

DEGENERATIVE LUMBAR SPONDYLOLISTHESIS TREATED WITH LUMBAR INTERBODY FUSION WITH CAGE AND PEDICLE SCREW FIXATION – A PROSPECTIVE STUDY

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Received : 16/07/2023
Received in revised form : 18/08/2023
Accepted : 31/08/2023

Keywords:

Dynamic instability, Posterior stabilisation, Interbody fusion, Pedicle screw, Neurological deficit.

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DOI: 10.47009/jamp.2023.5.5.150

Source of Support: Nil,

Conflict of Interest: None declared

Int J Acad Med Pharm
2023; 5 (5); 765-769



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Abstract

Background: Posterior lumbar interbody fusion systems using pedicle screw and rod attachment have surgically controlled lumbar spine dysfunction. The use of an interbody fusion system (Cage) to assist in fusion and improve the construct's stability is supported by many surgeons. This study assesses decompression and instrumentation for clinically significant lumbar spondylolisthesis with lumbar inter-body fusion. **Materials and Methods:** This randomised, controlled prospective study was conducted in Mahatma Gandhi Memorial Government Hospital, Trichy, from January 2019 – August 2020. All 30 patients were given a trial of conservative treatment before being given a choice of surgery. Visual Analogue Scale (VAS) intensity ranking, Oswestry Injury Index (ODI) and AP, Lateral and Flexion - Extension radiographs were taken to evaluate clinically and follow-up at six weeks, 3, 6, 12 months periods to post-op pain, fusion and functional results. **Result:** Females were predominant, with 62% of patients working and the least unemployed. 36% had radiculopathy relieved after decompression and stabilisation. 76.66% had no neurological issues, and 23.33% had bladder or motor/sensory deficits alleviated by decompression and stabilisation. 76.66% had dynamic listhetic segment instability, while 23.33% had slips without lateral radiograph improvement. After evaluation, patients were subjected to surgical stabilisation and fusion techniques, with PLIF with cage accounting for 76.66%, TLIF + CAGE 16.66%, and PLIF + BG ALONE (2 cases). **Conclusion:** Lumbar interbody fusion with cage improves safety, lower graft loss, and clinical results for lumbar spine dysfunction. Strong fusion in unstable lumbar segments leads to good functional performance. Cage-based lumbar interbody fusion reduces complications and patient satisfaction.

INTRODUCTION

Low backache is the predominant symptom in the orthopaedic outpatient department. A low back ache is often defined as pain between the inferior margin of the lowest ribs on either side on the posterior aspect above, spanning to the gluteal fold line below. Spondylolisthesis of the lumbar spine is one of the commonest causes of low back aches. Chronic low back pain patients belong to different ages, occupations, and socioeconomic classes.^[1,2] Many simultaneous degenerative changes occur in the lumbosacral spine complex, leading to lower back and leg pain. Various pathologies ensue due to chronic wear, tear and disproportionate lumbar spine

loading.^[3,4] While many aetiological reasons and types exist for spondylolisthesis, a degenerative type of spondylolisthesis is often seen in the middle-aged. The reason behind this is mainly due to the constant erect posture in the middle-aged population and elderly population in whom the lumbar spine goes for wear and tear, producing instability.^[5]

Spondylolisthesis is the forward slippage of the superior vertebra over the inferior vertebra. The main alteration here is in the structures that offer stability to the spinal column. The lumbar spine is a dynamic structure subjected to movements forward and backwards with a slight rotational component, and degeneration results in lysis of the elements and instability, eventually causing slippage.^[6,7] The

treatment options for this problem differ based on the intensity of the problem, its nature, and the need of the patient. It is broadly classified into non-operative and operative treatment. Non-operative treatment includes rest, analgesic tablets, skeletal muscle relaxant tablets, physiotherapy exercises and spinal traction techniques.^[8]

The prime aim of any spondylolisthesis surgery is to alleviate pain in the back by addressing the instability and relieving vertebral canal stenosis. The slippage of the vertebra has to be addressed, i.e., either it should be reduced in cases of higher grades or fixed in situ to prevent further slippage. The instability can be surgically corrected posteriorly by instrumentation like pedicle screw and rod fixation and combining various fusion techniques. The fusion facilitates the two spinal segments to function as one, i.e., move as one segment and reduce pain due to mechanical instability.^[9,10]

Degenerative Lumbar spondylolisthesis never exists alone, and it always has some intervertebral disc changes and ligamentum flavum element changes, spinal canal stenosis and nerve root compression (foraminal stenosis).^[11] So, often, surgeries are combined, and all the issues must be corrected at once, and the patient must be pain-free at the end of the surgery. On the operative front, the treatment chosen also should be convenient for the patient for rehabilitation and slowing the progression of degeneration of adjacent vertebra. Hence, this study aims to assess Decompression and Instrumentation for clinically significant lumbar spondylolisthesis with lumbar inter-body fusion.

