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Functional Outcome of Instrumentation and Interbody Cage Fusion in Cases of Lumbar Spondylolisthesis

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Abstract

Background: Primary lumbar vertebral instability or "spondylolisthesis" is perhaps one of the commonest radiological sign associated with lumbo-sacral pain after the third decade of life. **Aims and Objectives:** To find out the functional outcome in terms of clinical improvement in cases of single level lumbar spondylolisthesis by bone grafting and interbody cage fusion and pedicle screw fixation after decompression of neural elements. **Materials and Methods:** All the patients were evaluated by anteroposterior and lateral radiographs of the lumbosacral spine centered at the appropriate level. In all cases flexion and extension views were taken to assess the instability. More than 4 to 5 mm of sagittal translation and 10 degrees of rotation were considered as instability. All cases were evaluated further by MRI to evaluate facet joint pathology, sacralization/lumbarisation and to find the associated disc changes and the nerve root involvement. All patients were treated by decompression and interbody fusion with cage and bone graft by either Transforaminal or Posterior approach and instrumentation done with pedicle screws. Post operatively all patients were assessed for the functional outcome using the Oswestry Disability Index at 1 month, 3 month and 6 months **Results:** There is statistically significant difference in ODI Scores (Oswestry Disability Index) post operatively at 1 month, 3 month and 6 months. **Conclusion:** In agreement with good results, found in our study, we strongly believe that this technique of fusion and instrumentation is very useful in management of lumbar spondylolisthesis. However, this study should further be extended to a wider sample of patients with a longer follow-up.

Keywords: Back Pain, Interbody Cage fusion, ODI Score, Spondylolisthesis

1. Introduction

Low back pain is ranked as the greatest contributor to global disability (measured in YLDs, years lived with disability) and the sixth in terms of overall burden (measured in DALYs Disability-adjusted Life Year)[1].

Primary lumbar vertebral instability or "spondylolisthesis" is perhaps one of the commonest radiological sign associated with lumbo-sacral pain after the third decade of life[2]. Patients presenting with neurogenic claudication, radiculopathy and low back pain often have canal stenosis associated with spondylolisthesis[3]. Initially trial of non surgical methods, such as physical therapy[4], life style modifications[5], NSAIDS[6] and epidural corticosteroid injections[7,8] are tried which in most cases successfully relieve the patients of symptoms.

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Surgical intervention is considered in patients who have failed a full course of conservative treatment and have consistent severe back and predominant leg pain, evidence of instability on imaging with progressive spondylolisthesis, detereoration of the neurologic deficit or cauda equina symptoms[9]. Broadly surgical options are divided into two categories namely, repair of pars defect[10,11] as one and arthrodesis[12,13] of the involved segments to prevent slip progression with or without decompression of affected neural structures as other.

Most patients can expect to be satisfied with their surgical treatment results. One study reported a satisfaction rate of 86.6%[14]. Although the number of surgical options available to manage spondylolisthesis has increased in the past decade, decompression laminectomy with partial medial facetectomy and instrumented fusion remains the standard against which all other novel techniques are compared[15].

2. Aims and Objectives

The purpose of our study is to find out the functional outcome in terms of clinical improvement in cases of single level lumbar spondylolisthesis by bone grafting and interbody cage fusion and pedicle screw fixation after decompression of neural elements.

3. Materials and Methods

The present prospective study was conducted in the department of Orthopedics, Dr. Vasantrao Pawar Medical College, Hospital and Research Centre, Nashik, Maharashtra, India from June 2015 to December 2017. A total of 30 patients were included in the study after satisfying the eligibility criteria and after obtaining the written informed consent. The detailed clinical history, complete general, systemic and local examination and pre-operative investigation findings were noted.

3.1 Inclusion Criteria

- Patients of age group 25–70 years irrespective of gender.
- Failure of conservative management.
- Radiologically diagnosed cases of grade 1 and 2 lumbar spondylolisthesis.

3.2 Exclusion Criteria

- Metabolic bone disorders.
- Multiple level spondylolisthesis.
- Revision surgeries.
- Patient not willing for consent.

The drainage tubes were removed after 48 hours and the patient is allowed to turn in bed. The sutures are removed on 12th day. Patients were allowed to ambulate after drain removal with a lumbosacral belt. After 3 months the lumbosacral belt is withdrawn gradually.

Post operatively all patients were assessed for the functional outcome using the Oswestry Disability Index at 1 month, 3 month and 6 months. The Oswestry Disability Index[16] (also known as the Oswestry Low Back Pain Disability Questionnaire) is an extremely important tool used to measure a patient's permanent functional disability. The test is considered the 'gold standard' of low back functional outcome tools[16].

