

## Comparison of Outcome in Lumbar Spine Instability Treated Surgically with Pedicle Screw Fixation with or Without Interbody Fusion Device (Cage)

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### Abstract

**Background & Objectives:** Lumbar spine instability has been surgically managed by posterior lumbar interbody fusion devices using pedicle screw and rod fixation. Many surgeons advocate the use of an interbody fusion device (Cage) to assist in fusion and increase the stability of the construct.

The aim of the study is to assess and compare the functional and radiological outcome of patients undergoing surgical fixation with or without interbody cage.

**Methods:** 20 Patients were studied in Department of Orthopaedics in teaching hospitals Department of Orthopaedics, Shri Atal Bihari Vajpayee Medical College and Research institute, Bengaluru, who are diagnosed with instability of lumbar spine and willing for surgery. Clinical follow-up at 6wks, 3months, 6months, 12months intervals regarding pain, fusion and the functional outcome will be evaluated by visual analogue scale (VAS) pain rating, and Oswestry Disability Index (ODI) and AP, Lateral and Flexion - Extension radiographs.

**Results:** In our study, 10 patients were included in each of two groups treated with PLIF with Cage or Bone graft alone. Average age was 46.3 yrs in BG group and 47.4 yrs in cage group. Both groups showed improvement in pain and disability scores as measured by VAS, ODI, SF-36. Fusion rates at 3, 6 months and 1 year in BG group fusion rates were 0,30% and 90% as compared to Cage group were 0, 50% and 100% respectively. 30% had sensory disturbance in BG group and 10% in Cage group. Complications were screw loosening 20%, non-union 10%, Urinary disturbance 10% in BG group and Deep infection 10% in Cage group. Both groups had intra-op CSF leak of 10% each. All patients returned to Pre-injury status except 1(10%) in BG group.

**Conclusion** Addition of an interbody fusion device (Cage) helps in greater stability, lower implant failure, higher fusion rate and better functional outcome in patient treated with PLIF for lumbar spine instability. We conclude solid fusion would correlate with good functional outcomes in patients with unstable lumbar segments. PLIF with Cage is associate with lesser complication rate and better patients satisfaction in terms of pain relief.

**Keyw ords:** Lumbar spine instability; Interbody Cage; Interbody fusion; Bone graft; Pedicle screw.

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### 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 [1]. This back pain can be aggravated by activity, which then leads to avoidance of activity and eventually disability. Back pain is also one of the most expensive burdens on the health care system. 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 [2].

Non-specific low back pain can be characterized as acute if lasting less than six weeks, sub-acute if lasting between six weeks and three months, and chronic if lasting for longer than three months. Pain is often initiated by instability at a single motion segment, or the result of abnormal motion of verte-

bral bodies [2].

### **Lumbar Spine Instability.**

**Lumbar Spinal Instability** is defined as the loss of ability of the spine to maintain its pattern of displacement under physiologic loads with no initial or additional neurological deficit, no major deformity, and no incapacitating pain. [3]

Motion of a spinal segment is defined by the biomechanics of the intervertebral disc, facets, and ligaments, each of which offers a level of stability. Abnormal behaviour of any one of these three structures can alter the motion of the other two, and thus the entire motion segment. Often conservative treatments are exhausted before surgery is considered. A significant portion of the problem is of mechanical origin. It is often referred to as clinical spinal instability it is helpful to differentiate between mechanical instability and clinical instability. The former

defines inability of the spine to carry spinal loads, while the latter includes the clinical consequences of neurological deficit and/or pain [3].

To enumerate a few causes leading to instability are [1],

#### **1. Disc Degeneration**

Normal discs act as a hydrostatic fluid, absorbing energy from the compression of two vertebral bodies and distributing this energy in a controlled manner. Degenerated discs are often lacking or devoid of this fluid and as a result display high stress concentrations. The outer region of the annulus fibrosis contains nerve endings which can transmit pain signals. As a result, pain may surface when the outer region of the annulus is irritated. When discs become degenerated, the result is often abnormal movement and instability at that joint. The abnormal motion itself may not cause pain, but higher stresses on the endplates, stretching of the ligaments, or disc impingement on nearby nerves or the spinal cord can all result in pain.

