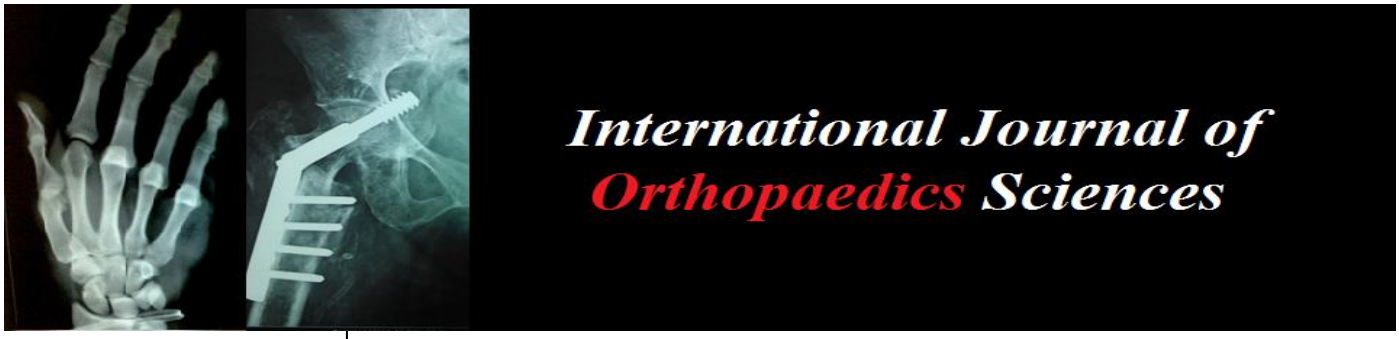

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Outcome of posterior lumbar interbody fusion using cage, combined with posterior instrumentation

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Abstract
Introduction: Degenerative lumbar spine disorders comprise the major proportion of etiology of chronic low back pain in adult population, which often leads to serious disability to carry out daily routine activities. The conservative management provides only temporarily insufficient relief. Since the origin of surgical management, multiple types of surgical techniques have been described with its own pros and cons and different success rates. However, controversy regarding the choice of surgical technique with better success rate, shorter learning curve, and minimal complication rate still persist.
Aim: To determine the functional and radiological outcome of Posterior lumbar interbody fusion using bone graft and cage, alongwith posterior pedicle screw-rod fixation.
Materials and Methods: The prospective study was done over 30 patients with various manifestations of degenerative lumbar spine disorder at the tertiary care teaching hospital in southern Rajasthan between January 2018 to June 2019. All patients underwent posterior lumbar interbody fusion with titanium cage and pedicle screw-rod fixation. Radiological fusion and functional assessment using Kirkaldy Willis criteria was done up to 6 months follow-up period.
Results: On evaluation, all the 30 cases (100%) had achieved solid union by the 6 months. The functional outcome according to Kirkaldy Willis criteria was excellent in 22 cases (73.33%), good in 6 cases (20%), fair in 1 case (3.33%), poor in 1 case (3.33%). So, considering excellent and good outcome as satisfactory outcome, functional outcome was satisfactory in 93.33 % cases.
Conclusion: We conclude that Posterior lumbar interbody fusion with cage and posterior instrumentation is a reliable surgical technique for degenerative lumbar spine disorders and produces excellent results and less complications after reasonable experience of surgeon.

Keywords: PLIF, low back pain, lumbar interbody fusion, titanium cage, degenerative lumbar spine disorder

