ORIGINAL RESEARCH PAPER
Volume - 14 | Issue - 06 | June - 2025 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

"COMPARATIVE STUDY ON FUNCTIONAL OUTCOME OF LUMBAR SPINE INSTABILITY TREATED WITH LAMINECTOMY WITH PEDICLE SCREW FIXATION WITH OR WITHOUT LUMBAR INTERBODY FUSION"

Orthopaedics

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ABSTRACT

Introduction: Low back pain is the most common cause of work-related disability and one of the most common contributors to missed time at work. This back pain can get aggravated and lead to avoidance of activity and disability. Low back pain(LBP) is a common medical problem. There is a 50–70% chance of a person having LBP pain during his or her lifetime. Pedicle screw instrumentation and lumbar spinal fusion have evolved as a treatment option for symptomatic disc prolapse, spinal stenosis, spondylolisthesis, and degenerative scoliosis. **Aim:** To assess the functional outcome of low grade lumbar spinal instability before and after laminectomy with posterior instrumentation with or without fusion. To evaluate fusion rates after poster lateral fusion. **Materials And Methods:** Case series of 34 patients with lumbar spine instability treated at Navodaya Medical College Hospital & Research Centre. A comparative prospective study was carried out for 30 patients who were assigned the following groups: Group 1 (n=17) consisted of patients treated with laminectomy with pedicle screw fixation and bone grafting. Group 2 (n=17) consisted of patients treated with laminectomy with pedicle screw fixation with interbody fusion cage. **Results:** Both groups showed improvement in pain and disability scores as measured by Modified Suezawa and Schreiber(MSS) clinical scoring system, Modified MacNab criteria and ODI scores. Fusion rates were better appreciated in PLIF with Cage group compared to Bone grafting group. All patients had significant improvement in functional outcome and daily activities after surgery. **Conclusion:** Addition of an interbody fusion cage helps in greater stability, lower implant failure, higher fusion rate and better functional outcome in patient treated with PLIF for lumbar spine instability. Patients with PLIF + Cage had better neurological improvement, pain reduction, reduced disability, generalised well-being and satisfaction. We conclude solid fusion would correlate with good functional outcomes in patients with unstable lumbar segments.

KEYWORDS

Pedicle screw; lumbar fusion; IVDP; spondylolisthesis; fusion cage

INTRODUCTION:

Lumbar spinal instability is defined as the loss of the ability of the spine under physiological loads to maintain relationships between vertebrae in such a way that the spinal cord or nerve roots are not damaged or irritated, and deformity or pain does not develop.[1] The concept of instability of the lumbar spine was first presented by Barr in 1951 when he espoused the view that the degenerative disc was responsible for a proportion of the genesis of low back pain.[2] The loss of disc height was thought to decrease restraint of passive stabilizers resulting in increased movement of vertebral segments. Pope and Panjabi[3] defined instability, from a biomechanical perspective, as a loss of stiffness in the spine. Stiffness was defined as the amount of motion within a system relative to a load applied to the structure. This would allow comparison of different responses in adjacent spinal segments to similar load applications, which they conjectured might be difficult to study in vivo. The loss of stiffness was thought to allow increased motion to occur at each vertebral segment. Paris[4] defined instability as aberrant (erratic) motion during movement (shake, catch, or hitch; sharp angulation; uncoordinated muscle contraction) or the presence of palpable defect both in standing and in prone.

Lumbar disc prolapse (herniation) can contribute to lumbar instability when the structural damage from the herniated disc disrupts the spine's normal biomechanics, leading to abnormal movement between vertebrae. Key mechanisms linking disc prolapse to instability:

1. Loss of Disc Integrity
2. Altered Load Distribution
3. Secondary Degeneration
4. Muscle Weakness/ Atrophy

Spondylolisthesis is a common cause of spinal instability is defined as forward slippage of a cephalad vertebra on a caudal vertebra and may be of Dysplastic, Isthmic (due to defect in the pars interarticularis), Degenerative (due to chronic lumbar instability), Traumatic or Pathological type.

