International Journal of Orthopaedics Sciences

ISSN: 2395-1958
IJOS 2017; 3(2): 784-788

www.orthopaper.com
Received: 23-02-2017
Accepted: 24-03-2017

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Outcome of one level instrumented posterior lumbar interbody fusion in indicated cases of prolapsed intervertebral disc (PIVD) – A clinical study

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DOI: http://dx.doi.org/10.22271/ortho.2017.v3.i2i.83

Abstract
Introduction: Lumbar disc herniation is one of the most common spinal degenerative disorders which lead to low back pain (LBP) and radicular leg pain. Heavy lifting, twisting and trauma were the most common causes of LBP, in which 52-60% are work-related. Instrumented Posterior Lumbar Interbody Fusion (PLIF) provides various advantages including load sharing, maintained the disc height, formation of three-column stability, with allowance for wider decompression, prevention of graft dislodgment, and improved fusion rate.
Aims and Objectives: To study the outcome of one level instrumented posterior lumbar interbody fusion in indicated cases of prolapsed intervertebral disc using a single cage.
Material and Methods: It is a prospective clinical study of 14 consecutive patients, who underwent one level instrumented posterior lumbar interbody fusion (PLIF). The duration of study is from June 2015 to May 2016. The duration of follow up range from 6 to 12 months. Clinical outcome is assessed using Oswestry Disability Index (ODI), Visual analog score (VAS). The radiological outcome is assessed using Modified Lee's criteria of fusion. All the data were analyzed using SPSS Statistics Desktop 22.0. Paired t test is used for comparison of preoperative and post-operative measurements and considered significant if the p-value < 0.05.
Results: Out of 14 patients, 10 were males and 4 female, with the mean age of 39.43 years. Clinically the preoperative and postoperative ODI score, VAS score are statistically significant $p<0.0001$ (the result is significant at $p\leq0.05$). The surgery restore the disc height and at a mean follow up of 9 months 12 patients (85.71%) shows possible fusion and 2 patients (14.29%) shows possible pseudoarthrosis.
Conclusion: Local bone are adequate for one level fusion. PLIF with single cage provide successful outcome when augmented with instrumentation in this type of cases.

Keywords: Posterior lumbar interbody fusion, single cage, local morselized bone graft

1. Introduction
Low back pain is a controversial subject, in which opinions differ and views conflict [1]. The lifetime prevalence of low back pain is reported to be as high as 84% [2]. Heavy lifting, twisting and trauma were the most common causes of LBP, in which 52-60% are work related [3]. In India Prasad *et al.* found that the incidence of lumbar disc prolapse was more common in people from rural area, moderate and heavy workers, vehicle drivers on bad roads [4]. Lumbar disc herniation is one of the most common spinal degenerative disorders which lead to low back pain (LBP) and radicular leg pain.[5] Massive herniation is defined as disc material occluding at least 50% or more of the spinal canal on axial MRI scans [6,7]. Lumbar spine segmental instability is also one of the important causes of low back pain, but its clinical signs and symptoms are remained poorly defined [8]. Instability of the spine has been studied *in vivo*. since 1944 when Knutsson, using functional radiographs, to study the instability associated with disk degeneration in the lumbar spine [9]. White and Panjabi defined clinical instability of the spine as the loss of the ability of the spine under physiologic loads to maintain relationship between vertebrae in such a way that there is neither damaged nor subsequent irritation to the spinal cord or nerve roots, and in addition, there is no development of incapacitating deformity or pain due to structural changes [10].

Mixter and Barr concluded that the treatment for rupture of intervertebral disc is surgical and the results are very satisfactory if compression has not been too prolonged [11].

