Original Article

Outcome of transforaminal lumbar interbody fusion in spondylolisthesis—A clinico-radiological correlation

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ABSTRACT

Introduction: Lumbar spondylolisthesis is a common cause of morbidity in middle aged individuals. Spinal fusion with instrumentation has become the gold standard for lumbar segmental instability. Studies which correlate the improvement in radiology postoperatively with functional outcome show contrasting reports. This study is aimed at finding the correlation between clinical and radiological outcomes after surgery with transforaminal lumbar interbody fusion.

Methods: A retrospective study in 35 patients who underwent transforaminal lumbar interbody fusion in a period of 1 year was done. Preoperative pain (VAS Score), functional ability (ODI), radiological parameters (slip angle, slip grade, disc height, foraminal height, lumbar lordosis) were compared with postoperative recordings at the last followup. Functional improvement (Macnab's criteria) and fusion (Lee's fusion criteria) were assessed. Statistical analysis was done with student's paired *t*-test and Pearson's correlation coefficient.

Results: VAS score, ODI improved from 8 to 2 and 70 to 15 respectively. Slip angle improved from 23° to 5° on an average. 80% patients showed fusion and 85% showed good clinical outcome at 1 year followup. Analyzing with Pearson correlation coefficient showed no significant relation between pain scores and radiological parameters. But there was statistically significant relation between radiological fusion and the final clinical outcome.

Conclusion: TLIF produces spinal fusion in most individuals. Strong spinal fusion is essential for good clinical outcome in spondylolisthesis patients who undergo TLIF. Reduction in slip is not necessary for all patients with listhesis.

1. Introduction

Lumbar segmental instability is defined as an abnormal response of the lumbar motion segment to physiological loads and characterized by its movement beyond the physiological limits.¹ It is a common cause for low backache and radiculopathy in middle aged individuals.

PLIF, first described by Cloward,² provides 3 column fixation of the spine. Lumbar interbody fusion with transforaminal approach is an unilateral approach and a modification of PLIF. Compared to anterior lumbar interbody fusion, the neurovascular complications are less. It reduces the handling of dural sac and nerve rootlets. Hence the incidences of their injury are less and chances of epidural fibrosis are reduced.^{3–5}

The clinical results of TLIF have been excellent. But whether all patients who achieved the satisfactory clinical outcome had strong spinal fusion, which is the ultimate aim of surgery done for instability, is questionable. There are numerous studies but with conflicting reports on the correlation of clinical and radiological outcomes. Hence this study is done to assess the clinic-radiological correlation of TLIF in

spondylolisthesis.

2. Materials and methods

35 patients operated from January 2014 to September 2015 were included retrospectively in the study. The inclusion criteria for patients were: 1) degenerative spondylolisthesis, 2) isthmic spondylolisthesis who failed atleast 6 months of conservative treatment. All patients underwent transforaminal lumbar interbody fusion and pedicle screw fixation. Patients excluded from the study were 1) previous spine surgery, 2) significant trauma and 3) postinfective sequelae, 4) multilevel spinal pathology. Preoperative VAS score,⁶ ODI score, neurological status were recorded. Radiological evaluation was done with anteroposterior radiograph, flexion-extension lumbar lateral radiographs (Fig. 1) and MRI lumbosacral spine, measuring disc height, foraminal height, lumbar lordosis, slip angle and slip grade.

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Fig. 1. Anteroposterior and stress lateral radiographs of the lumbar spine showing spondylolisthesis at L4–L5 level.

2.1. Operative procedure

With the patient in prone position, standard midline approach to lumbar spine was used. Pedicle screws were inserted under image intensifier control. Laminectomy was done in patients with significant canal stenosis. Unilateral Facetectomy was done on the side of radiculopathy. The disc space was prepared. Interbody bean cage was inserted. Rods were contoured to recreate lumbar lordosis (Fig. 2). No reduction maneuvers were attempted. All patients were mobilized on day 2 after drain removal. Bending forwards and weight lifting were restricted for 3 months.

Postoperatively radiological assessment was done measuring the same parameters. All patients were followed up every 3 months for at least 1 year. Radiological fusion was assessed using modified Lee

Fig. 2. Postoperative radiograph of TLIF showing reduction of listhesis with bean cage and pedicle screws.

criteria. Radiological structural restoration (disc height, foraminal height, lordotic angle and slip reduction) (Fig. 3) and overall functional outcome (using MacNab's criteria) are studied at the final followup. Postoperative Visual analog scale score and Oswestry disability index were recorded (Fig. 4). Statistical analysis was done with student's paired *t*-test and Pearson's correlation coefficient.

The present study was approved by the hospital ethics committee. All patients gave their informed consent before inclusion in the study.

3. Results

The average followup period of patients was 1 year. 26 patients were females and 9 were males. Most patients had grade 2 spondylolisthesis. 30 patients had degenerative type and 5 patients had isthmic type. The average operating time was 80 min. The mean blood loss was 300 ml. L4/L5 level was the most commonly involved level. The mean hospital stay was 13 days.

The mean visual analog scale for back pain was 8 in preoperative period and it significantly had reduced to 2 in the last followup period. The preoperative VAS of leg pain reduced from 8 to 2 in postoperative period.

The preop ODI of 70 improved to 15 in the last followup and it was clinically significant. The average slip angle was 23° and it had improved to 5°. The slip degree reduced in all patients by atleast one grade. The average cage size used was of 10 mm. The disc height and foraminal height were 7 mm and 14 mm in preoperative period and it measured 11 mm and 18 mm in the postoperative period.