Over the past 25 years, lumbar fusions were performed using the inter transverse technique, necessitating wide exposure and possible use of local laminectomy and facectomy bone grafts or iliac crest graft.[5] Fusion is defined as "the presence of bridging trabecular bone between the vertebral bodies". The most reliable radiographic indication of fusion postoperatively is the sentinel sign, or the presence of bridging bone anterior to the fusion cage.[6] The advent of transpedicular fixation revolutionised spine surgery, allowing rigid fixation and enhancing the likelihood that fusion will occur. Instrumentation provides instant stability which may improve fusion rate, it provides the opportunity for reestablishment of normal lordosis.[7] The quality of the bone graft, both biologically and as a load-bearing device, is crucial in achieving solid fusion.[8]

Aim:

To assess the functional outcome of low grade lumbar spinal instability before and after posterior instrumentation and fusion. To evaluate fusion rates after postero-lateral fusion.

MATERIALS & METHOD

Sample Size: 34
Study Duration: April 2023 to April 2025
Study Design: Prospective study

METHOD

Patients with lumbar spinal instability were selected after clinical and radiological analysis.

1. Detailed history and clinical examination was done. Investigations required for surgery was done.
2. A pre-anaesthetic evaluation was done.
3. Pre-operative preparations were performed and informed written consent was taken.
4. Follow ups - 6, 12 and 24 weeks were made.

Inclusion Criteria

1. lumbar intervertebral disc prolapse (single or multiple levels)
2. Spondylolisthesis(Grade I & II)
3. isthmic and degenerative lumbar instability
4. Age group between 18 and 70 years
5. Intractable pain more than 6 weeks
6. Failed conservative management even after 6 months.

Exclusion Criteria

1. Age less than 18 years and above 70 years.
2. Cases of tumour, trauma.
3. Patient with comorbid conditions and not fit for surgery.

4. Associated with bilateral hip, sacroiliac joint problem, infective etiology.
5. Severe grades of spondylolisthesis.

Evaluation Of Outcome

Post-operatively, patients were evaluated using Oswestry Disability Index, Modified Suezawa and Schreiber(MSS) clinical scoring system and MacNab Criteria.

Symptoms	Score		
	2	1	0
Low back pain	None	Activity related	At rest
Sciatica	None	With SLRT	At rest
Sensory deficit	None	Dysesthesia Paresthesia	Hypesthesia Anesthesia
Motor weakness	None	Full function With slight resistance	Two reflexes impaired
Reflex changes	None	One reflex impaired	Two reflexes impaired

SLRT - Straight leg raise test

Fig No.1: MSS Scoring system.

Grade	Criteria
Excellent	No pain; no restriction of activity
Good	Occasional back or leg pain of sufficient severity to interfere with the patient's ability to do his normal work
Fair	Improved functional capacity, but handicapped by intermittent pain of sufficient severity to curtail or modify work or leisure activities
Poor	No improvement or insufficient improvement to enable increase in activities; further operative intervention required

Fig No.2: MacNab score.

Operative Procedure:
Anaesthesia: General Anaesthesia
Position: Prone over bolsters.
Procedure: Laminectomy with pedicle screw fixation with or without lumbar interbody fusion.

We performed posterolateral fusion through a single midline skin incision. Lumbodorsal fascia was incised. Paraspinal muscles were elevated as single unit on both sides. The fusion bed consists of dorsal aspect of transverse fusion, the facet joints and the pars interarticularis. The tips of the transverse processes can now be palpated in the depths of the wound.

Expose the articular facets by excising the joint capsule. A cobb elevator used to strip the soft tissues of the capsule without disturbing the capsule itself. The junction of the transverse process and the superior articular process is identified and cleaned of soft tissues to expose the entry point of pedicle screws. If L5-S1 fusion is planned, it is important to expose the sacral ala, which lies just lateral to the L5-S1 facet joints.