Introduction
The common musculoskeletal condition which affects adult population today is Low back pain (LBP). Chronic LBP (CLBP) is a syndrome in which there is pain in lower back region, which lasts minimum 12 weeks [1]. The prevalence of chronic low back pain is 4.2 % in individuals between 24 to 39 years of age, while it is 19.6% in individuals between 20 to 59 years of age [2]. Its prevalence rises linearly from third decade of life till 60 years of age, with women affected more than men. Disability produced by CLBP is significantly affecting world and leads to major economic loss [3].
Degenerative lumbar spine disorders like Degenerative Disc Disease, Degenerative Spondylolisthesis, Isthmic Spondylolisthesis, Degenerative Canal stenosis, Recurrent disc herniation, Pseudoarthrosis comprise the commonest cause of debilitating chronic low back pain. These conditions are often managed initially using conservative treatment like various analgesic drug therapies like NSAIDs, rest core extension muscle strengthening exercises, lumbosacral brace. However, unfortunately all these measures fail most often and are unable to cure the discogenic and/or mechanical back pain arising due to various aforementioned pathologies or to prevent the instabilities arising due to some earlier spinal surgery performed, if any.
There are various surgical modalities which have been offered for these conditions like decompression alone, decompression alongwith posterolateral fusion, and latest technique is decompression with interbody fusion.

Most of the patient for degenerative lumbar spine disorders suffer from not only the symptoms of radiculopathy in the form of radiating pain (sciatica), neurological deficit either sensory or motor; but also, there is major problem of low back pain arising because of degenerated intervertebral discs. The degenerated disc is the cause of constant discogenic pain in back. As this disc degeneration progresses, it eventually collapses and leads to stenosis of interverbal neural foramina compressing the exiting nerve roots; produces tension in capsule of facet joints due to slipping of facets, produces osteophytes which again compress traversing and exiting nerve roots. This generates the spinal instability in flexion, extension, rotational movements of spinal column. Decompressing the compressed nerve roots may although alleviate the radicular signs and symptoms, but the constant discogenic back pain and mechanical back pain arising due to spinal instability are not cured. Only posterolateral fusion may not help get rid of discogenic back pain and decrease flexibility of spine in long term. So, the next option is Interbody Fusion by means of bone graft and implant to fuse the whole anterior column which bears the maximum portion of the weight transmission through spine.

The current choice for treating lumbar degenerative disc diseases is interbody fusion surgery [4]. On the basis of approaches, methods are of five types: a) posterior lumbar interbody fusion (PLIF), b) Transforaminal lumbar interbody fusion (TLIF), c) Oblique lumbar interbody Fusion / anterior to psoas (PLIF/ATP), d) Anterior lumbar interbody fusion (ALIF), e) Lateral lumbar interbody fusion (LLIF).

The very first to be used was Posterior lumbar interbody fusion (PLIF) [5]. PLIF is an ideal procedure to deal severe low back pain with radiculopathy from lumbar canal or foraminal stenosis as it gives benefits of decompressing spinal canal, anterior column fusion, foraminal stenosis decompression, and reduction of sagittal slips from a single posterior approach. The original PLIF technique used only bone chips for interbody fusion [6].

Thereafter, it kept on evolving from use of autologous or synthetic bone graft, various new interbody implants and pedicle screw fixation for posterior instrumentation.

Internal fixation with instrumentation like facet screws, pedicle screw-rod/plate system is to prevent motion at intervertebral level and strengthen the PLIF [27, 28]. Interbody spacer or cage with bone graft provide effective immediate interbody stability alongwith the distraction of the disc space and thereby increasing the size of neural foramina where the nerve roots exit the spinal column. The various studies have supported the use of these interbody spacer or cage [9-17].

Materials and Methods

A prospective, therapeutic study was conducted over 30 patients after approval from institutional research ethics committee, who were diagnosed with degenerative lumbar spine disorder with various manifestations and operated PLIF with cage and bone graft, along with posterior instrumentation in Orthopaedics department of a tertiary care teaching hospital in southern Rajasthan between January 2018 to June 2019. After clinical evaluation of patients with low back pain which could be associated with radicular pain or neurological impairment or both, radiological imaging with x-ray, CT, MRI scans were done for confirmation of diagnosis and preoperative assessment for surgical planning.

The inclusion criteria of patients enrolled in study were age above 18 years, diagnosed with Degenerative Disc Disease (DDD), Spinal Canal Stenosis, Spondylolisthesis of isthmic or degenerative type, Facet Joint Arthritis.

