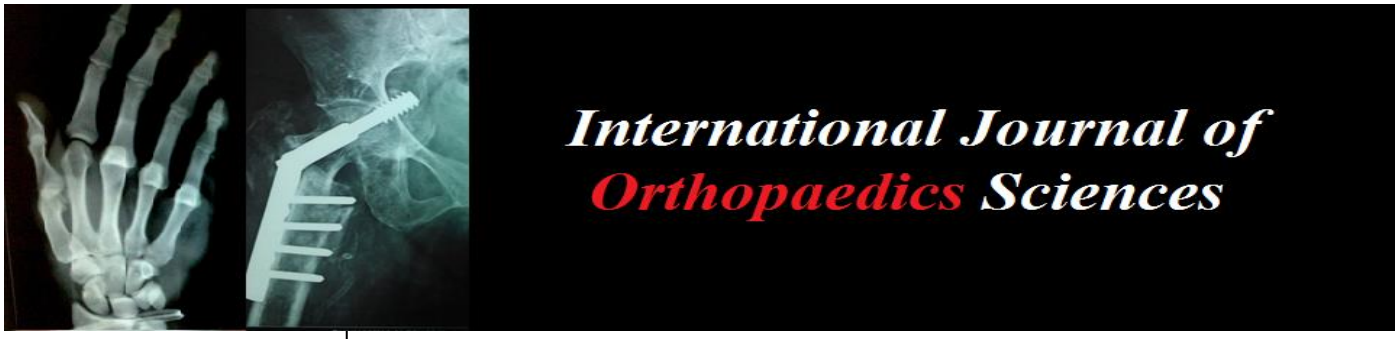

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Instrumented posterior lumbar interbody fusion using a single cage and corticocancellous laminectomy bone chips for L4-L5 massive lumbar disc herniation with instability

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Abstract
Introduction: Lumbar disc herniation is one of the most common spinal degenerative disorders which leads to low back pain and radicular leg pain. The aim of this study is to evaluate the clinical and radiological outcome of Instrumented Posterior Lumbar Interbody Fusion in L4-L5 massive lumbar disc herniation with instability.
Materials and Methods: It is a prospective clinical study of 10 consecutive patients. The duration of study is from July 2015 to July 2016. The duration of follow up range from 12 to 18 months. Clinical outcome is assessed using Oswestry Disability Index (ODI), Visual Analog score (VAS), The Japanese Orthopaedic Association (JOA) score. Radiological outcome on fusion by using Modified criteria of Lee *et al.*
Results: Of the 10 patients (8 male and 2 female) with the mean age of 60.9 years. Average follow up duration is 14 months. Mean BMI of the patients is 26.14 + 1.95 kg/m^2. The difference in pre-operative and post-operative patient's ODI, VAS and JOA scores are significant (p value < 0.05). Surgery restores the disc height and at a mean follow up of 14 months, 8 patients shows possible fusion and 2 patients shows possible pseudoarthrosis.
Conclusions: Corticocancellous Laminectomy bone chips with single cage provide adequate fusion and stability in L4- L5 Instrumented Posterior Lumbar Interbody fusion.

Keywords: Spinal fusion, posterior lumbar interbody fusion, single cage, corticocancellous laminectomy bone chips

1. Introduction
Degenerative lumbar spine is one of the most common spinal degenerative disorders which lead to low back pain (LBP) and radicular leg pain [1]. Massive herniation is defined as disc material occluding at least 50% or more of the spinal canal on axial MRI scans [2, 3]. 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 [4]. Instability of the spine has been studied *in vivo* since 1944 when Knutsson F, using functional radiographs, to study the instability associated with disc degeneration in the lumbar spine [5]. 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 (over 85 per cent). He then concluded that PLIF operation is the treatment of choice in the care of the patient with a ruptured lumbar intervertebral disc [6]. PLIF using bilateral interbody cages has been a standard practice to predictably restore segmental alignment and balance, and obtain a successful fusion. However, occasionally only a unilateral cage can be used because of various circumstances during surgery such as limited size of the disc space, nerve root anomalies which block access to the disc space, and limited ability to retract nerve roots due to epidural scarring of previous surgery [7]. A single cage with instrumented PLIF provide approximate biomechanical stability, slight greater subsidence, and a slight increase in pedicle screw stress but less early degeneration in adjacent disc as compare to the double cage [8]. Although autologous iliac crest bone graft results in good fusion there are various complication like

donor site infection and persistent pain [9, 10]. Using cage with local bone graft provide less operating time and blood loss [11]. There are various study using local bone graft with 100% successful fusion rate [12].

Though there are various type of operation for lumbar disc herniation. The purpose of this study is to evaluate the clinical and radiographic outcomes of Instrumented Posterior Lumbar Interbody Fusion using a single cage, local corticocancellous laminectomy bone chips and pedicle screw fixation for L4-L5 Degenerative Lumbar Spine.

