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The outcome of using a single cage in posterior lumbar interbody fusion in management of lumbar instability

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Abstract
Helicobacter pylori infection causes chronic and severe peptic ulcer disease, which is very common. Stress, inheritance, and personality have all been connected to this illness in the past .It remained high and rose as time went on, while the resistance rates to clarithromycin, metronidazole and levo-floxacin were low and constant. As time went on

Keyword: Single cage; PLIF; lumbar instability

1. Introduction

One of the most common causes of back pain and neurological compression is spinal instability. This has long been regarded as a primary reason for spinal fusion surgery [1]

The goal of lumbar fusions is to alleviate pain, retain a corrected spine following deformity, or prevent the progression of neurological degeneration due to instability in the lower spine. However, this results in the loss of mobility in the fused parts of the spine. [2]

The clinical prognosis of lumbar spinal fusion is directly linked to the success of the bone fusion procedure. Only in combination with additional osteoconductive and osteoinductive agents can these implant materials provide a high fusion rate. By reducing subsidence and stress shielding and its accompanying problems, interbody implant integration is predicted to promote fusion and enhance implant longevity[3]

According to Weiler et al, between 20 and 30 percent of those who suffer from back discomfort have some degree of spinal instability. Spinal instability cannot be accurately predicted by low back pain alone. For the identification of spinal instability, radiologic evidence remains the gold standard [1] rather than symptoms or clinical evaluation.

Many other functional lateral spinal radiographs for instability detection have been suggested. Radiographs taken from a flexion-extension or a standing neutral lateral view position are the two most often used modalities for diagnosis. [1]

In a non-traumatic environment, CT scanning is not the preferred method of confirming spinal instability. However, various CT imaging characteristics, such as facet joint openness and orientation, vaccum phenomenon, osteophytes, and subchondral sclerosis, have been explored, which might indicate a possible spinal instability. [4]

Except for the vacuum phenomena, MRI is the gold standard for identifying spinal degenerative abnormalities. The MRI may be used to predict the likelihood of a fracture. [5.[

Spondylolisthesis, degenerative scoliosis, and spinal stenosis combined with instability are the primary reasons for lumbar interbody fusion surgery.[٦] .

Decompression treatments like laminectomy or laminotomy, as well as judicious use of partial medial facetectomies and foraminotomies, with or without discectomy, have historically been used in the therapy of people with lumbar instability. Decompression and in situ posterior lumbar fusion are advised in individuals with signs of spinal instability in the context of lumbar stenosis. [7]

Recurrent lumbar disc herniation, lateral or severe disc herniations, unsuccessful prior lumbar fusions by other procedures, and discogenic low back pain are also secondary indications. [8]

In the early days of PLIF, the primary drawbacks were insufficient allograft compressive strength and poor fusion rates. CFRP cages were created as a result, which improved mechanical strength by distributing the load across several fibres. [9]

Poly-Ether-Ether-Ketone (PEEK) is the conventional therapy for PLIF with two interbody cages, one on each side (bilateral). This helps to restore the alignment, disc height, the load bearing of the anterior structures, and to achieve greater rates of fusion. However, it requires substantial laminectomy, bilateral facetectomy, and needless stress to the lumbar musculoligamentous system. [10]

Only one interbody cage, laminectomy, facetectomy, and bilateral screw fixation are being used to analyse the results of this investigation. Disc height restoration, indirect foraminal decompression, and lumbar spine alignment and balance may all be accomplished while decreasing patient morbidity (as measured by operating time, blood loss, lumbar musculoligamentous complex damage, and most likely length of hospital stay).

2. Patients and methods

This study has been conducted on 20 cases of symptomatic lumbar instabilities who have failed medical treatment at the orthopedic department, faculty of medicine, Benha university hospitals.

Inclusion criteria:

This study include 20 cases of symptomatic lumbar instabilities who have failed medical treatment which includes one or more of the following

- ✓ Evident instability on radiographic evaluation (static and dynamic films)
- ✓ Including those who have been previously operated or not Associated with inefficiency in daily activities

Exclusion criteria:

Any cases the following criteria excluded

- ✓ Incomplete radiological documentation
- ✓ Inaccurate radiological documentation before or after the surgery
- ✓ Anticipated poor cooperation of the patient.