The exclusion criteria were Multiple Level Disc Degeneration, Acute traumatic conditions, fractures, Neoplastic condition, Failed Back Surgery Syndrome, infective conditions.

All patients underwent detailed history and thorough clinical evaluation. Data of all patients were collected including clinical signs and symptoms, neurological impairment, and radiological investigations. Fitness of patient was assessed preoperatively by carrying out routine preoperative laboratory investigations and pre-anaesthetic check-up. Informed consent was taken and patients were explained the need for surgery, its advantages, disadvantages, and complications before planning the surgery.

Surgical technique

Under general anaesthesia patient is positioned prone on radiolucent table over two longitudinal bolsters below the trunk with abdomen free in-between the bolsters. This complete position maintains the normal lordotic curvature of lumbar spine. Vertebral levels to be fused are marked with the help of IITV in both AP and Lateral plane.

After painting and draping of required field for the surgery the site of incision is infiltrated with mix containing Lignocaine 2% with Adrenaline 1 in 200000. The incision is midline over the lumbar spine region with extension from one level above and below the marked vertebral levels of fixation. Superficial and deep dissection is done. Bilateral paraspinal muscles are separated from spinous process and vertebra exposed up to transverse process. Haemostasis is achieved. The pedicle screws are inserted with “free hand targeting” technique. Over one side pedicle screws, rod of appropriate length is fixed after bending with French Rod Bender and tightened in adequate distraction to pedicle screws by Angled Distraction Forceps. Posterior decompression at desired level is done. Extraction of disc done with end plate of vertebra preparation with curette and rasp. Bone graft acquired from spinous process and lamina prepared and filled in cage of adequate size and inserted in disc space and fixed by means of compression on titanium rod over pedicle screws. Wound closure is done in layer by layer fashion.

Follow up was done postoperatively observing relief in symptoms, neurological assessment, assessment of radiological fusion with X-ray at 2 weeks, 6 weeks, 3 months and 6 months. Fusion status was decided by AP and lateral radiographs with Flexion-extension lateral views. The fusion was defined as ‘solid’, ‘probable’ and ‘non-union’ (Table 1). Overall clinical results were determined by the Kirkaldy Willis Criteria [18] (Table 2). The statistical analysis was done using SPSS statistics software version 21.

Table 1: Radiological criteria

Solid	Bony trabecular continuity, less than 4 degrees of mobility between adjacent fused segments
Probable	Trabecular continuity was not clear but mobility less than 4 degrees
Non union	Visible gap, graft collapse and motion more than 4 degrees

Table 2: Functional outcome (Kirkaldy-willis criteria)

Excellent	Return to work with no complaints
Good	Return to work with some restriction
Fair	Reduced working capacity
Poor	Can’t return to work

Results

Total 30 cases were included in our study. The average age was 48.56 years (range from 29 to 75 years). The sex ratio was 1:2 for males and females. Males were 10 cases (33.33%) and females were 20 cases (66.66%). There were 7 cases of Isthmic spondylolisthesis (23.33%), 6 cases of Degenerative spondylolisthesis (20%), 17 cases of PIVD with secondary LCS (56.66%) (Table 3). The average age of cases of Isthmic spondylolisthesis was 47 years, degenerative spondylolisthesis was 56.67 years, PIVD with sec. LCS was 46.92 years. The level of fusion was L4-5 in 19 cases (63.33%), and L5-S1 in 11 cases (36.66%). Average length of stay in hospital was 5 days (range from 4 to 8 days). All the patients were mobilized postoperative day one onwards. All the cases (100%) had shown bone dense shadows with trabecular appearance in the disc space suggestive of complete incorporation of bone graft. Hence, achieved solid fusion by the 6 months follow-up.

All the 30 cases had preoperative complaint of low back pain (LBP), which was resolved in 26 cases (86.66%) postoperatively. Pearson's Chi-Square Test (value = 45.882) suggested this change as significant change (p value <0.01). 28 patients (93.33%) who had radicular pain, recovered completely postoperatively (Chi-Square value = 52.500, p value <0.01) and 24 patients (80%) with positive passive SLRT, showed negative test postoperatively (Chi-Square value = 40.000; p value <0.01). The cases which presented with some degree of neurological deficit (17 out of 30) either sensory or motor, resulted complete recovery in 15 cases (88.23%) after 6 months (Chi-Square value = 17.330; p value <0.01), and none of the cases had developed new neurological deficit (Graph 1).