MATERIALS AND METHODS

This randomised, controlled prospective study was conducted in Mahatma Gandhi memorial government hospital, Trichy, from Jan 2019 – August 2020. Thirty patients with lumbar spondylolisthesis were selected based on the inclusion criteria, and informed consent and ethical approval were obtained. All 30 patients were given a trial of conservative treatment before being given a choice of surgery. One of the posterior approaches was used, and PLIF or TLIF was used for inter-body fusion.

Inclusion Criteria

Clinico-radiologically significant spondylolisthesis, spondylolisthesis with lumbar spine instability, radiculopathy and neurological deficit, patients aged more than 18 years and less than 60 years, and failure of conservative treatment were included.

Exclusion Criteria

Patients under 18 and over 60 with other spinal abnormalities like polio, cerebral palsy, generalised bone disorders, systemic infection, previous interbody fusion at the target level, and pregnancy and lactation were excluded.

By using plain radiographs, Dynamic X-rays AP and Lateral views in flexion and extension were taken to note the lysis or vertebral level with slips and

involved, pars interarticularis defect detected, and slip percentage calculated. Meyerding Grading was done based on that; Pelvic incidence (PI) was measured. Magnetic resonant imaging was done to find nerve root compression, spinal canal stenosis, facet hypertrophy, and IV Disc Prolapse.

The patients were followed up at 1 month, 3 months, 6 months, 12 months, and 15 months and assessed for pain using the Visual analogue pain scale-VAS Score. Functional outcome was evaluated using the Oswestry disability index ODI and modified Macnab's low back ache criteria. CT/Plain X-ray lumbar spine was taken to evaluate the fusion, the postoperative reduction and the proper cage position with bone graft in situ.

Visual Analogue Scale (VAS), Oswestry Disability Index and Mc Nabs criteria were used to evaluate the pain and compare them objectively between pre-and postoperative periods. The cumulative clinical and functional outcome was assessed with the Kirkaldy-Wyllis criteria.

The pre-operative evaluation was carried out as follows: The patient's written informed consent was obtained, and a detailed history was gathered from the patient. Clinical examinations encompassing local and systemic assessments were performed to identify the root cause of instability. Pain and instability were graded using various clinical and radiological scales, including Benzel's updated Japanese Orthopaedic SF-36 Bodily Pain Rate (SF-36), Visual Analog Scale (VAS) for pain assessment, and Oswestry Impairment Index (ODI). Radiological analyses were conducted using X-ray imaging (AP, lateral, and F-E radiographs), CT scans, and other applicable imaging methods. A diagnosis was established through a comprehensive radiological and clinical findings evaluation.

The surgical procedure consisted of employing the posterior technique of pedicle screw fixation, with the surgeon having the discretion to choose between using an interbody fusion cage or performing bone grafting. The decision to utilise a cage was made based on the surgeon's professional judgment.

The patient received antibiotics, analgesics/anti-inflammatory medications post-surgery during the pre-operative, immediate postoperative, and later recovery phases. Medical follow-ups occurred at 4- to 6-week intervals and 3, 6, and 12 months after surgery. These assessments used established scoring systems and intricate radiography to evaluate practical outcomes and fusion success. Comprehensive CT scans were conducted at the one-year mark. Fusion success was determined by limited intersegmental motion, absence of a black halo around the implant, minimal disc-space height reduction, absence of fractures, lack of significant sclerotic shifts, and visible new bridging bone in the fusion cage on radiographs. These measures ensured careful postoperative care and monitoring.

Statistical Analysis

All quantitative data is expressed as mean \pm SD and one-tailed student's t-test evaluated the significance

of difference in means. All qualitative data were expressed as percentages, and the Chi-square test with age correction evaluated the significance.

RESULTS

Among 30 patients, females were the predominant (n=18), and males were lesser (n=12). The mean age in males was 51.5 years, and in females was 51.44 years. Hence, the age is directly proportional to the frequency of the incidence. Most patients belonged to the labour group (62%), while the least belonged to the unemployed group, supporting the mechanical derangement theory leading to pain and deficit.