5 patients had preoperative neurological deficit in the form of sensory blunting in 4 patients and motor weakness in 4 patients. It had improved in all except one patient. Dural tear occurred in 3 patients. All were sutured and none had new postoperative neurological deficit. One patient had superficial infection of wound site and it subsided with appropriate antibiotics.

Fusion assessed by Lee's criteria showed definitive fusion in 20 patients, possible fusion in 8 patients, possible pseudarthrosis in 4 patients and definite pseudarthrosis in 2 patients. Clinical outcome by macnab's criteria showed excellent outcome in 25 patients, good in 5 patients, fair in 5 patients and poor in 2 patients.

4. Discussion

Instability of lumbar spine from degenerative aetiology is a common problem involving mainly the lower lumbar region motion segments in middle aged individuals. This instability arises from the degeneration of articular facets and discs leading to abnormal motion under the physiological loads of activities of daily living. The resultant spondylolisthesis manifests clinically with low backache with radiculopathy which is mostly activity related.

Spinal fusion has become the gold standard in symptomatic spondylolisthesis patients who have failed conservative treatment. Adequate neural decompression, stabilization and fusion restore segmental stability and produces satisfactory outcome in these patients.⁷ Solid Spinal fusion reduces the pain due to instability at that lumbar spine motion segment.³

Interbody fusion with cages has revolutionized the surgical management of these patients with improved fusion rates. In 1990, intersomatic carbon cages introduced by Brantigan⁸ gave 92% successful and reproducible results. Interbody fusion produced better results than posterolateral fusion with reduction of slippage, lesser nonunions and implant failures.⁹ Interbody cages restore the height of disc and intervertebral foramen. This improvement in radiological outcome in a way restores the sagittal balance leading to better clinical results in long term.¹⁰

Transforaminal lumbar interbody fusion decompresses the spinal canal and neural foramen. It reconstructs anterior column and brings back the sagittal balance in through an all posterior approach.¹¹ TLIF

Fig. 3. This chart depicts the improvement in parameters post TLIF surgery when compared with their preoperative values.

Fig. 4. Illustration of reduction in the scores post surgery.

maintains the posterior soft tissues covering the dural sac. In biomechanical point of view, the interbody construct provides anterior support and the posterior soft tissues, pedicle screws and rods provide posterior tension band.

Poh et al.¹² in their results found VAS score for back and leg pain improved significantly and improved by > 4 points in 59% and 62% respectively in 2 years followup. Poor radiological outcome correlated significantly with higher VAS scores in single level fusion. In our study, VAS score for back pain (mean difference 5.88) and leg pain (5.17) has improved significantly after surgery. The ODI score improved by a mean of 48.53 from preoperative status.

Improvement in Slip angle (mean difference 24.94), Foraminal height (mean difference 5.176) and disc height (mean difference 2) was noted in our study. Slip grade reduced by 1 grade in 78% patients, 2 grades in 8% patients and did not change in 14% patients. In a study by Hayashi,¹³ the slip angle decreased from 17% to 9.7% without change in lumbar lordosis which is comparable to our study. Many studies^{14,15} have found increase in disc height and foraminal height decompresses the nerve root effectively, brings back the normal lumbar lordosis and hence the proper sagittal balance.

Kim¹⁶ in his study found that even though patients improved clinically, radiological fusion was seen in only 35% patients in 1 year. It took 4 years for radiological fusion to occur in 82% patients. Agazzi¹⁷ in his study in 71 interbody fusions reported 66% clinical success and 90% fusion rate without a significant relationship between clinical and radiological outcomes. In a significant study by Femke,¹⁸ they concluded that there was no statistical correlation between the clinical results and improvement in radiological features. Good improvement in pain scores occurred in their patients despite the amount of reduction of slip.

No significant correlation could be identified in patients with or without reduction in both high grade and low grade spondylolisthesis patients, in a prospective study by Beni¹⁹ comparing patients who underwent instrumented fusion. All these studies show that the patients need not have a radiologically sound fusion for good clinical outcome

eventhough theoretically they do. Thalgott et al.²⁰ in their 42 cases of adult spondylolisthesis treated with instrumented PLF without reduction, the fusion rate correlated with clinical outcome. In our study, all patients had improvement in radiological parameters and 70% patients had good clinical outcome. But there was no significant correlation between the VAS scores of back pain, leg pain and radiological parameters which defined the slip.

On analysis with Pearson correlation coefficient, the two tailed p value of 0.1269 showed there was no correlation between the type of listhesis and functional outcome. But all patients who had poor outcome had isthmic type of listhesis.

In the study by Femke et al., they stated presence or absence of a true bony fusion does not influence clinical outcome of patients after surgery for lumbar fusion in isthmic as well as degenerative spondylolisthesis. In our study, patients with poor functional outcome had radiological pseudarthrosis at that site. With a significant p value in Pearson correlation coefficient, Lee's fusion grade radiologically had significant correlation with functional outcome by Macnab's criteria in our study.

There are few limitations in our study. There is no control group to compare with. Secondly, the duration of followup of minimum 1 year is short period, considering the fact that spine fusions take few years to occur in some patients. Patients who did not have strong fusion at 1 year in our study might have fused with further followup in the subsequent years. There was no distinction made between the results of isthmic and degenerative listhesis.

5. Conclusion

The improvement in patient's pain did not have a positive correlation with radiological parameters used to define spondylolisthesis. Fusion occurred in most of the patients after transforaminal lumbar interbody fusion. Patients who had radiological fusion had good clinical outcome.

Conflict of interest

This manuscript has not been published or presented elsewhere in part or in its entirety and is not under consideration by another journal. All authors have approved the manuscript and agree with submission to your esteemed journal. The authors affirm that there are no potential or existing conflicts of interest that would influence our interpretation of the data in this paper.

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Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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