Scoring instructions (Table 1)

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 1. Interpretation of scores of Oswestry Disability Index

0% to 20%: minimal disability:	The patient can cope with most living activities. Usually no treatment is indicated apart from advice on lifting sitting and exercise.
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. Personal care, sexual activity and sleeping are not grossly affected and the patient can usually be managed by conservative means.

41%-60%: Severe Disability	Pain remains the main problem in this group but activities of daily living are affected. These patients require a detailed investigation.
61%-80%: Crippled	Back pain impinges on all aspects of the patient's life. Positive intervention is required.
81%-100%:	These patients are either bed-bound or exaggerating their symptoms.

3.3 Methodology

All the patients were evaluated by anteroposterior and lateral radiographs of the lumbosacral spine centered at the appropriate level. In all cases flexion and extension views were taken to assess the instability. More than 4 to 5 mm of sagittal translation and 10 degrees of rotation were considered as instability. All cases were evaluated further by MRI to evaluate facet joint pathology, sacralization/ lumbarisation and to find the associated disc changes and the nerve root involvement. All patients were treated by decompression and interbody fusion with cage and bonegraft by either Transforaminal or Posterior approach and instrumentation done with pedicle screws.

3.4 Statistical Analysis

All the collected data was entered in Microsoft Excel sheet 2007 and then transferred to SPSS software version 17 for analysis. Qualitative data was presented as frequency and percentage and analysed using one way repeated measure "ANOVA" and Post hoc test for analysis between individual groups . P-value <0.05 was taken as level of significance.

4. Results

In the present study, mean age of the study participants was 58.83 (SD= 8.12) (Table 2). There were female predominance (63.33%) among the participants (Table 3). Degenerative Spondylolisthesis was the most common type encountered in the present study (Table 4).

The patients were followed-up post operatively at 1 month, 3 month and 6 months. During follow-up patients were assessed clinically for pain, spasm and neurological deficit. The quality of life is assessed by a scoring system called Oswestry Disability Index as described previously taking into account the social life which is more important than the radiological indices.

The Oswestry Disability Index scores went on decreasing during the post-operative follow-up visits (Table 6). The difference was statistically significant (Table 7,8,9).

Table 2. Mean age of the study participants

Age: in years

Mean	58.83
Standard Deviation	8.12
Highest	69
Lowest	29

Table 3. Gender distribution of study participants

Sex :

Male	11 (36.67%)
Female	19 (63.33%)

Table 4. Shows type of spondylolisthesis

Degenerative Spondylolisthesis	27 (90.00%)
Isthmic Spodylolisthesis	3 (10.00%)

Table 5. Showing type of surgery done

PLIF	6 (20%)
TLIF	24 (80%)

Table 6. Showing ODI (Oswestry Disability Index) scores at various times

ODI Scores

	ODI Score (Mean ± SD)
Pre-op	70.10 ± 5.44
Post op 1 month	64.77 ± 4.20
Post op 3 months	56.12 ± 5.34
Post op 6 months	23.80 ± 6.23

Table 7. Showing statistically significant difference in ODI values post operatively

One way Repeated Measures ANOVA

	SS	df	MS	F Statistics
Columns	38731.15	3	12910.38	529.4853
-Error	2121.312	87	24.38289	
-Subjects	1204.726	29	41.54229	
Total	42057.19	119		

F (3,87) = 529.4853, F crit = 2.709402, p-value = 9.63E-56

As F>Fcrit, (p<0.001), there is a Highly Significant Difference in the outcome.

Table 8. Showing significant p-value by one way repeated Analysis of Variance (ANOVA) by one way repeated measures ANOVA

F statistics	p-value	Significance
F (3,87) = 529.4853	<0.001	Highly Significant

Table 9. Showing statistically significant results between individual groups Post hoc test (Analysis between Individual groups) Bonferroni corrected α value = 0.0083

Between Groups	p-value	Significance
Pre-op ODI and PO ODI(1)	3.06E-05 (<0.001)	Highly Significant
Pre-op ODI and PO ODI(3)	1.106E-12 (<0.001)	Highly Significant
Pre-op ODI and PO ODI(6)	7.75E-25 (<0.001)	Highly Significant
PO ODI(1) and PO ODI(3)	1.77E-09 (<0.001)	Highly Significant
PO ODI(1) and PO ODI(6)	1.04E-22 (<0.001)	Highly Significant
PO ODI(3) and PO ODI(6)	1.97E-19 (<0.001)	Highly Significant

Complication: Dural sac puncture was seen in 2 patients (6.67%).

