FUNCTIONAL OUTCOME OF SPONDYLOLISTHESIS TREATED BY TRANSFORAMINAL LUMBAR INTERBODY FUSION WITH CAGE AND PEDICULAR SCREW FIXATION – A PROSPECTIVE STUDY

Original Article
Orthopaedics

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Abstract:

Background: Spondylolisthesis when symptomatic is treated by a variety of fusion techniques, the two commonest being posterior lumbar interbody fusion and transforaminal lumbar interbody fusion. The purpose of this study is to evaluate the functional outcome of spondylolisthesis treated by transforaminal lumbar interbody fusion with cage and pedicular screw fixation.

Materials and methods: 30 patients of spondylolisthesis who underwent transforaminal lumbar interbody fusion with cage and pedicular screw fixation between September 2013 and June 2015 were included in this prospective study. The pre-operative and post-operative functional outcomes at the end of 1 year were assessed using Oswestry Disability Index (ODI) and p value calculated.

Results: Out of the 30 patients included in the study, female-male ratio of 2:1 was observed. The mean age of the patients was 49.13 years (range 36-65 years). Twenty three patients (76.7%) had Grade I spondylolisthesis and 7 (23.3%) had Grade II spondylolisthesis. The mean operation time was 143.33 minutes (range 110-240 minutes) with a mean blood loss of 300 ml (range 150-500 ml). The average follow-up was 8.1 months (range 6-20 months). The mean ODI score pre-operatively was 31.46% (range 25-42%) and post-operatively 16.9% (range 10-28%). 3 patients developed intermediate complications with no long term effects. Excellent results were noted in 21 (70%) patients, good results in 8 (26.66%) and fair result in 1 (3.33%) patient. P value was found to be highly significant.

Conclusion: Transforaminal lumbar interbody fusion with cage and pedicular screw fixation is an effective treatment option for spondylolisthesis with high fusion rates and minimal postoperative morbidity.

Key-words: *Spondylolisthesis, transforaminal lumbar interbody fusion, Oswestry disability index.*

Introduction:

Lumbar spinal instability caused by spondylolisthesis is a very common disease entity seen in day to day orthopaedic practice. Spondylolisthesis is defined as anterior or posterior slipping of one segment of the spine on the next lower segment.[1] Spondylolisthesis usually involves a bony defect in the pars interarticularis.

The prevalence of spondylolisthesis in the general population is estimated to be around 5-8%.[1] However, the incidence is as high as 47% in elite athletes especially in those who are involved in high risk sports activity like diving and gymnastics.[1] Patients with spondylolisthesis are initially treated non-operatively. Surgical intervention is required when the condition worsens with significant neurological deficit. Non operative treatment includes restriction of daily activities, life style modifications, weight reduction measures in case of obese patients, lumbar brace, lumbar strengthening exercises and intrathecal steroid injection for pain management. Conservative management yields good results and only about 10% of the patients require surgery. Surgical intervention is aimed at achieving neurological decompression and maintaining lumbar stability both in the coronal and sagittal planes. This could be achieved by posterior decompression and lumbar fusion. Currently a variety of techniques of lumbar fusion are available for spondylolisthesis.[2] However the ideal technique of lumbar fusion still remains controversial.[3] In recent times, the interbody fusion has evolved as the most reliable fusion technique available for the lumbar spine instability. Two methods of interbody fusion by posterior approach are described namely the posterior lumbar interbody fusion (PLIF) and transforaminal lumbar interbody fusion (TLIF). The technique of PLIF has undergone several modifications since its original description by Cloward.[4-6] However PLIF is associated with high incidence of fusion complications like graft collapse and non-union[5,6] in addition to longer operating time with greater blood loss and tissue scarring.[7-9] On the contrary, TLIF has gained popularity owing to diminished rate of dural injury, nerve root injury and pseudoarthrosis.[10-12] The purpose of this study is to evaluate the functional outcome of spondylolisthesis treated by transforaminal lumbar interbody fusion with cage and pedicular screw fixation.