The cause of persistent or recurring pain after intervertebral disc operations may be due to removal of an insufficient number of herniated discs, recurrence of the herniation when the intervertebral disc has been incompletely removed, arthritis of the articular facets in the area involved, narrowing of the intervertebral canal with a nerve root pressure and removal of the wrong disc. If lumbar spine fusion is done following removal of the intervertebral disc there will be no recurrence following incomplete removal of a herniated intervertebral disc [12]. In 1953 Cloward describe PLIF without instrumentation using bone plugs as a graft taken from the patient ilium bone and found that patients recover with high percentage of complete long-term cures.[13]

Instrumented Posterior Lumbar Interbody Fusion (PLIF) provides various advantages including load sharing, maintained the disc height, formation of three-column stability, with allowance for wider decompression, prevention of graft dislodgment, and improved fusion rate [14, 15]. Consequently, rods can be contoured to preserve or restore physiological lumbar lordosis [16].

PLIF using bilateral interbody cages has been a standard practice, in this study we present the clinical and radiological outcome in patients with one level instrumented PLIF with single cage and local morselized bone graft.

2. Material and methods

It is a prospective clinical study of 14 consecutive patients (10 male and 4 female), with a mean age of 39.43 years (range 30-50 years).

Inclusion criteria: Age between 18 to 60 years irrespective of sex, patient who give consent for surgery, massive disc prolapsed, clinical and radiological features of instability with PIVD Exclusion criteria: Age less than18 years and more than 60 years, who did not give consent for MRI and surgery, patient with contraindicated to MRI (pacemakers and metal implant), psychiatric diseases, infection like-osteomyelitis, epidural abscess, tumor like- metastasis, primary spinal tumor, Inflammation – osteoarthritis, sacroilitis, metabolic spinal diseases like osteoporosis, congenital anomalies of spine, spondylolisthesis.

All the patient underwent one level instrumented fusion using titanium pedicle screws with rods and bone cage. After discectomy the end plates were cleared of the cartilage. Bone cage is filled with a local morselized bone graft composed of the lamina, parts of medial facet bone and the spinous process obtained during posterior decompression, and were devoid of all soft tissue attachments. The local morselized bone chips were prepared into the size of 3–5 mm in all dimensions and were inserted into anterior third of the disc space. Then a bone cage of is inserted into the disc space, pack and tamp more graft behind it. The screw rod assembly was tightened and held in compression. Before wound closure, any free bone graft fragment pressing on neurological structures was removed. Drain is put and wound is closed in layers.

Passive leg rising exercises started on day1 postoperative. All patient are mobilized out of bed on the 2nd or 3rd postoperative day depending on the compliance of the patient using lumbosacral belt and walker. The patients are discharged and called for follow up and suture removal at 10-14th post-operative day. Bending, sitting, squatting, lifting weights were allowed at 3 to 4 months. The patient demographic data, clinical outcome assessed by ODI and VAS score, and radiological fusion by Modified Lee's criteria of fusion as shown in table 2, and related complication were analyzed.

3. Results

The fused level were L1-L2 (n=2), L4-L5 (n=10) and L5-S1 (n=2). The mean blood was 419 ml (range 355 ml- 555 ml). The mean surgical time was 121 minute (range 100-145 minutes).The mean body mass index in our study is 23.57kg/m2 with a standard deviation of 2.2 (range is 20.6 to 27.33). The mean duration of hospital stay was 12.28 days (8-15 days). The patient demographic data shown in table1

Table 1: Patient demographic data.

Case	Age /sex	Occupation	Fused level
1	30/Male	Moderate worker	L4-L5
2	45/Male	Moderate worker	L4-L5
3	38/Male	Moderate worker	L4-L5
4	38/Female	Sedentary worker	L4-L5
5	50/Male	Moderate worker	L4-L5
6	39/Male	Sedentary worker	L4-L5
7	40/Male	Heavy worker	L1-L2
8	39/Male	Moderate worker	L1-L2
9	38/Male	Moderate worker	L5-S1
10	42/Female	Moderate worker	L5-S1
11	34/Female	Moderate worker	L4-L5
12	45/Male	Moderate worker	L4-L5
13	34/Female	Sedentary worker	L4-L5
14	40/Male	Moderate worker	L4-L5

Table 2: Modified Lee's criteria of fusion

Definitive fusion	Definitive bony trabeculae bridging across the graft host interface. No movement (less than 3°) on dynamic radiographs and no gap at interface.
Probable fusion	No definitive trabeculae crossing the graft host interface, but no Detectable movement and identifiable gap at the interface.
Possible pseudoarthrosis	No definitive trabeculae crossing the graft host interface, but no detectable movement but identifiable gap at the interface
Definitive pseudoarthrosis	No definitive trabecular bone, definitive gap, and movement more Than 3° at the interface.