Methods of diagnosis:

- ✓ All patients are evaluated clinically by history and physical examination. Special attention is directed towards associated neurology, previous spine procedures, gait disturbance, limb length discrepancy, asymmetry of the spine and any change in body habitus and posture.
- ✓ All the patients have standing radiographs lumbosacral spine (Anteroposterior and lateral views).
- ✓ All the patients have dynamic lateral radiographs lumbosacral spine, measuring the degree of the angulation and translation.

Assessment and outcome evaluation:

Assessment and outcome evaluation include:

Patient's history:

- ✓ Clinical history was taken from the patient in the sort of name, sex, age, job, address and smoking habits.
- ✓ Associated illness like diabetes, hypertension and cardiac condition.
- ✓ Patients were asked about the mechanism of injury and if there is any associated injuries.

Clinical examination:

The clinical manifestations of spinal stability fall into three categories

- ✓ Neurologic deficit due to cord, cauda equina, or nerve root compression
- ✓ Pain
- ✓ Incapacitating deformity

Radiological evaluation:

The bony union was evaluated with careful assessment of the formation of bone bridging and the absence of radiolucency around the cages. A solid bony union was considered to be obtained when the endplates became invisible on the follow-up radiographs, and bony trabecular continuity and bone bridging were observed in the intervertebral space. Fusion failure was defined as the presence on anteroposterior and lateral radiographs of a definite radiolucent line around a cage or pedicle screw or more than 5° of motion on lateral flexion extension radiographs. 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.

Clinical improvement:

Clinical improvement over a six month period as measured by:

Visual Analogue Score (VAS):

We used the visual analog scale (VAS) is a pain rating scale first used by Hayes and Patterson in 1921. Scores are based on self-reported measures of symptoms that are recorded with a single hand written mark placed at one point along the length of a 10-cm line that represents a continuum between the two ends of the scale—"no pain" on the left end (0 cm) of the scale and the "worst pain" on the right end of the scale (10 cm).Measurements from the starting point (left end) of the scale to the patients' marks are recorded in centimeters and are interpreted as their pain.

The Oswestry Disability Index :

Section 1 – Pain intensity
Section 2 – Personal care
Section 3 – Lifting
Section 4 – Walking
Section 5 – Sitting
Section 6 – Standing
Section 7 – Sleeping
Section 8 – Sex life (if applicable)
Section 9 – Social life
Section 10 – Travelling

Surgical technique:

Fitness to surgery:

The patients were assessed for fitness for surgery by clinical history, examination and routine pre-operative laboratory investigations.

Consent:

Standard consent was taken from the patients.

Surgical procedure:

1. Operating room setup
   - ✓ The patient is taken to the operating room and placed prone on a radiolucent operating table.
   - ✓ Fluoroscopy C-Arm is used throughout the procedure.
2. The spine is approached through a standard posterior midline incision

including exposure out to the tips of the transverse processes so that an adequate intertransverse fusion can be performed.

3. Pedicle screw placement is undertaken via a standard approach.
4. Decompression is initiated with a laminectomy in the midline, exposing the ligamentum flavum.
5. The ligamentum is carefully removed, and hemostasis is obtained. A unilateral facetectomy is then performed.
6. Once the posterior bone elements are resected and the decompression is complete, the dura and neural elements are mobilized. The goal is to be able to access the posterior anulus and disc space easily without any dural tension.
7. Distraction through the PLIF level helps facilitate interbody placement, achieved by a lamina spreader or distraction on the contralateral pedicular screws.
8. A safe triangular window is identified between the exiting, traversing roots and the pedicle. This window is enlarged using Kerrison rongeurs. A window that is a minimum of 10 mm in size facilitates disc space preparation.
9. Disc space preparation is performed using a combination of curettes, pituitary rongeurs, and end-plate preparation tools. Thorough disc-space preparation is critical for both correcting the deformity and obtaining a solid fusion.
10. The disc space is sized for an appropriate interbody cage. The anterior aspect of the disc space and the cage are both packed with bone graft. This may involve the use of iliac crest graft, local bone, or bone substitutes, depending on the specific clinical situation.
11. The single Cage and bilateral pedicular screws position is verified by biplane radiography and lordosis is restored by compression across the screws bilaterally.
12. If the lateral gutters have been exposed, grafting in this region is undertaken as well. Care must be taken with graft placement on the PLIF side as facet and pars resection leaves the exiting route exposed.
13. Closure is undertaken in a standard fashion.

Postoperative care:

The patients are admitted to the hospital .the patients receive intravenous antibiotics and pain medication as require. The patient is typically mobilized out of bed the day after surgery.