Materials and methods:

This study was undertaken in the Department of Orthopaedics at Sri Manakula Vinayagar Medical College and Hospital, Pondicherry after obtaining approval from the institutional ethical committee. It is a prospective study of all patients in the age group 18-65 years with symptomatic spondylolisthesis who attended our institution between September 2013 and June 2015. Patients with grade I and II spondylolisthesis, degenerative and isthmic spondylolisthesis, spondylolisthesis causing lumbar spine instability at single motion segment and those who failed conservative management were included in the study. Patients with other spinal deformities, poliomyelitis, cerebral palsy and other generalised bone disorder, patients with systemic infection, previous interbody fusion at target level and pregnant/lactating women were excluded from the study. All patients received at least three months of conservative treatment before proceeding to surgery.

A total of thirty patients who fulfilled the inclusion/exclusion criteria were included in the study after obtaining informed consent. A thorough clinical history was elicited followed by local and systemic examination to assess the cause of lumbar spinal instability. Anteroposterior and lateral radiographs centred at appropriate levels along with flexion and extension lateral views were taken for all patients to assess the instability. Also further evaluation using MRI was done to assess the facet joint pathology, sacralisation/lumbarisation, and to find the associated disc changes and nerve root involvement. Transforaminal lumbar interbody fusion (TLIF) with cage and pedicular screw fixation was performed for all patients by a single senior surgeon after reserving adequate blood depending on the individual requirements. Prophylactic intravenous antibiotics were administered just before induction of anaesthesia.

Surgical technique:

Under general anaesthesia, patient was placed in a prone position on a radioluscent table. After preparation of the surgical parts, the level of listhesis was confirmed by C-arm machine using a lateral view. Through a 5-7 cm midline posterior incision centering over the involved segment, paraspinal muscles were retracted laterally on either side. Spinous process, lamina and the facet joints were exposed. Further subperiosteal reflection of the muscles exposed the base of the transverse process on either side. Entry point for pedicular screw was identified by either the mammillary process technique or the intersection technique. Using an awl the dorsal cortex of the pedicle was penetrated.

Curved or straight pedicle probe was used to develop a path for the screw through the pedicle into the body. A pedicle sounding probe was used to make sure that there was no violation of the pedicle cortex. After tapping the path, 6.5 mm titanium screw of the longest possible length was inserted in all the four pedicles at the target level. The screw penetration was usually between 50-80% of the anteroposterior diameter of the vertebral body. Once the pedicle screws were placed, a rod of appropriate length was inserted on one side and the cap screws were tightened with distraction across the screw heads. The distraction assisted in opening up the disc space for cage insertion. Facetectomy was then performed using an osteotome at the inferior articular process of upper vertebra and the superior facet of the caudal vertebra. The removed bone was morselized to serve as fusion autograft. Discectomy was performed through the transforaminal approach and an interbody cage of appropriate size packed with autograft was impacted into the disc space. Distraction across the screw heads was released to compress the cage and another rod of appropriate length was placed on the other side. Wound was sutured in a routine fashion with a surgical drain in situ. Post-operatively, intravenous antibiotics were continued for three days along with analgesics and anti-inflammatory drugs. Patients were ambulated from 2nd post-operative day. Fusion level was protected with lumbosacral brace for 3 months post-operatively.

Clinical follow-ups at 2 weeks, 6 weeks, 3 months, 6 months and 1 year were done. During each visit, the patients were clinically assessed for pain, spasm and neurological deficit. Radiological assessment of spinal fusion was done using standard anteroposterior and lateral radiographs and oblique view if necessary, to know the progression of spondylolisthesis. The quality of life was assessed using Oswestry disability index (ODI) pre-operatively and post-operatively as the patients' social life is more important than the radiological indices. Perioperative, immediate and late post-operative complications were recorded.

Frequency tables were generated and percentage was calculated for all variables. The test of significance was calculated by applying paired sample t-test. Using the pre-operative and post-operative ODI scores, the probability value (p value) was calculated. P value less than or equal to 0.05 was considered as statistically significant.

