms, and to improve the posture and gait by eliminating the instability of the lumbosacral region. A multitude of surgical procedures exists for operative treatment of this condition. Posterolateral fusion using a pedicle screw system is the most popular spinal fusion technique to treat spondylolisthesis. Recently, anterior or posterior lumbar interbody fusion, instrumented reduction and repair of the defect and muscle pedicle bone grafting for fusion of lumbosacral listhesis have been described. Sufficient decompression of nerve roots is essential to obtain good surgical outcomes as is the need for stabilization.

The purpose of this study was to evaluate the pain relief, functional improvement and improvement in radiological grading of spondylolisthesis after posterior instrumentation with pedicle screws, posterior loose fragment excision, decompression and posterolateral fusion.

Materials and Methods

After patient is examined clinically and radiologically (Plain radiographs, MRI) after meeting inclusion criteria

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patients were taken for posterior instrumentation with pedicle screws posterior loose fragment excision. Patients were considered for surgery only if failure of non-surgical options that included non-steroidal anti-inflammatory drugs, weight reduction, activity modification, muscle relaxants, narcotics etc to relieve patient symptoms. Preoperative evaluation involved complete clinical, neurological, functional, radiographic and MRI evaluation. Patients were evaluated for pain and functional status by using the Japanese Orthopaedic Association Score. MRI was done to exclude disc disease or nerve root compression that would necessitate discectomy or decompression compression and posterolateral fusion.

**Surgical technique**

After the administration of hypotensive general anesthesia, the patient is placed prone on the operating table in a knee-chest position, level to be operated is marked under c-arm guidance before painting and draping. 2% adrenaline is locally administered in the line of incision to minimize bleeding.

A standard posterior midline incision is made and the paraspinal musculature detached and freed to the outer margins of the transverse processes. Haemostasis is achieved by means of electro-cauterization and packing. Care is taken to identify and cauterize the dorsal branches of lumbar arteries. After clearing of soft tissue, under direct visualization and with aid of image intensification, the pedicles of each vertebra identified and expose the cancellous bone of the pedicle canal by decortication at the intersection of the base of the facet and middle of transverse process. Bone awl used to ream a small canal into the vertebral body through its pedicle. Under image intensification, the hole is then tapped with cancellous bone tap. Pedicle canal probing done to feel for any violation of its walls and obtaining radiographic confirmation. Pedicle screw inserted until the large cancellous threads are buried into body and the pedicle. According to the level of fixation inclination of the screw should be strictly maintained as defined. If there is a lack of attention to this fact, screw bending or excessive tilt of the vertebra may result when system is tightened and compression occurs. The remaining pedicles are identified and screws inserted bilaterally at each segment level.

Posterior loose fragment is removed. If indicated, extensive decompression and laminectomy are then carried out at single or multi levels with care taken not to injure the underlying dura or spinal nerves. Epidural plexus bleeding is controlled with bipolar cauterization or packing with neurospinges. Each nerve root is then inspected at predetermined levels and wide and extensive decompression carried out, including facetectomies, if necessary, each nerve root followed out past its nerve root canal to ensure adequate decompression and release of the adhesions, scar tissue, or any other bony or soft tissue impingements. Connecting rod is placed ipsilateral. Next a tapered nut is threaded on the screw until it is partially imbedded in the pedicle. Distraction or compression and reduction of listhesis attained. Transverse connector is placed wherever required.

Bone graft obtained from the excised loose fragment or from iliac crest made into slivers and after preparation of intertransverse area, corticocancellous strips placed beneath the transverse processes, over the transverse ligament. The graft with the cortical side placed toward the ligament. All cartilage from the facets should be removed, which are to be fused. Cancellous bone grafts to be placed in the facet defects. Gel foam placed at laminectomy site where dura exposed and suction drain placed closure done in multiple layers. The patient is put in the post-operative ward and all the vital parameters are recorded. Blood transfusion is done based on the assessment of per operative and post-operative loss.

Parenteral antibiotics were administered for 5 days. The patient is given bed rest and adequate care is given as far as prevention of bedsores is concerned. On 1st post-operative day encourage patient to sit. The 2nd day after the surgery the drains are removed and the operative wounds are inspected and mobilized out of bed by assisted walking for a day then advised walking without support. The patient is given bed rest for a week and during this period the neurological as well as the symptomatic improvement recorded. The skin sutures are removed on the 10th postoperative day and the patient is discharged and asked to continue follow up on a regular basis to note clinical and radiological parameters.

All patients were followed at regular intervals i.e 6weeks, 24weeks, 48 weeks and followed upto 2 years. The results of the surgical procedure were assessed by reduction of slip and by Meyerding classification.

The Meyerding classification is based on the amount of anterior subluxation of the cephalad vertebra in relation to the caudal vertebra. The slippage is graded as the...
percentage relative to the sagittal diameter of the inferior body. The slip grade is calculated by determining the ratio between the anteroposterior diameter of the top of the inferior vertebra and the distance the cephalad vertebra has slipped anteriorly. Grade 1 25% or less, Grade 2 between 25% and 50%, Grade 3 between 50 to 75%, Grade 4 more than 75%.

Pain relief and functional improvement was analysed on the basis of Japanese Orthopaedic Association Score Clinical results are evaluated based on Kim and Kim criteria
Excellent : Complete relief of pain in back and lower limbs. No limitation of activation. No analgesic usage
Good : Pain relief mostly from back and legs. Return accustomed employment. Physical activity slightly limited. Analgesics used infrequently
Fair : Partial relief of pain from back and lower limbs. Able to return to accustomed employment. Able to return to accustomed employment with lighter duties. Physical activities definitely limited. Mild analgesics used frequently.
Poor : Little or no pain relief in back and lower limbs. Unable to return to the accustomed employment. Physical activities greatly limited. Analgesics used regularly.