Results were Excellent in 22 cases (73.33%), good in 6 cases (20%), fair in 1 case (3.33%), poor in 1 case (3.33%) (as per Kirkaldy Willis Criteria). So, considering excellent and good outcome as satisfactory outcome, functional outcome was satisfactory in 93.33 % cases (Graph 2). So, overall this fusion technique was successful. 6 cases (20%) required blood transfusion perioperatively. Immediate postoperative surgical site infection was observed in 2 cases (6.66%), which was treated with intravenous antibiotics according to culture and sensitivity reports.

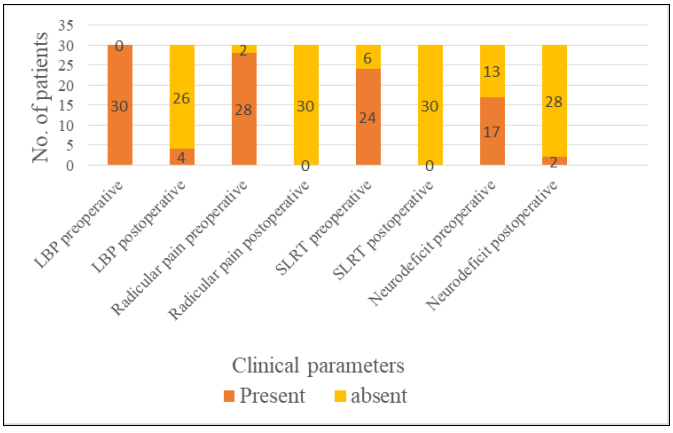
Preoperative xray

Postoperative xray

Follow up (6 months): Solid Fusion

Table 3: Indications of surgery

Indication of surgery	No. of patients	Percentage
Isthmic Spondylolisthesis	7	23.33 %
Degenerative Spondylolisthesis	6	20 %
Degenerative disc Disease (PIVD with LCS)	17	56.66 %



Graph 1: Preoperative versus postoperative comparison of clinical parameters

Graph 2: Functional outcome (Kirkaldy Willis Criteria)

Discussion

Chronic low back pain is one of the common problems encountered by general population in their course of life. LBP frequently leads to disability in active people to such extent that it doesn't allow them to carry out normal routine activities of daily living and often leads to absenteeism from work.

The treatment of chronic low back pain arising due to degenerative lumbar spine disorders comprises a broad spectrum of modalities ranging from conservative measures like palliative medicines, physiotherapy, braces to surgical measures of decompression, decompression with posterolateral fusion, interbody fusion with posterior instrumentation. However, many studies in the past have clearly stated the superior outcomes of interbody fusion.[19-22]

In this study, mean age was 48.56 years (range: 29 to 75). The major proportion of cases (76.66%) fell in the age group between 30 to 60 years. The literature of the various studies done till now shows the similar pattern of mean age like in this study [23-27].

The sex ratio of males and females was 1:2. Majority of the studies have supported the sex ratio of our study with female predominance [23, 25, 28]. However, the reverse sex ratio showing male predominance is also seen in few studies [41, 51]. The reason is not clear in any study. We believe that since all cases which were operated had degenerative lumbar spine and the osteoporosis is one of the certain signs of degeneration. In Indian scenario, where osteoporosis is a highly prevalent in females as compared to western and other Asian counterparts, the progression of spine degeneration should also progress more and earlier in females [29].

The common indications which were included in this study design were isthmic lumbar spondylolisthesis in 7 patients (23.33 %), degenerative lumbar spondylolisthesis in 6 patients (20%), Degenerated disc disease with lumbar canal stenosis in 17 patients (56.66%). The various causes of lumbar spine instability which we operated had similar distribution in previous literature [25, 26]. Since previously operated cases were categorised in exclusion criteria, so no pseudoarthrosis case was enrolled in this study.