Follow up:

Patients were asked to return to hospital for follow-up at 4 weeks, 3 months, and 6 months for clinical and radiographic assessment.

Statistical methods

Data management and statistical analysis were done using SPSS version 25. (IBM, Armonk, New York, United States). Quantitative data were assessed for normality using the Shapiro-Wilk test and direct data visualization methods. Then, numerical data were summarized as means and standard deviations or medians and ranges. Categorical data were summarized as numbers and percentages. VAS score and ODI were compared at different times using Friedman's test. Post hoc analyses were Bonferroni corrected. All statistical tests were two-sided. P values less than 0.05 were considered significant.

3. Results:

This study included 20 cases of symptomatic lumbar instabilities who have failed medical treatment. The mean age of the studied patients was 53 years with a standard deviation of 14 years. Regarding gender, more than half of the patients were females (55.0%). The mean BMI was 28.5. About one-quarter were smokers (25.0%). (Table 1)

Table (1) General characteristics of the studied patients

Age (years)	**Mean ±SD**	**53 ±14**
Gender	**Males n (%)**	**9 (45.0)**
	Females n (%)	**11 (55.0)**
BMI	**Mean ±SD**	**28.5 ±4.3**
Smoking	**N (%)**	**5 (25.0)**

Level of affection of the studied patients

More than half of the studied patients showed L5/S1 affection. About one-third showed L4/5 affection. Only 10% and 5% showed L3/4 and L2/3 affection, respectively. (Table 2)

Table (2) Level of affection of the studied patients

		n (%)
Level of lesion	**L2/3**	**1 (5.0)**
	L3/4	**2 (10.0)**
	L4/5	**6 (30.0)**
	L5/S1	**11 (55.0)**

Presenting symptoms of the studied patients

All patients had leg pain, and most of them (85%) had back pain

Table (3) Presenting symptoms of the studied patients

	N (%)
Leg pain	**20 (100.0)**
Back pain	**17 (85.0)**

VAS score

VAS score of leg pain showed an overall significant difference (P-value < 0.001). Post hoc analysis revealed that it was significantly higher pre-operative (8) compared to 3 months (2) and 12 months (1), with no significant difference between 3 and 12 months.

Table (4) VAS score of leg pain at pre-operative, 3 months, and 12 months

VAS	Median (range)	P-value
Pre-operative	**8 (7 - 10) [a]**	**< 0.001**
At 3 months	**2 (1 - 7) [b]**	
At 12 months	**1 (0 - 2) [b]**	

Oswestry disability index (ODI)

Oswestry Disability Index (ODI) score showed an overall significant difference (P-value < 0.001). Post hoc analysis revealed that it was significantly higher pre-operative (50) compared to 3 months (20) and 12 months (10). Also, it was significantly higher at 3 months compared to 12 months**.**

Table (5) ODI at preoperative, 3 months, and at 6 months

ODI	Median (range)	P-value
Pre-operative	**50 (34 - 90) [a]**	**< 0.001**
At 3 months	**20 (8 - 64) [b]**	
At 12 months	**10 (4 - 72) [c]**	

Complications:

Two patients showed cage posterior migration. One patient showed screw malposition, and one patient showed superficial infection.

Table (6) Distribution of complications.

	n (%)
Cage posterior migration	**2 (10.0)**
screw malposition	**1 (5.0)**
superficial Infection	**1 (5.0)**
No complications	**16 (80.0)**

Patients' satisfaction

Most patients (70.0%) reported excellent outcomes. Only 20% and 10% reported good or fair outcomes, respectively.

Table (7) Satisfaction grade of the studied patients

		n (%)
Satisfaction	**Fair**	**2 (10.0)**
	Good	**4 (20.0)**
	Excellent	**14 (70.0)**

Case presentation:

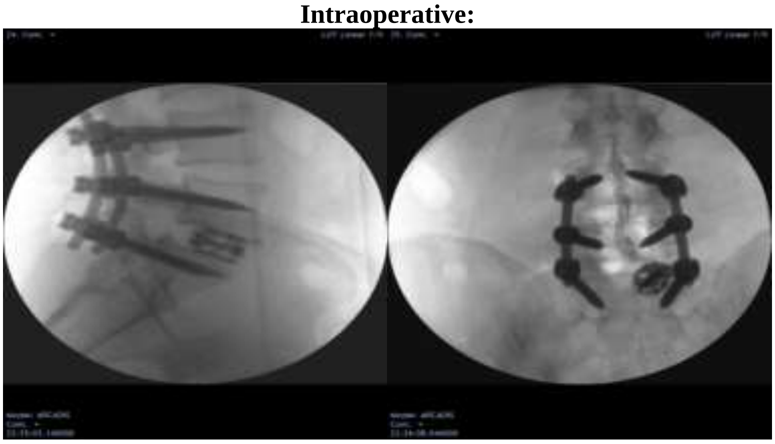
Case 1:

51 year old male with back pain and bilateral leg pain. Had an L5/S1 decompression and PLIF.