#### **2. Degeneration of Posterior Elements**

When speaking of pain or degeneration of posterior elements, the facets are the structure which is most commonly involved. The superior articular facets of one vertebra and the inferior articular facets of the vertebra above form the zygapophysial joints. These joints are synovial joints with the articular surfaces coated with hyaline cartilage. With time; the degeneration of the cartilage can cause more pressure on the bone, leading to osteophytes caused by increased loading. All of these factors can alter the range of motion of the segment and the mechanics of other areas of the motion segment.

### **3. Stenosis**

Lumbar spinal stenosis is defined as a narrowing of the spinal canal. It most often is a result of degeneration of the disc and facet joints in older patients. The first mechanism would be the disc bulging and protruding into the canal space and applying pressure to the spinal cord. The other may be caused by an increase in stresses in the region of the facet joint resulting in bone hypertrophy in the foraminal space. The pressure on the spinal nerves can cause pain and numbness radiating to the buttocks and legs.

### **4. Degenerative Spondylolisthesis**

The true deformity of degenerative spondylolisthesis does not seem to be pure translation, but rather a rotary deformity that may distort the dura and its contents and exaggerate the appearance of spinal stenosis. Existing theories to explain the development of degenerative spondylolisthesis include the primary occurrence of sagittal facets and disc degeneration, with secondary facet changes accounting for anterolisthesis. The sagittal facet theory suggests a predilection for slippage because of facet orientation that does not resist anterior translation forces and, over time, results in degenerative spondylolisthesis. The disc degenerative theory proposes that the disc narrows first and subsequent overloading of the facets results in accelerated arthritic changes, secondary remodeling and anterolisthesis.

### **Fusion**

Spinal fusion is a procedure in which two or more vertebral bodies are fused together using a bone graft and some form of stabilizing device. The majority of fusions are performed in an attempt to alleviate pain or correct disorder in the region of the intervertebral disc space, and success of this procedure relies on the type of instrumentation, bone graft material, and the individual biological factors of the patient [4]. The biomechanical result of a successful fusion is the elimination of movement at the instrumented segment [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].

Fusion drastically changes the mechanics of the spine. The main problem results from the fact that it does not change the total amount of load placed upon the lumbar spine. The angular requirements for movement of the spine are then met by fewer segments, which have greater bending moments applied to them as a result. This can easily speed up the degeneration process at other segments, especially those adjacent to the fusion site [7].

Over the past 25 years, surgical treatment for low back pain has rapidly evolved from uninstrumented fusions with varying results [8].

While instrumentation increased the fusion rate, this was not necessarily indicative of a more successful outcome. Fusion remains one of the most common surgeries for several spinal pathologies but comes with risks and deficiencies [9].

The advent of transpedicular fixation revolutionized spine surgery, allowing rigid fixation and enhancing the likelihood that fusion will occur. Previously, lumbar

fusions were performed using the intertransverse technique, necessitating wide exposure and possible use of iliac crest graft [10].

Recent technological advances in cage, instrumentation and revision surgery is often difficult. Because of these drawbacks, surgeons looked for other surgical means of treating back pain. Earlier use of allograft bone required time-consuming by the surgeon.

Use of machined allograft is an alternative to threaded fusion cages, as well as non-machined allograft or autograft [11].

Machined allograft spacers often require less bone removal for insertion and allow surgeons to visualize bone incorporation with standard radiographic techniques. Bone can be impacted to allow restoration of disc space height and provide anterior column support. Iliac crest grafting, with its potential complications, is not required [12].