5. Discussion

5.1 Classification

Spondylolisthesis is derived from the Greek word "spondylos" (vertebra) and "olisthesis "(to slip or fall). Spondylolisthesis is defined as the forward slippage of a cephalad vertebra on a caudal vertebra[17,18]. In terms of the adult lumbar spine, this displacement results from a causative defect in bony architecture, trauma or degenerative changes over time[19].

The classification scheme of Wiltse, et al.[20] has gained wide acceptance. It combines both anatomic and etiologic elements; however, this combination is one criticism of this system (Table 10).

Table 10. Showing types of spondylolisthesis

Type	Description
Type 1 (Congenital spondylolisthesis)	Inherited defect in superior or inferior facet or both with anterior translation of vertebra. It is most common at L5S1 level.
Type 2 (Isthmic spondylolisthesis)	Defect in pars interarticularis
Type 3 (Degenerative spondylolisthesis)	Degenerative changes in facet leading to remodelling and anterolisthesis
Type 4 (Post traumatic)	Acute trauma leading to failure of posterior elements
Type 5 (Pathological)	Pathological destruction of posterior elements .

Wiltse classification (From Wiltse, et al.[22])

5.2 Incidence

The incidence of defects in the pars interarticularis is 4% to 6% overall. Isthmic spondylolisthesis has an incidence between 2.6% and 4.4% and is more prevalent in males[21] with L5-S1 as most common level. The incidence of isthmic spondylolisthesis also varies according to race with 6.4% in white American males, 2.8% in black males, 2.3% in white females and 1.1% in black females. Degenerative spondylolisthesis is four to five times more common in females than in males with 8.4% incidence in females against 2.7% in males. It is more common in black population.

5.3 Imaging

Initially plain radiographs are adviced with standing antero-posterior views and dynamic lateral views. In cases of lytic spondylolisthesis oblique views are required. MRI is investigation of choice to assess the compression on nerves. A radiographic grading system was given by Meyerding in 1932 which is most common in use nowadays[22], with distance of vertebral body translation anteriorly measured in percentage (Table 11).

Table 11. Imaging modalities[23]

Modality	Benefits	Notes
Radionuclide (Technetium 99 mm) Bone Imaging	Identify pars interarticularis stress fractures	Recent trauma/ symptomatic with strenuous activity: increased uptake in
	without a visible bony defect	spondylolytic area Chronic LBP: normal scan if defect is chronic, sclerotic, and avascular
SPECT (Single Photon Emission Computed Tomography)	More sensitive than plain radiographs or technetium bone scan	"Hot scan" suggests increased activity (orthotic immobilization may be beneficial) "Cold scan" suggests chronic lesion/not metabolically active (unlikely to respond only to orthotic immobilization)
CT (Computed Tomography)	Gauge degree of spondylolisthesis Assess healing potential of identified pars defect	Superior to plain radiographs in revealing dysplastic facets, pars defects, changes in apophyseal joints
MRI (Magnetic Resonance Imaging)	Soft tissue Neural structures	No exposure to radiation

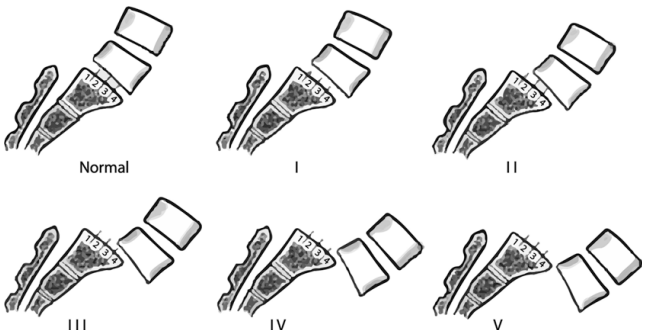

Figure 1. Meyerding grading system.

The five grades of the Meyerding grading system[22]. Grade 1, 0–25% of the vertebral body; grade II, 26–50%; grade III, 51–75%; grade IV, 76–100%; grade V, spondyloptosis (Figure 1).

Spondylolisthesis is a condition reported over two centuries ago with different types and grades of slip. General population prevalence rates for the condition are not known but probably around 5-6%[25] in the adult population.

In our study of 30 cases, the mean age of patients were found to be 58.83 years. Many other observations in this study are also comparable to the established facts described in the literature. This includes the overwhelming female preponderance in this condition. (Female – Male Ratio 2:1)[24], more common diagnosis of degenerative spondylolisthesis[25] and the fact that spondylolisthesis being commonest in the lower lumbar level[26].

The goals of the surgery in spondylolisthesis are to relieve pain and the neurological deficit to provide stability and to prevent progression by fusion. Following are some of the points to discuss in management:

Whether surgery is indicated or not.