3.1 Clinical outcome

The mean preoperative Oswestry Disability Index (ODI) score is 85.86 and at 9 months postoperative it is 26.71. The difference in the preoperative ODI and postoperative at 9 months ODI are statistically significant (t value is -26.45 and p value is < 0.00001, significant at $p \leq 0.05$).

The mean preoperative VAS score was 7.5 and at 9 months VAS score is 2. The difference in the preoperative VAS and postoperative at 9 months follow up are statistically significant (t value is -36.47, p value is < 0.00001, significant at $p \leq 0.05$).

3.2 Radiological outcome

3.2.1 Disc Height (in millimetre): The mean preoperative disc height at the involved segment was increasing from 5.97± 0.58 mm, to 7.53± 0.84 mm at immediate postoperative examination but dropped to 7.35± 0.74 mm at 9 months follow up. The difference in the preoperative and at 9 months postoperative follow up are statistically significant, (t value is 11.37 and p value is <0.00001 significant at $p \leq 0.05$).

3.2.2 Modified Lee's criteria of fusion: At a mean follow up of 9 months, 12 patients (85.71%) shows possible fusion and 2 patients (14.29%) shows possible pseudoarthrosis.

3.3 Complications: Two cases of intra-operative dural tear without postoperative complications and one case of superficial infection.

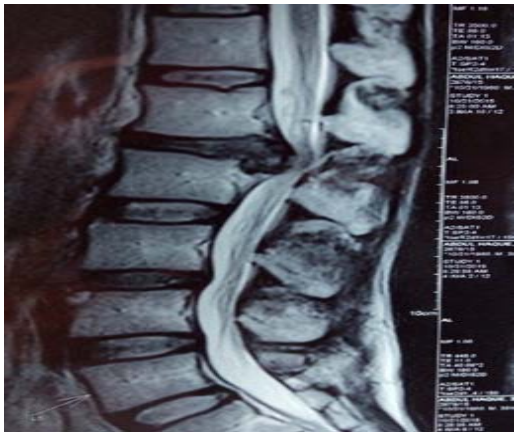

Fig 1: T2W MRI sagittal view material showing L1-L2 disc prolapsed.

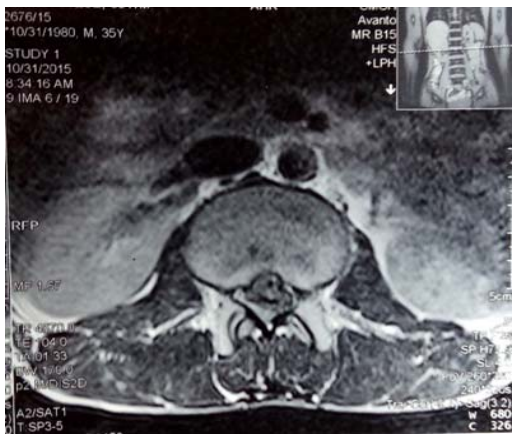

Fig 2: T2W MRI axial view showing disc Occluding more than50% of canal diameter.