Preoperative:

Preoperative MRI (Bilateral foraminal stenosis, more on RT).

Intraoperative:



Postoperative:

6 m F/U:

4. Discussion:

In order to alleviate leg discomfort caused by pinched nerve roots and to establish bone fusion at the desired levels, the objective of lumbar interbody fusion surgery is achieved. [11]

This procedure not only eliminates the symptomatic side's nerve compression-induced discomfort by decompressing its neural supply to the affected area, but it also helps restore disc height, keep the spinal column aligned, and allow the patient to bear weight again. In comparison to posterolateral bone grafting, PLIF has been shown to have a greater intervertebral segment fusion rate and better clinical results. [12]

Most often, two cages are placed through a bilateral procedure with substantial laminectomy or posterior facetectomy and a combination of bilateral pedicle screws to give spinal stabilisation using the classic PLIF method There are a few drawbacks to the surgery itself. Due to substantial intraoperative paraspinal muscle exposure around the posterior parts of the surgery, blood loss and trauma increase, resulting in paraspinal muscular denervation and atrophy, which leads to a failed back syndrome. [13]

Since its inception, the PLIF has come in three varieties:

1. The most often used procedure involves implanting two cages by bilateral or complete laminectomy.

In the second procedure, two tiny laminar windows are used to implant two cages at the same time.

Implanting a single cage was used in this research's technique of investigation. [14]

A single cage with pedicular screws offered acceptable stability in all directions, notably in flexion, according to Oxland and Lund's study results. Using two cages may also raise the likelihood of a brain damage, according to the researchers. Zhao et al. [15] reported that single-cage PLIF was simpler to operate than two-cage PLIF, which is another benefit of a single cage PILF. To lessen the danger of nerve and dural injuries, it was thought that just one cage may be used, thereby lowering the chance of nerve and dural damage. Those with a single compressed nerve root (such as those experiencing pain or weakness in just one leg) may benefit most from this. They also noted that single-cage PLIF reduced blood loss, operation time, and hospitalisation.

When using single-cage PLIF, the expense of an extra cage might be reduced while still delivering adequate decompression and an excellent decompression rate, great stability, and a spectacular fusion rate.

P-value 0.001 demonstrated a significant difference between the groups on the Oswestry Disability Index (ODI). Prior to the operation, it was found to be 50, however after 3 months and 12 months it was only 20 and 20 respectively (10). Also, at 3 months, it was much more than at 12 months.

The Abduljabar et al research on 41 patients with lumbar degenerative illness handled with PLIF is in agreement with this. According to their findings, they discovered that the ODI averaged a preoperative 53 (SD, 15.99) and had fallen to a final follow-up of 22.73 (SD, 20.00). Among the individuals we examined, only one had symptomatic cage posterior migration. Jin et al. did a retrospective research on 75 patients who underwent lumbar interbody fusions and found that this is in agreement with the findings of this investigation. Five of these cage migrations have been produced (6.7 percent). After surgery, the cages were found to have moved to the side of the patient's body. [17]

Although Bingqian et al. observed no problems, such as infection or neurological impairment, in their research of 31 patients, Neither a broken screw nor a loose screw was found in any of the instances studied. [18] One patient had screw malposition in our research. Less than the Aslanbaş et al. study of 100 patients with thoracolumbar screws fixation published here. Of the 692 screws implanted in this patient group, 11.85% were found to be out of place. [19]

On the other hand, Woo et al. found that screw malposition and cortical perforation of pedicular screws varied widely in the literature, from 2 percent to 50 percent. Oral antibiotics treated a patient who had a superficial infection in our trial. A review paper on postoperative spinal infections by Dowell et al. reported an infection rate ranging from 0% to 18%. The infection rate rose from 6% to 18% when fusion was performed with instruments. [21]