Results:

A total of 30 patients were included during the study period. The mean age of the patient was 49.13 years (range 36-65 years) (Table 1). There were 10(33.33%) males and 20(66.66%) females. The site of involvement was L_3-L_4 in 4 (13.33%) patients, L_4-L_5 in 18 (60%) and L_5-S_1 in 8 (26.66%) patients. Twenty three patients (76.7%) had Grade I spondylolisthesis and 7 (23.3%) had Grade II spondylolisthesis. The mean operation time was 143.33 minutes (range 110-240 minutes) with a mean blood loss of 300 ml (range 150-500 ml). The average follow-up was 8.1 months (range 6-20 months). The mean ODI score pre-operatively was 31.46% (range 25-42%) and post-operatively 16.9% (range 10-28%). At the final follow-up at 1 year, the functional outcome was considered excellent if the final ODI score had reduced and was less than 20%, good if ODI score reduced and was between 20-40%, fair if there was no significant improvement and bad if the final ODI score was higher than the preoperative score. In our study, excellent results were noted in 21 (70%) patients, good results in 8 (26.66%) and fair result in 1 (3.33%) patient (Table 2). No patient was found to have bad result with deterioration in the ODI score. The p value was calculated for the above results with paired sample t-test. The calculated t was 15.27 and the degree of freedom (df) was 29. The p value was found to be 0.0001, which was highly significant.

Out of the 30 patients, only 3 (10%) patients developed complications post-operatively (Table 3). One patient with uncontrolled diabetes mellitus developed superficial wound infection and culture and sensitivity reports showed Klebsiella growth. The infection settled down with adequate glycemic control, debridement and antibiotics. One patient had transient bladder incontinence which improved by the end of 3 months. Another patient was found to have proximal screw cut-out at the end of 6 months. In spite of the complication, the overall clinical picture of the patient improved symptomatically after surgery.

Table 1: Age distribution of the study subject

Age group (years)	Frequency (n)	Percentage (%)
35-40 yrs	5	16.66%
41-45 yrs	8	26.66%
46-50 yrs	5	16.66%
51-55 yrs	3	10.00%
56 -60yrs	7	23.33%
61-65yrs	2	6.66%

Table 2: Outcome of study

Outcome	Frequency (n)	Percentage (%)
Excellent	21	70%
Good	8	26.66%
Fair	1	3.33%
Bad	0	0

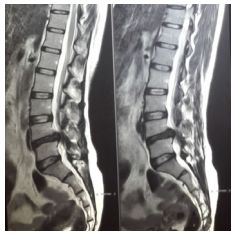
Table 3: Complications

Complications	No. of patients
Superficial infection	1
Transient bladder incontinence	1
Screw cut-out	1
Total	3

Case 1:

Pre-op X-ray

Pre-op stress views



Pre-op MRI

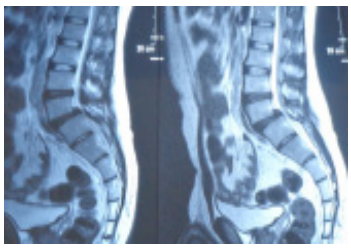
Immediate post-op X-ray

1 year follow-up X-ray

Case 2:

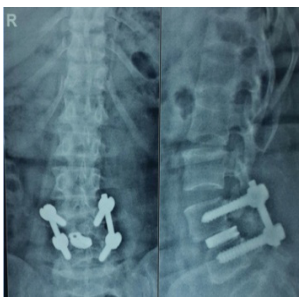
Pre-op X-ray

Pre-op stress views



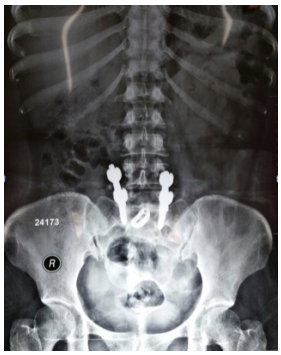
Pre-op MRI

Immediate post-op X-ray



1 year follow-up X-ray

Complication:



Screw cut-out

Discussion:

Spondylolisthesis is a common clinical disorder, which every orthopaedician encounters on a daily basis. A Belgian obstetrician, Herbinaux in 1782, however first described this condition. He described it as a bony prominence over the sacrum, which obstructed the vagina. Since then our understanding of the disease, has increased tremendously.