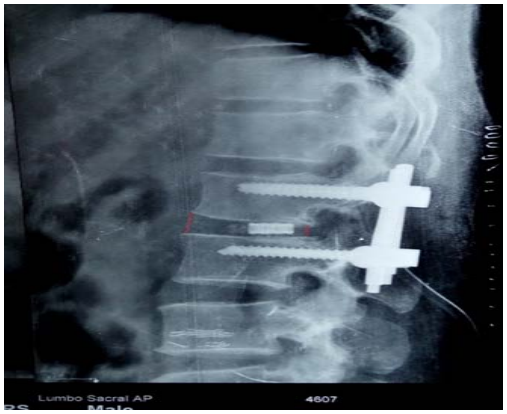

Fig 3: Immediate postoperative lateral view

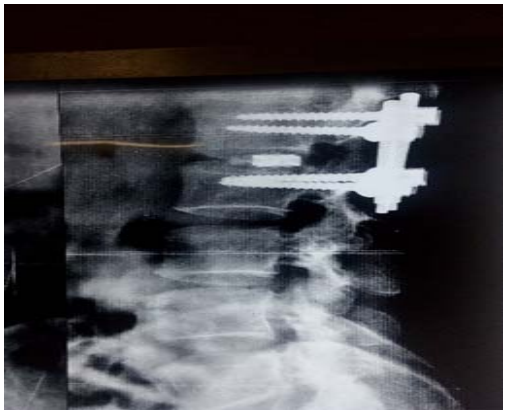

Fig 4: At 9 months lateral views showing possible fusion

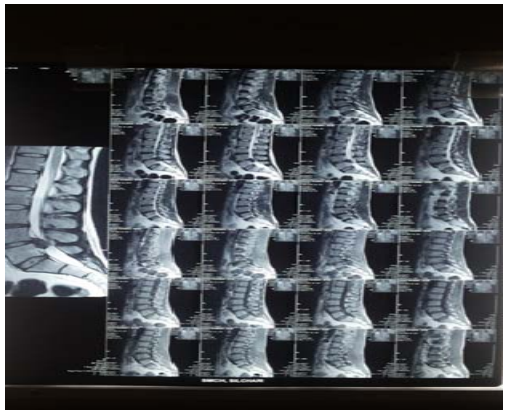

Fig 5: T2W MRI sagittal view showing prolapsed.