Our research found that 70% of patients were happy with their treatment, and many of them thought it was doing wonders for them. Most people (80%) reported bad or unsatisfactory results. According to Zhao's research of 27 patients with posterior lumbar interbody fusion and one cage, 55% of them had excellent outcomes, 37% were good, and 3.7% were fair or bad. Zhao's findings were in accord with ours. Furthermore, 92.5 percent of patients achieved fusion at one year, and all patients obtained arthrodesis after two years, according to the study results. According to their findings, PLIF may be achieved more affordably and safely by employing a single cage in conjunction with pedicular screws. [22]

According to Fogel et al. [23], who carried out a retrospective investigation of 26 patients treated with a unilateral cage to see whether healing and clinical outcomes were equivalent to those achieved with bilateral cages. Pseudarthroses and instrumentation failures were not seen at any of the single cage levels throughout this investigation. The procedure restored and maintained the foraminal and disc space heights. 23 out of 26 patients (88 percent) achieved clinical success with Prolo scores, while 3 patients failed. A total of 23/26 (88 percent) of fusions were successful at all single cage fusion levels. By using just one interbody cage instead of two, the research found that fusion and clinical success rates were not affected. As a Level III-2 Therapeutic investigation, the outcomes of this retrospective comparative study will be examined in comparisons to other studies that used several interbody cages for PLIF surgery.

There were 31 patients with unilateral radiculopathy who had been diagnosed with spinal stenosis, as well as degenerative disc disease, a herniated intervertebral disc, and unstable lumbar discs, who underwent the use of a single cage and a single set of pedicle screws for the unilateral PLIF surgery. VAS and the Oswestry Disability Index (ODI) were used in the postoperative clinical assessment to measure back and leg pain at various time points after the operation. Preoperative, immediately postoperative, 1, 2, 3, and 6 month postoperative, as well as the most recent follow-up lateral plain radiographs were used to complete radiological evaluations. All of the patients received a single-level fusion, which took an average of 94 minutes to complete. Blood transfusions were not necessary in any of the instances, despite the fact that the average haemorrhage volume was 250 ml. All patients had excellent or good outcomes at 12 months postoperatively (Excellent in 28 patients and Good in 3). Prior to surgery, the average pain score was 6.8, and at the three-month follow-up, it had dropped to 2.3. There were no major problems or neurological impairment throughout the procedure. There were no fusion failures in any of the 31 patients. Neither a broken screw nor a loose screw was found in any of the instances studied. As a result of the research, Decompression and solid interbody fusion may be performed with minimum invasion of the posterior spinal components when performing PLIF employing a single cage inserted diagonally with additional unilateral transpedicular screw instruments. PLIF may be performed in a safer, simpler, and more cost-effective manner with this method. [18]

Using a single interbody cage to do unilateral PLIF provides a number of benefits. Unilaterally inserting an interbody cage affects fewer anatomical structures than bilaterally inserting two cages. Unilateral PLIF, however, has not been shown to be as stable as bilateral PLIF. According to Suke et al. [12], in lumbar spinal fusion, either unilateral or bilateral pedicle screw fixation was equally successful. Their findings cannot be applied to the cage-instrumented PLIF since the decompression boundary is different (especially facetectomy). It has been shown by Tencer et al. that using two PLIF structural devices reduces torsional stiffness more effectively than using only one. [24]

In spinal surgery, Chen et al. showed that unilateral fixation with two cage insertions is an option worth considering. Using an oblique insertion of a single BAK cage in an instrumented PLIF may limit exposure and allow for accurate implantation, according to Wang et al [25]. According to these studies, unilateral fusion does not give as much stability as bilateral fusion. Unilateral PLIF treatments have not become common in the treatment of degenerative lumbar spine disease because they are not considered safe and effective. [26]

Using fresh human spines, Goel et al. found that the unilateral plate system caused coupled movements owing to its intrinsic asymmetry and was insufficiently stiff. Lumbar spine rotational deformity may occur due to the persistence of the underlying asymmetries. They concluded that the disc had to be completely removed. Unilateral cage-instrumented PLIF may be able to overcome the asymmetry inherent in the system. In light of the findings of the last research, this one had a dual purpose. PLIF cage-instrumented unilaterally and bilaterally were compared for biomechanical stability. The other was to assess whether or not the unilateral group was affected by the negative impact of pair motion due to innate asymmetry. [27]

5.Conclusion

As a result of this procedure, the intervertebral disc space is maintained, there is excellent boney union between the vertebrae, the patient's spine is rigidly stabilised, and a high fusion rate is achieved in the treatment of lumbar instability.

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