All 30 patients (100%) reported experiencing back pain. Twenty-two patients (73.33%) had radicular pain, which indicates pain radiating along the nerve pathways. Twenty-one patients (70%) had paresthesia, indicating abnormal sensations like tingling or numbness. Twelve patients (40%) exhibited motor weakness. Six patients (26%) had sensory issues like reduced sensitivity or hypoesthesia. None of the patients had bowel or bladder involvement.

Three patients (10%) experienced a dural tear, a potential complication during surgery that involves damage to the protective layer around the spinal cord. Four patients (13.30%) encountered significant epidural bleeding. Three patients (10%) developed a wound infection. None of the patients experienced discitis and neural damage [Table 1].

Based on Kirkaldy-Willis criteria on patients returning to work, (82%) of patients showed excellent results, and 16% showed good results, for which we are taking the result as acceptable.

In most cases (n=19), 63% had no radiculopathy, and 11 cases (36%) had radiculopathy, relieved after decompression and stabilisation. In most cases (n=23), 76.66% didn't have neurological, and 7 cases (23.33%) had some bladder or motor/sensory deficit, relieved by decompression and stabilisation.

Most cases involved L4-L5 isolated level for the lesion level, accounting for 53.33% (n= 16). L3-L4 accounts for 16.67% (n=5), and L5-S1 accounts for 20% (N=6). Combined level involvement was found in 3 cases accounting for 10%. 76.66% of the cases were found to have demonstrable dynamic instability of the lishetic segment (n=23). 23.33% had just a slip but no change in flexion and extension lateral radiographs. Among the symptomatic patients,

73.33% had Grade II Meyerding slips (n=22), while Grade 1 and Grade 3 were 4 cases each, accounting for 26.66%.

After careful evaluation, patients were subjected to either of one of the techniques for surgical stabilisation and fusion, among that PLIF WITH CAGE accounted for 76.66% (n= 23), TLIF+CAGE (16.66%) n=5, PLIF+BG ALONE (2 cases, couldn't place cage because of very narrow space).

The difference in ODI scores at 1 to 15 months was insignificant [Table 2]. In all those cases, those who presented with back aches before surgery got better at the end of follow-up after surgery (p <0.001), which is statistically significant. Cases that presented with radicular pain at the first visit also improved after surgical fixation and fusion (p<0.001), which is statistically significant.

None of the patients in the Bone Graft or Cage group exhibited fusion at the 3-month. At the 6-month, three patients in the Bone Graft group and five patients in the Cage group showed signs of fusion. After a year, nine patients in the Bone Graft group and 10 in the Cage group had achieved fusion. The fusion results were confirmed using CT scans, with nine patients in the Bone Graft group and ten in the Cage group demonstrating fusion [Figure 1].

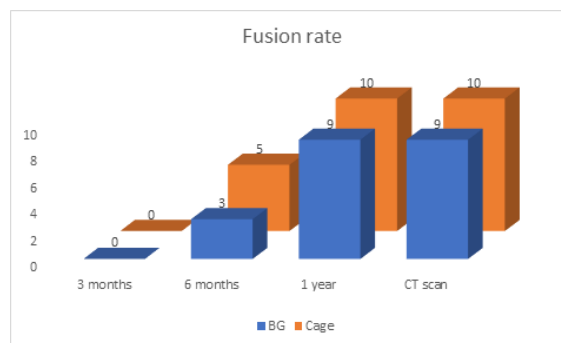


Figure 1: Fusion rate

88% of patients in the cage with graft group achieved fusion. The difference in fusion rates between groups was not statistically significant (p = 0.31). 84% of patients in the cage with graft group reported being satisfied with the results. There was no significant difference in patient satisfaction between the groups (p = 0.52). 76% of patients in the cage with graft group experienced an improvement in radiculopathy. The difference in improvement was not statistically significant (p = 0.27) [Table 3].