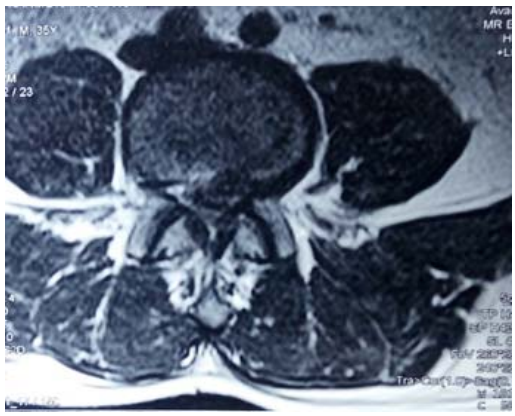

Fig 6: T2W Axial view L4-L5 disc Occluding more than 50% off canal diameter

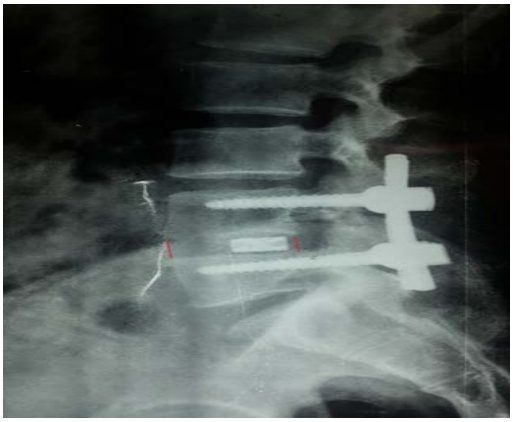

Fig 7: Immediated postoperative lateral view

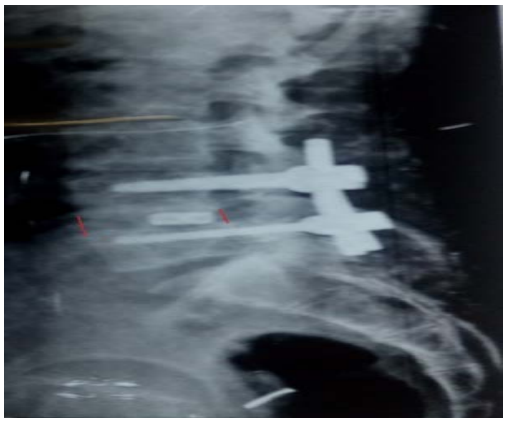

Fig 8: At 9 months lateral views showing possible fusion

4. Discussion

There are various complication following lumbar discectomy without fusion, Ambrossi *et al*. found that symptomatic same level recurrent disc herniation developed in 12% of patient after a primary discectomy resulting in the increased health care costs and morbidity of the patient [17]. Padua *et al*. found 20% of patient developed instability following discectomy [18]. Satoh *et al.* reported that lumbar disc herniation with massive herniation or segmental instability as an indication for PLIF [19]. In various study instrumented PLIF with double cage has been used but in a biomechanical study by Murakami et at, found that the single mega-cage provided an equivalent-sized cancellous bed for fusion as compared to the dual cages [20]. Molinari RW *et al.* used only a single cage in 19 patients with bone graft inserted from a bilateral approach, and concluded that the outcome is not different in using 1 or 2 cage. But the costs were higher for the 2-cage group [21].

In this study, the clinical and radiological study are comparable with other study. The mean preoperative Oswestry Disability Index (ODI) score is 85.86 and at 9 months postoperative it is 26.71. The difference in the preoperative ODI and postoperative at 9 months ODI are statistically significant and the mean preoperative VAS score was 7.5 and at 9 months VAS score is 2. The difference in the preoperative VAS and postoperative at 9 months follow up are statistically significant. Similarly in the study done by Kim DH *et al.* the ODI score improved from 70 preoperatively to 37.9 at last follow up. The VAS score for back pain improved from 6.5 to 1.8 and VAS score for radiating pain improved from 6.1 to 1.8 which are statistically significant [22]. Jin Z *et al*. also used VAS score and ODI score and they found that the preoperative and postoperative difference are statistically significant ($p<0.05$) [23].

Radiologically, in our study the mean preoperative disc height at the involved segment was increasing from 5.97$\pm$ 0.58mm, to 7.53$\pm$ 0.84 mm at immediate postoperative examination but dropped to 7.35$\pm$ 0.74 mm at 9 months follow up. The difference in the preoperative and at 9 months postoperative follow up are statistically significant. In the study done by Lee SK *et al.* the preoperative disc height increased from 7.1$\pm$ 3 mm to 9.6$\pm$3 mm and 9.2$\pm$2.5 mm at last follow up [24].

The mean spinal fusion in our study at 9 months postoperatively shows, possible fusion in 12 patients (85.71%) and possible pseudoarthrosis 2 patients (14.29%). Similarly in the study done by Satyanarayana *et al*. using Modified Lee's radiological criteria 26 patients shows definitive fusion, 21patients shows possible fusion, 3 patients shows possible pseudoarthrosis, and no patient with definitive pseudoarthrosis, The mean time of fusion in their study was 16 months postoperatively [25].

5. Conclusions

Local bone are adequate for one level fusion. The duration of operation time is less and the complication of harvesting iliac crest bone graft like persistent donor site pain, donor site infection, even iatrogenic fracture of iliac bone are overcome. Using single cage in this type of cases are costs effective and expenditure of the patient is reduced, as most of the patient are daily wage earner. PLIF with single cage provide successful outcome when augmented with instrumentation in this type of cases.

The imperfection of this study is that the clinical cases are relatively few. Although, we did not encounter any problems related to quality of implants, but we could not use implants of international standard in all patients due to prohibitive cost and our patients could not afford them. Duration and follow up of our study was short due to limited time period, as all the cases were managed conservatively for a minimum of 6 weeks before considering operation and more time is required to note the definitive fusion.

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