In our study of 30 patients, a female preponderance was noted, which is in accordance with the study by Abumi et al.[13] Also the mean age of the patients in our study was 49.13 years. This could be explained by the fact that almost 50% of the degenerative spondylolisthesis occurs in the 4th and 5th decade. Loubresse[14] based on his research concluded that the highest incidence of spondylolisthesis was in the lower lumbar segments. This was in accordance with our study, where 18 (60%) of the patients had spondylolisthesis at the L_4L_5 level, 8 (26.66%) at L_5S_1 level and 4 (13.33%) at L_3L_4 level. With better understanding of the natural history and biomechanics, the treatment options have evolved over the time. Most patients respond well to conservative treatment and only a small percentage of individuals require surgery. Surgical treatment has shown to produce good results once patients

fail a 6-week trial of standardized nonsurgical treatment that includes physical therapy, medications, and spinal injections.[15] The main aim of surgery is to provide stable fusion across the unstable segment and to relieve pain and neurological deficit. Restoration of the segmental stability by adequate neural decompression, fusion, and stabilization helps to improve clinical symptoms and achieve normal spinal anatomy.[16] Posterior lumbar interbody fusion (PLIF) offers solid fusion, restores the spinal stability, and maintains load bearing capacity of spine. With these advantages, PLIF has long been the gold standard treatment for lumbar spine instability.[17,18] Transforaminal lumbar interbody fusion (TLIF), introduced by Harms, is essentially a modification of PLIF. With lesser complication rates, this technique has widely gained popularity.

In our study, all patients underwent TLIF with cage and pedicular screw fixation. Pedicular screws are chosen over other implants because they are the only three-column fixation devices available at present.[19] Fishchgrund et al[20] in their study observed that in patients with single level degenerative spondylolisthesis, the use of pedicular screws increased the fusion rate. Deguchi et al[21] in their study of 83 patients, observed that rigid pedicle screw fixation in multilevel isthmic spondylolisthesis resulted in higher fusion rates and for single level instability, both rigid and semi-rigid fixation provided equally good results.

The source of bone graft used is another area of debate. The iliac crest bone graft has long been the gold standard for bone grafting but recent studies have proven that the local bone graft is as effective as iliac crest bone graft and reduces the donor site morbidity. John CF et al[22] in their study compared the effectiveness and safety of local bone graft with iliac crest bone graft. They concluded that local bone graft was safe and efficacious as iliac bone graft for instrumented fusion in the lumbar degenerative spondylolisthesis. Similar results were documented in our study where local bone graft was used in all patients.

In our study, the functional outcome was assessed for all patients using the pre-operative and post-operative Oswestry Disability Index (ODI) score which reduced from 31.46% to 16.9%. 21 (70%) patients showed excellent results, 8 (26.66%) showed good results and 1 (3.33%) showed fair result. Using the pre-operative and post-operative ODI scores, the calculated p value (0.0001) was found to be highly significant. Similar results were observed by Schoffermann et al[23] in their study where the ODI score reduced from 57.5% to 38.2% after circumferential fusion. Buttermann et al[24] in their study of 35 patients who underwent lumbar fusion reported an improvement of ODI from 63% to 33%. In another series of 201 lumbar fusions, Fritzell et al[25] reported improvement in the ODI from 47.3% to 35.7% after two year follow-up.

Though TLIF with cage and pedicular screw fixation provides a stable construct, it is associated with complications like pedicle fracture, screw malposition, screw cut-out, screw breakage, soft tissue irritation, adjacent level degeneration, dural tear, nerve root and spinal cord injury and anterior vascular injury.[19] In our series of 30 patients, one developed superficial infection which resolved with intravenous antibiotics and debridement. One patient developed transient bladder incontinence which was treated conservatively. Although one patient developed proximal screw cut-out, her follow-up showed improvement in the clinical and functional outcome.

The limitations in our study are a small sample size with shorter follow-up period. A larger prospective study with longer follow-up may be needed to provide a higher level of evidence.

Conclusion:

For individuals who do not respond to conservative management, fusion in situ remains the gold standard procedure and is known to produce long lasting good results. Of the various techniques available, the transforaminal lumbar interbody fusion (TLIF) with cage and pedicular screw fixation offers better fusion rates than posterolateral fusion and lesser complications than PLIF. With these advantages, TLIF has started gaining popularity.

Source of support: Nil

Conflict of interest: Nil

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