Case Photos

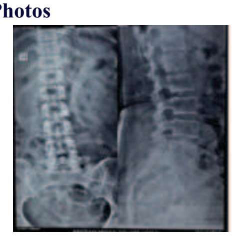


Fig no.3: Pre-Op X-ray-AP and Lateral views
Fig no.4: Flexion and Extension lateral views

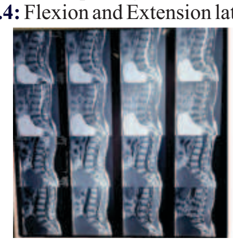
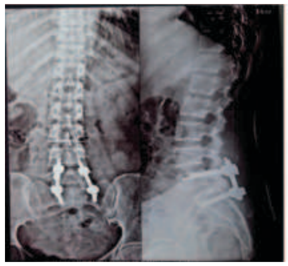


Fig no.5: MRI
Fig no.6: Post-Op X-ray



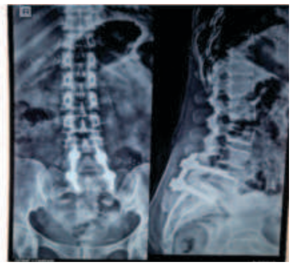


Fig no.7: 6 Months Post-Op X-ray
Fig no.8: 1-year Post-Op X-ray

After the proper position is obtained, rods was fixed to pedicle screws and gentle compression force was applied over the adjacent screws to achieve firm contact between end plates and grafted materials and rods was tightened to pedicle screws.

S1 pedicle screw are inserted by using bicortical technique. Polyaxial or multiaxial screws make the rod insertion easy. A short rod is chosen and inserted into screw head, and set screws are applied. Standard wound closure in layers was performed following haemostasis. The postoperative care and rehabilitation protocols will be the same for both groups.

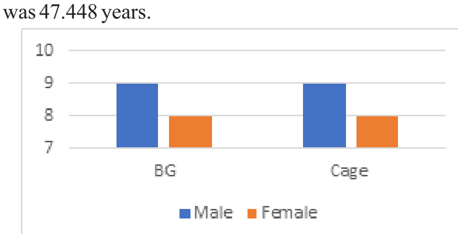
RESULTS

Our study comprises of two groups, the bone graft (BG) group (n=17) and the fusion cage (Cage) group (n=17). For patients in BG group, we used iliac crest and spinous process bone grafts for PLIF fusion. For patients in the Cage group, we used interbody cages packed with morselized autograft bone chips for PLIF.

1. Age And Sex Distribution

In our series of 34 patients, 18(53%) were males and 16(47%) were females. In both BG group and Cage group. 9(53%) were males and 8(47%) were females.

Average age of patients in BG group was 48.277 years and in Cage group was 47.448 years.

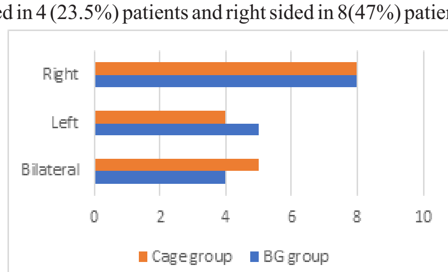


Graph no.1: Sex Distribution

2. Radiculopathy

In BG group, bilateral radiculopathy was found in 4(23.5%) patients, left sided radiculopathy in 5(29%) patients and right sided in 8(47%) patients.

In Cage group, bilateral radiculopathy was found in 5(29%) patients, left sided in 4 (23.5%) patients and right sided in 8(47%) patients.

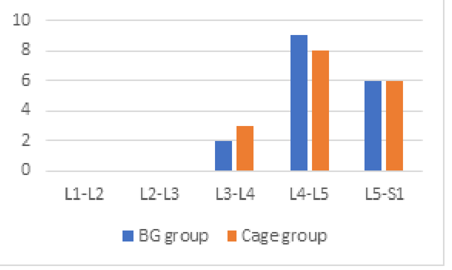


Graph no.2: Radiculopathy

3. Level Of Instability

In BG group, 2(12%) patients had L3-L4 level instability, 9(53%) patients had L4-L5 level instability and 6(35%) patients had L5-S1 level instability.

In Cage group, 3(17%) patients had L3-L4 instability, 8(47%) patients had L4-L5 instability and 6 (35%) had L5-S1 instability.



Graph no.3: Level of Instability

4. Mode Of Instability

Table No.1: Mode Of Instability

Mode	BG	Cage	Total	%
Spondylolisthesis	7	8	15	44
Lumbar Canal Stenosis (LCS)	2	2	4	11
Spondylolisthesis + LCS	2	1	3	9
LCS + FBS	0	0	0	0
Failed back syndrome (FBS)	0	0	0	0
Degenerative disc disease	2	1	3	9
Intervertebral Disc Prolapse	4	5	9	26

5. Duration of Surgery

Average duration of surgery in BG group was 118 minutes and in Cage group was 135 minutes.