Table 1: Symptoms and complications in the study

		No of cases (n=30)	Percentage
Symptoms	Back pain	30	100%
	Radicular pain	22	73.33%
	Paresthesia	21	70%
	Motor weakness	12	40%
	Sensory (hypoesthesia)	6	26%
	Bowel/bladder involvement	Nil	Nil
Complications	Dural tear	3	10%
	CSF leak	1	3.30%
	Significant epidural bleeding	4	13.30%
	Wound infection	3	10%

	Discitis	0	0
	Neural damage	0	0

Table 2: ODI score

ODI			
Postoperative	PLIF+CAGE	TLIF+CAGE	P value
1-month	31.28	31.35	0.81
6-month	17.48	18.33	0.86
9-month	13.81	14.22	0.93
12-month	10.37	11.4	0.96
15-month	10.34	9.29	0.78

Table 3: The outcome of the study

Outcome	Cage with graft in situ group (n = 30)	P value
Rate of Fusion	88%	0.31
Patient fulfilment	84%	0.52
Improvement in Radiculopathy	76%	0.27

Five patients (16.66%) developed complications; intraoperative complications accounted for 10% (3). Intra-operative complications were dural tears and pedicle failure causing medial wall penetration. Postoperative complications were radicular pain 10% (3 cases), superficial wound infection 6.66% (2 cases), Rod extrusion (1 case), and radiculitis.

DISCUSSION

Males were 40%, and females were 60% in our study. In their research, Ching-Hsiao Yu et al. had 56% males and 46% females in the BG category, 23% males and 77% females in the cage group with an average age of 59%.^[12] The plurality of instances was observed to include an isolated L4- L5 ratio of 53.33% (n= 16) about the level of injury. L3-L4 accounts for 16.67% (n=5), and L5-S1 accounts for 20% (N=6). In 3 situations, the combined amount of attendance accounts for 10%. At 12 months of follow-up, 80% of 10 patients in the BG community and 90% of 10 patients in the Cage group recorded reduced pain and impairment as assessed by VAS and ODI, respectively.

In the Ching-Hsiao Yu et al. analysis, the artificial cages made greater functional progress than the Bone chip community in the ODI and VAS scales.^[12] With 30% paresthesia in the BG category and 10% paraesthesia in the Cage group, both patients had uneventful motor recuperation. All patients returned to their former lifestyle except for 1 (10%) in the BG community. While all BG and cage groups demonstrated substantial functional change after PLIF in the ODI, VAS and Benzels ratings, there was a greater improvement in the Cage group than in the BG Group, which is not statistically significant. In the Cage category, adequate findings were obtained because disc space, vertebral height and no collapse were better preserved. Bone graft is included in the BG group, which is less rigid and contributes to breakdown before fusion happens, and this has been due to growing discomfort, injury and less happiness even after treatment.

In our study, fusion rates in the Cage group were 0, 50% and 100%, respectively. Ching Hsiao Yu et al.

recorded the average fusion rate from 90% to 95.7% in non-cage PLIF patients and 90% to 100% in PLIF cage patients. The outcome of our fusion was close to that of other reported research. In their research, Arnold PM et al,^[13] recorded that unilateral PLIF was 98% at 12 and 24 months, with local morselised bone graft fusion. A rigid spacer is related to a stronger fusion outcome in the cage community, which preserves disc room and avoids irregular movement before fusion happens. The cage configuration also prevents more slip and a lack of reduction. Vertebral bodies do not break, and there are no complications of screw loosening or implant loss.

Our results are comparable with Ching-Hsiao Yu et al., which reported 6% screw breakage in the BG Group and high intra-op and post-op complications in the Cage group.^[12] Noboru Hosono et al. reported a 0.4% deep infection, 6.7% screw misplacement and 8.8% CSF leak.^[14]

All cases were followed up to a mean of 16 months; one patient lost to follow-up after one year, one died at six months follow-up due to an accident, and one had revision surgery done. Pre-operative measurements of slip angles, disk space height and other parameters were not considered. The selection of the cage was at the operative surgeon's absolute discretion.

CONCLUSION

Pedicle screw fixation is a harmless and consistent method of attaining rigid internal fixation of the lumbar spine by experienced surgeons. Instrumentation increases the fusion rate and its clinical outcome in degenerative lumbar spine disorders. Nevertheless, more clinical research data are required for instituting the role of transpedicular fixation in patients with mechanical back pain. Even though pedicle screw fixation bids several benefits, it should be done wisely in judiciously selected patients to curtail the risk of unfortunate complications. The risk-benefit ratio of adding instrumentation ought to be scrutinised carefully, especially in elderly patients. Comprehensive surgical principles of fusion must be accomplished using the techniques discussed.

Our study concludes that the lumbar interbody fusion using pedicle screws and cage yields promising results in treating lumbar spondylolisthesis. The technique will result in early postoperative pain relief, return to normal daily activities, neurological symptom improvement, satisfactory fusion and good functional outcome. The risks of infection and implant failure are less, and appropriate patient choice and scrupulous surgical methods will give unsurpassed results.

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