Our study although had only single level fusion cases with 100% fusion rate and 93.33% clinical success rate. On the contrary, some multiple level fusion studies did not produce similar results of fusion rate and clinical outcome in comparison to many single level fusion studies [12]. Also, multilevel fusions were associated with longer duration of surgery, more invasive procedure, and more blood loss.

Type of cage used in the present study was flat, porous, serrated, titanium cage filled with morselized cancellous bone chips. Also, only single cage was used for fusion in one disc space. The fusion rate achieved with these was 100 %.

The conclusion found here regarding type of cage and bone graft usage in PLIF with posterior instrumentation is that different types of cage material (titanium, PEEK,CFRP,FRA), geometry (shape, surface, length), number of cage (unilateral or bilateral), type of bone graft (iliac crest or local autologous) don't influence the fusion success. However, we preferred titanium cage due to its comparatively lower cost, used single cage as rate of fusion was not diminished by use of single cage in comparison to commonly used bilateral cage [23], used local bone graft obtained from surgical site to avoid pain and morbidity of donor site like iliac crest. The only advantage of non-metallic cage use like FRA spacer and CFRP is the better visualization of fusion status by simple radiographic evaluation but FRA and CFRP use is limited due to non-availability of bone bank facilities everywhere and higher cost respectively.

In the present study fusion status was confirmed radiographically and functional outcome was assessed using Kirkaldy Willis Criteria [18] with the ability of the patient to return to work. The result in our study was 100% fusion success and satisfactory functional outcome in 28 out of 30 cases (93.33%) comprising excellent results in 22 cases (73.33%) and good results in 6 cases (20%). However, there was fair result in 1 case (3.33%) and poor in 1 case (3.33%). Complete relief or improvement in back pain was seen in all 30 cases (100%). Nerve root tension sign (SLRT) was negative in all 24 cases postoperatively. Neurological deficit was present in 17 cases preoperatively and persisted in 2 cases with one grade improvement in 1 case and no improvement in another 1 case. There was no case with newly developed immediate or late postoperative neurological deficit.

The result of our study is consistent with most of the earlier studies like Ray CD *et al.* [11], Periasamy *et al.* [26], which clearly proves the advantage of higher success rate of fusion using interbody cages but functional results have shown some variation in some studies. Agassi S *et al.*[14] found 90% fusion rate and patient satisfaction rate in 67% cases only with excellent to good results achieved in just 39% cases. We believe that there must be some other causes for variable clinical success rate like psychosocial, socioeconomic factors, duration of preoperative suffering with severity of nerve root damage, adjacent degenerative disc disease, variable improvement in neurological deficiency, which needs further evaluation in future. Many studies have shown that patients with persistent back pain were sent in pain clinics, physiotherapy clinic for further relief.

In the present study, 6 cases (20%) required blood transfusion. Immediate postoperative complication of surgical site infection was seen in 2 cases (6.66%), which was resolved after giving sensitive antibiotic intravenously and patient showed no effect in long term follow-up. However, other complications like neural injury, dural tearing, implant failure, cage migration or dislodgement, additional surgery for adjacent degenerative disease were not seen in 6 months follow-up. Long term survivorship of implant, degenerative changes in nearby segments could not be assessed in this study because of short duration of follow-up.

Conclusion

PLIF with cage and supplementary transpedicular instrumentation has appeared to be a reliable modality to treat the disabling low back pain with radiculopathy or neurological deficit. It results in fusion of spine in such rigid manner that all pain and nerve compression due to instability is cured. It helps the patient to return to his/her normal work routine with no or minimal restriction in activities in 93.33% cases. The use of single cage has shown the ability to

maintain the disc space normal, and proved to be economical for the patient and their family. The various advantages of posterior approach are that it allows fusion and nerve decompression through single approach, decreases surgical procedure duration, and prevents potential complications of various other extensive approaches and procedure like ALIF/LLIF/OLIF.

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