6. Blood loss

Table No.2: Blood loss

	BG group	Cage group
Avg. Blood loss	350ml	320ml

7. Radiological Fusion

In BG group, 6(35%) patients achieved radiological fusion at 6 months and all 17(100%) patients achieved fusion at 1 year.

In Cage group, 10(59%) patients achieved radiological fusion at 6 months and all 17(100%) achieved fusion at 1 year.

8. Oswestry Disability Index Scores

	Pre-Op	3Mnth	6Mnth	1yr
BG group	70	41	27	18
Cage group	69	38	23	14
P value	0.68	0.22	0.105	0.15

ODI scale (0-100) taken at pre-op, 3 months, 6 months and 1 year showed statistically significant improvement in disability in both the groups after surgery. However, there is no significant difference between the BG and Cage groups.

9. MSS score and MacNab score

Group	MSS score	MacNab score
BG group	8.4	Good-Excellent
Cage group	8.8	Excellent

All patients recovered from motor weakness and sensory deficits.

Complications

There were no intra-operative complications such as bleeding or nerve root injury. Overall, there was 1 case of CSF leak post-operatively in the BG group.

DISCUSSION

The present study compared clinical and radiological outcomes between patients undergoing posterior lumbar interbody fusion (PLIF) with iliac crest/spinous process bone grafts (BG group) versus interbody cages packed with autograft bone chips (Cage group). Both groups demonstrated significant improvements in functional outcomes, with no statistically significant differences in Oswestry Disability Index (ODI) scores at any postoperative interval. However, nuanced variations in surgical parameters and early fusion rates provide insights into the comparative efficacy of these techniques.

Demographics And Preoperative Comparability

Both groups were well-matched in age, sex distribution, and preoperative clinical profiles, including radiculopathy patterns and modes/levels of instability. This homogeneity strengthens the validity of direct comparisons between the two surgical approaches. The predominance of L4-L5 instability and spondylolisthesis as the primary mode of instability aligns with existing literature on degenerative lumbar pathologies, underscoring the relevance of the cohort to typical clinical populations.

Surgical Parameters

The Cage group required longer operative times (135 vs. 118 minutes), likely reflecting the technical complexity of cage insertion and preparation compared to autograft harvesting. Conversely, the BG group exhibited marginally higher blood loss (350 vs. 320 mL), potentially attributable to iliac crest graft harvesting, a known contributor to intraoperative bleeding. These findings are consistent with prior studies highlighting trade-offs between graft harvesting and cage-related procedural demands.

Radiological Fusion

While both groups achieved 100% fusion at 1 year, the Cage group demonstrated superior early fusion rates at 6 months (59% vs. 35%). This suggests that cages may provide immediate structural stability, accelerating bony union in the initial postoperative phase. However, the equivalence in long-term fusion rates underscores the robustness of both techniques for achieving definitive arthrodesis, corroborating existing evidence that autografts and cages are reliable for PLIF.

Functional Outcomes

ODI scores improved significantly in both groups postoperatively, with no intergroup differences at any follow-up interval ($p > 0.05$). This indicates comparable effectiveness in reducing disability, irrespective of the surgical method. Similarly, MSS and MacNab scores trended slightly higher in the Cage group, though the clinical significance of this difference remains unclear without statistical validation. These results align with meta-analyses concluding that patient-reported outcomes after PLIF are influenced more by surgical success than graft type.

Limitations

The study's single-center design and small sample size (n=17 per group) limit generalizability. Additionally, the lack of blinding in outcome assessment may introduce bias. Long-term follow-up beyond 1 year would further clarify durability differences, particularly in adjacent segment degeneration.

CONCLUSION

Both BG and Cage techniques yield excellent long-term fusion and functional improvement in PLIF. The Cage group's faster early fusion may benefit patients requiring rapid stabilization, while BG remains a viable option for avoiding cage-related costs. Larger, multicenter studies with extended follow-up are warranted to refine patient selection criteria and optimize surgical decision-making.

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