Whether spinal decompression is required.

Spinal fusion – whether posterior or anterior or combined.

Whether instrumentation required for improving fusion.

Whether reduction should be attempted or not.

In general the younger the patient with painful spondylolisthesis, the more definite is the

indication for surgery and the more likely is surgery to be successful. Persistence of symptoms in spite of adequate conservative management constitutes the main indication in our study. 'Risk of progression of slip if not surgically treated' is an often used surgical indication. However, it is difficult to quantify what the real risk of progressive slipping is. Wiltse and Hutchinson[27] have described a reasonable policy for the surgical treatment of spondylolisthesis and are widely accepted.

In isthmic spondylolisthesis, conservative management is the mainstay of treatment. Only if it fails, surgical management is considered. With the available literature, instrumentation with interbody spinal fusion is the current method of choice with or without decompression. Decompressive procedures in spondylolisthesis have their proponents and there are two basic methods – removal of the loose posterior element (Gill's operation) or decompressive laminectomy. In isthmic types a true neurological deficit is rare radicular symptoms occasionally encountered resolve with solid fusion, along with other symptoms such as Hamstring tightness. In our study of 3 cases of isthmic lytic spondylolisthesis, our management involved instrumentation with interbody spinal fusion without decompression except in 1 case where associ-

ated disc changes were present. All patients during their follow up showed an improvement in their clinical and functional outcome, though radiologically, slip were not reduced. We are treating the clinical picture rather than radiological picture!

Degenerative Spondylolisthesis (DS) is a special problem, that it produces symptoms of stenosis of either the canal or the lateral recess. Vilbert, et al. suggested that if patients fail a reasonable course of therapy of 4–6 weeks, they may benefit in the short term from a course of epidural steroid injections.

Physiotherapy mostly used method to apply non-operative treatment of symptoms associated with Degenerative Spondyloisthesis. Despite many surgical options exist for the treatment of DS, it is generally agreed that in most cases non-operative treatment should be attempted before surgical intervention is pursued. Surgical management requires decompression of the appropriate roots by laminectomy and foraminotomy with insitu instrumentation and fusion with interbody cage . In our series of 27 cases, we did laminectomy and instrumented fusion with excellent results during the follow up. Thus decompression has a definite role in most of the cases of Degenerative Spondylolisthesis.

With regard to spinal fusion, fixation of the unstable spine by interbody fusion is the treatment most surgeons prefer. Posterior rather than anterior fusion is preferred by most because its technique is more flexible, it permits exploration of the defects, nerve roots and intervertebral discs. In addition it is relatively safe. In our study the overall fusion rate achieved was 95% and it is comparable with most literature.

Another interesting debating point is whether spinal instrumentation is required to improve the results in surgery for spondylolisthesis. Pedicle screw fixation and rods has shown the greatest improvement in the overall fusion rates in adults. Deguchi in their study of 83 cases concluded that for multilevel spinal fusion in isthmic spondylolisthesis a rigid pedicle screw fixation resulted in a high fusion rate and single level fusion was equally effective with either rigid or semi-rigid pedicle screw instrumentation. In our study the fusion rate with pedicle screw instrumentation was 95%.

"Spondylolysis and Spondylolisthesis are diagnoses that, for most patients have a benign prognosis and can be managed non-operatively. For most symptomatic patients for whom this management fails, fusion in situ yields satisfactory and long lasting results and remains the gold standard against which other surgical treatment must be compared" (Smith JA 1999).

6. Summary and Conclusion

6.1 Summary

The highest age of patient in our study was 69 years and lowest age was 29 years with mean age of 58.83 (standard deviation 8.12) with female (63.33 %) predominance. The most common diagnosis was of degenerative spondylolisthesis (90%) followed by isthmic spondylolisthesis (10%). Fusion with instrumentation was done by two techniques, TLIF (Transforaminal Lumbar Interbody Fusion) and PLIF (Posterior Lumbar Interbody Fusion). TLIF done in 80% cases and PLIF in rest 20% cases. Two patients had intra operative complication of dural sac puncture (6.67%). There is statistically significant difference in ODI Scores (Oswestry Disability Index) post operatively at 1 month, 3 months and 6 months.

6.2 Conclusion

Spondylolisthesis is a common condition for which conservative treatment is successful. Surgical management mainly depends upon the patient symptoms, radiology findings and surgeon's preference.

In agreement with good results, found in our study, we strongly believe that this technique of fusion and instrumentation is very useful in management of lumbar spondylolisthesis. However, this study should further be extended to a wider sample of patients with a significant follow-up.

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