2. Material and Methods

It is a prospective clinical study in 10 consecutive patients. Informed consent was obtained from each patient before participation in the study. The duration of follow up ranges from 12 to 18 months. The duration of study is from July 2015 to July 2016. All the patients underwent a neutral radiograph of Lumbosacral spine and functional radiograph of lumbosacral spine in flexion and extension are taken to detect any instability by using Dupuis *et al.* [13] measurement technique of instability. Functional radiograph is taken in lateral decubitus position. The height of the intervertebral disc space was calculated as the mean of the sum of the vertical distances between the anterior and posterior edges of the vertebral endplates in lateral view [14]. MRI of Lumbosacral spine is done to confirm the diagnosis. Inclusion criteria: Age between 50 to 70 years irrespective of sex who did not response to 6 weeks of conservative therapy, patient who give consent for surgery, massive disc prolapsed with clinical and radiological features of instability. Exclusion criteria: Aged <50 years and >70years, who did not give consent for MRI and surgery, patient with contraindicated to MRI (pacemakers and metal implant), Lumbar spine fracture, Spondylolisthesis, Failed back syndrome. Clinical outcome is assessed using Oswestry Disability Index (ODI), Visual Analog score (VAS), The Japanese Orthopaedic Association (JOA) score and radiological fusion by Modified criteria of Lee *et al.* [15] (Table 1)

2.1 Surgical Procedure: All the patient underwent instrumented fusion using titanium pedicle screws with rods and bone cage (Nebula). 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.

The size of a cage was determined based on the disc height. Then a bone cage of is inserted into the disc space, pack and tamp more graft behind it. Pedicle screw fixation was carried out after inserting the cage to secure the stability and to improve the bony union immediately after surgery. Before wound closure, any free bone graft fragment pressing on neurological structures was removed. Drain is put and wound is closed in layers.

2.2 Postoperative rehabilitation protocol: Passive leg rising exercises started on day1 postoperative. All patients 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.

2.3 Statistical data analysis: All the data were analysed by specific statistical test to various sets of data using SPSS Statistics Desktop 22.0. Paired t test is used for comparison of preoperative and post-operative measurements. P-values were calculated out and differences between the two groups were considered significant if the p-value < 0.05.

3. Results

Of the 10 patients (8 male and 2 female) with the mean age of 60.9 years (Range, 50 – 70 years). The average follow-up duration is 14 months (Range, 12- 18 months). Mean BMI of the patients is 26.14 + 1.95 kg/m^2 (Range, 22.5 – 29.2 kg/m^2) (Table 2). The patient's Oswestry Disability Index (ODI), Visual Analog score (VAS), The Japanese Orthopaedic Association (JOA) score are increased significantly from preoperatively to final follow up postoperatively (Table 3). Radiologically, the mean preoperative disc height at the involved segment was increasing from 6.77 + 0.58 mm, to 7.95 + 0.84 mm at immediate postoperative examination but dropped to 7.42 + 0.74 mm at 14 months follow up. The difference in the preoperative and at 14 months postoperative follow up are significant, (p value is <0.00001, significant at $p \leq 0.05$). At a mean follow up of 14 months, 8 patients show possible fusion and 2 patients (14.29%) shows possible pseudoarthrosis according to Modified criteria of Lee *et al.* [15]. The mean blood is 300 ml (range 280 ml- 390 ml). The mean surgical time is 125 minutes (range 95 -148 minutes). The mean duration of hospital stay is 11 days (7-14 days). One case of intra-operative dural tear without postoperative complications and one case of superficial infection which heal with antibiotic.

Table 1: Showing Modified criteria of Lee *et al.* [15]

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.

Table 2: Demographic data of the patients

Case	**Age**	**Sex**	**BMI (Kg/m^2)**
1	55	Male	25.9
2	50	Male	26.33
3	60	Female	24.93
4	63	Male	27.33
5	70	Female	26.6
6	65	Male	25.5
7	62	Male	24.57
8	59	Male	28.5
9	68	Male	29.2
10	57	Male	22.5

Table 3: Clinical outcome scores

Scores	Pre-operative (mean score +SD)	Final follow-up postoperative (mean score +SD)	P value (significant at p≤0.05)
Oswestry Disability Index (ODI)	79.86+6.25	32.71+4.55	<0.00001
Visual Analog score (VAS)	8	3	<0.00001
Japanese Orthopaedic Association (JOA)	10.64 + 1.86	20.43+1.08	<0.00001

Fig 1: A. Corticocancellous laminectomy bone chips packed inside cage B. Showing bone cage insertion