Outcome
In our study 34 patients of spondylolisthesis of varied etiology are operated with posterior instrumentation with pedicle screw fixation, posterior loose fragment excision and posterolateral fusion.

Youngest patient was 24 years old and oldest 70 years. Maximum number of patients was between 31-60 years and the average age was 43.6 years.
Male patients were 9 and female patients 25.
32 were single level slip and 2 cases were multi level slip.
Level of slip was L4-L5(21), L5-S1(8), L3-L4(2) and L1-L2(1).
Radiological grading preoperatively for level 1 was 21 (61.8 %) level 2 was 11 (32.3%) and level 3 was 2 (5.9%).
The main symptom was low-back pain with radiating pain to the lower extremities. There was no difference in the clinical symptoms and physical findings between the males and females, the duration of symptoms ranging from 1 week to 10 years. All the patients have had spinal tenderness and palpable step while most of them had paraspinal muscle spasm (31) and transverse furrow (29), few patients have scoliosis (3) and kyphosis (1). All patients had reduced spinal movements. 28 patients had motor deficit in left or right lower limbs. 26 had sensory deficit with distribution along L4, L5 or S1 dermatomes and 6 patients had a sluggish ankle reflex.

All the patients underwent posterior instrumentation with pedicle screws, decompression and loose fragment excision, decompression and posterolateral fusion with bone graft (local or iliac crest) done.
Most of patients (70.6%) underwent one level fixation, 23.5% patients underwent two level fixation and 5.9% patients with three levels fixation depending on the severity of spine instability.
Post operatively 38.3% patients were normal (without slip), 58.8% had grade I, and 2.9% patients had grade II spondylolisthesis based on Meyerding classification. In this series, 70.6% patients reduction attained was by one grade, 2.9% reduction by two grades and 26.5% reduction not attained.
Average improvement in the symptoms and functional status of the patients based on JOA Score was 87.7% (range from 44% to 95%). 87% cases had >70% improvement in and only 1 case had <50% improvement.
There were 4 complications seen in three patients (8.8%). For foot drop in one patient, ipsilateral pedicle screws were removed but he did not recover. Intraoperative pedicle failure was seen in one with screw breakage 2.9%, one patient had pedicle screw breakage identified in 3rd follow up (6 months) radiographs but the fixation appeared stable.
The establishment of fusion was strictly derived from radiograph confirmation of continuous bone traversing the grafted segments which showed no evidence of motion in flexion extension views. 23 out of 34 obtained bony fusion while 11 patients did not till their last follow up. The fusion rate was 67.6%.

Results
Evaluation of clinical results based on Kim and Kim criteria was done. 73.6% patients had achieved clinical successful results (Excellent 5.9%, Good 67.7%, Fair 23.5% and Poor 2.9%).
Discussion
Posterior instrumentation with pedicle screw fixation, posterior loose fragment excision decompression and posterolateral fusion has long been considered the gold
standard technique\textsuperscript{17} for surgical treatment of adult spondylolisthesis and is preferred by many in the treatment of low-grade symptomatic lesions. We believe that the initial relief in the symptoms may be due to the stabilization effect of the internal fixation device, and permanent relief can be related to attainment of satisfactory fusion, and resorption of the osteocartilaginous mass may also contribute to the clinical improvement.

We used JOA score for evaluating pain relief, functional outcome because we found it to be simple and our results showed a 87.7% (range 40-95%) improvement as postoperative outcome and it is comparable to the 60-98% reported in the literature\textsuperscript{18,19}. Improvement of average JOA scores of 8 to 21.8. A strict comparison of results is, however, difficult because of differences in surgical procedures, types of bone grafts, choice of instrumentation, postoperative protocol, rehabilitation, smoking and analyzing score. The clinical outcome is assessed based on Kim and Kim criteria and in our observation showed satisfactory results (73.6% including excellent and good) and comparable with other studies.

We compare our clinical results with Mohammed et al, BJ Shin et al, JC Lee et al, based on Kim and Kim\textsuperscript{20} criteria. The results are nearly similar to other studies ie. in our study satisfactory (including excellent and good) results 73.6%, Mohammed et al\textsuperscript{21} 66.6%, BJ Shin et al\textsuperscript{22} 83.4%

**Conclusion**

1. From this study we concluded that the results in symptomatic spondylolisthesis in adults, with low back and radicular pain and without major neurological deficit, of posterior instrumentation with pedicle screws, posterolateral fusion with posterior loose fragment excision, decompression yield a satisfactory outcome in the majority of cases.

2. Fusion is achieved in a large number of subjects and is closely related to the satisfactory outcome. Following posterior instrumentation with pedicle screw fixation, posterior loose fragment excision and posterolateral fusion there is improvement in substantial pain, functional disability and quality of life in most of the patients.
3. This is relatively more safe procedure and is associated with a high rate of clinically successful result in the hands of an experienced surgeon.

4. Therefore it is recommended that this procedure should be the method of choice in the surgical treatment of spondylolisthesis especially with low grade (Grade I and II) spondylolisthesis and in older age.

5. Careful patient selection appears critical in predicting the maximum benefit from this technique. Few patients have intermittent symptoms which are relieved by medication. It needs to be addressed to keeping in mind all the various factors that are involved with it.

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**Competing Interests**

We declare that there are no impending interests in publishing this article.