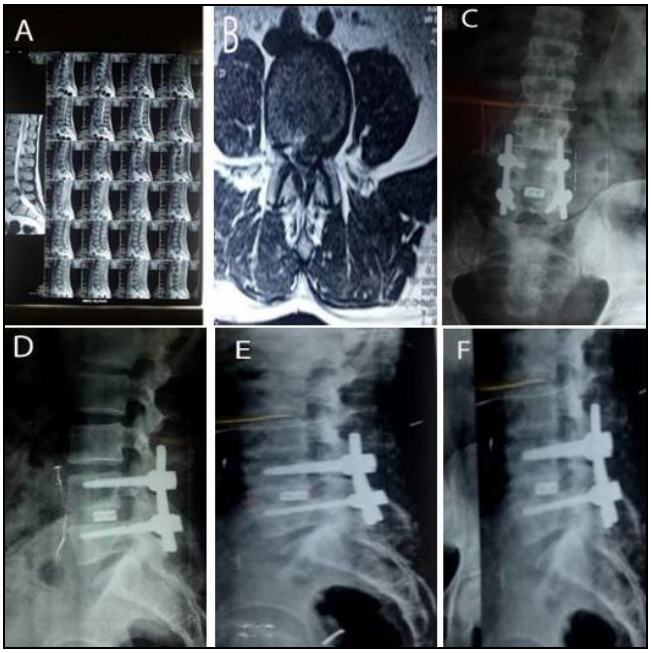

Fig 2: Preoperative MRI lumbosacral spine showing massive disc herniation at L4-L5, **A.** sagittal view **B.** Axial view MRI showing occluding of more than 50% of the spinal canal. **C.** Immediate postoperative X- ray in AP view **D.** Immediate postoperative X- ray in lateral view **E**. X-ray in lateral view at 6 months postoperative **F.** X-ray in lateral view at 14 months postoperative showing possible fusion.

4. Discussion

The advantage of posterior approach to the spine include the ability to simultaneously decompress and stabilized the spine with instrumentation. Interbody grafts significantly decrease the strain in the posterior spinal implants when subjected to compression or flexion loads. Satoh I *et al.* [16] reported that lumbar disc herniation with massive herniation or segmental instability as an indication for PLIF. In various study instrumented PLIF with double cage has been used but in a biomechanical study by Murakami H *et al.* [17] found that the single mega-cage provided an equivalent-sized cancellous bed for fusion as compared to the dual cages. Molinari RW *et al.* [18] 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 cages. But the costs were higher for the 2-cage group.

In this study, the mean body mass index in our study is 26.14 + 1.95 kg/m^2 and is comparable to that of Jeon CH *et al.* [19] study. The mean amount of blood loss is 300 ml and the amount of blood loss is comparable to other study by Lee SK *et al.* [20] and Jin Z *et al.* [21]. The mean operative time is 125 minute and it is comparable with other study by Lee SK *et al.* [20] and Jin Z *et al.* [21]. The mean hospitalization period is 11 days, and it is comparable with the other study by Jin Z *et al.* [21] and Kim DH *et al.* [22].

Clinically, the mean preoperative Oswestry Disability Index score is 79.86+6.25 and at 12 months postoperative is 32.71+4.55. The mean preoperative VAS score is 8 and at 12 months follow up is 3. The mean preoperative JOA score is 10.64+1.86 and at 12 months follow up is 20.43+1.08. Kim DH *et al.* [22] used ODI, VAS, Prolo scale and kim and kim criteria. 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. The Economic Prolo Scale was 3 in 3 cases, 4 in 38 cases and 5 in 12 cases while the Functional Prolo Scale was 3 in 5 cases, 4 in 36 cases and 5 in 12 cases, according to the Kim & Kim criteria 12 (23%) of the 53 cases had a score of excellent, 39 (73%) good, and 2(4%) fair cases. Jin Z *et al.* [21] used VAS score and ODI score the preoperative and postoperative difference are statistically significant (p<0.05).

Radiologically, the mean preoperative disc height at the involved segment was increasing from 6.77 + 0.58 mm, to 7.95 + 0.84 mm at immediate postoperative but dropped to 7.42 + 0.74 mm at 14 months follow up which is comparable to various study. In the study done by Lee SK *et al.* [20] the preoperative disc height increases from 7.1+3 mm to 9.6+3 mm at immediate postoperative and 9.2+2.5 mm at last follow up. Kim DH *et al.* [22] also found that the preoperative disc height increases from 9.2+2.68 mm to 13.62+1.35mm at immediate postoperative and decrease to 12.46+1.61mm at last follow up. At a mean follow up of 14 months, 8 patients show possible fusion and 2 patients shows possible pseudoarthrosis. In a study by Patil SS *et al.* [23] out of 35 patients, 16 patients show definitive fusion, 15 patients' probable fusion, 4 patients with possible pseudoarthrosis, and no patient had definitive pseudoarthrosis with the mean fusion time was 18 months.

5. Conclusion

The conclusion of this study is that, Corticocancellous Laminectomy bone chips with single cage and instrumentation provide adequate fusion with stability. 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 is circumvented. Using single cage is costs effective and expenditure of the patient is reduced. The limitation of this study is that the clinical cases are relatively few. Duration and follow up of this study were short, and more time is required to note the definitive fusion.

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