The machined allograft can be supplemented with bone removed during decompression, which can be placed in either the interbody or inter-transverse space.

A successful biological cage needs to both address the lordosis of the lumbar spine and provide stability to the spine. The quality of the bone graft, both biologically and as a load-bearing device, is crucial in achieving solid fusion [13].

The PLIF biological cage, used since January 1999, is an innovative lumbar interbody allograft, harvested and processed by the Musculoskeletal Transplant Foundation (MTF, Edison, NJ) and designed and available through Synthes Spine (West Chester, Pa) [12].

Fusion remains one of the most common surgeries for several spinal pathologies but comes with risks and deficiencies. While the goals of fusion are common no matter the technique, there are several different approaches which a surgeon may take to fuse one or more segments.

In current practice, bone grafting and instrumentation are often used concurrently based on the ex-

pectation that internal fixation of spine enhances the success of bone fusion while a successful bone fusion eliminates the possibility of hardware failure by reducing the chronic biomechanical stresses on the hardware construct.

A variety of techniques are available for the application of interbody grafts, and each technique has its particular advantages, disadvantages and complications. Hence, I would like to do a comparative study to assess the pedicle screw and interbody fusion with (cage) or without (bone grafting) devices.

### Material and Methods

20 Patients were studied in Department of Orthopaedics in teaching hospitals Department of Orthopaedics, Shri Atal Bihari Vajpayee Medical College and Research institute, Bengaluru, who are diagnosed with instability of lumbar spine and willing for surgery. Clinical follow-up at 6wks, 3months, 6months, 12months intervals regarding pain, fusion and the functional outcome will be evaluated by visual analogue scale (VAS) pain rating, and Oswestry Disability Index (ODI) and AP, Lateral and Flexion - Extension radiographs.

### Inclusion Criteria:

- Patients with lumbar instability secondary to fracture, degeneration and congenital conditions will be included in the study.
- Patient aged 18 years or more will be included in the study.
- Patient with features of instability as per defined criteria.
- Patient willing to give consent for surgery.
- No response to conservative treatment modalities for 6 months (minimum) preceding enrolment.

### Exclusion Criteria:

- Patient with co-morbid conditions and not fit for surgery.
- Patient with spinal deformities, polio and cerebral palsy.
- Patient with active localised or systemic infection.
- Previous interbody fusion attempt at target level.
- Pregnancy and lactating mother.
- Immunosuppressive disorder.

### Results

Our study comprise of two groups, depending on the surgeon's choice: the bone graft (BG) group (n = 10) and the Artificial cage (Cage) group (n = 10). For patients in the BG group, we used local host bone chips only for PLIF.

For patients in the Cage group, we used interbody cages packed with morselized autograft bone chips for PLIF.

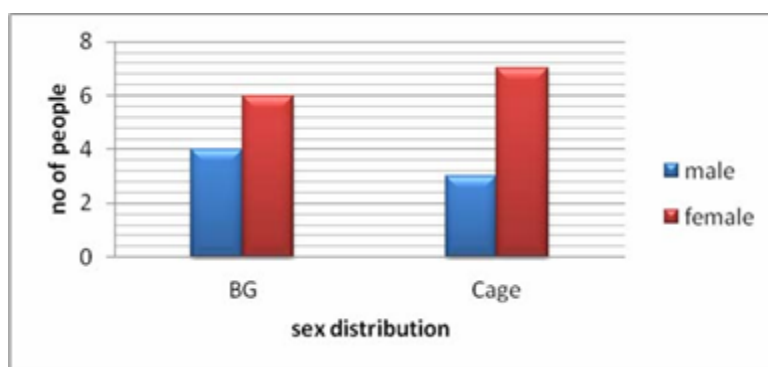
1. **Age and Sex Distribution:** In our series of 20 patients, 7(35%) were males and 13(65%) were females. In Bone graft group (BG), 4(40%) were males and 6(60%) were fe-

males. In Cage group 3(30%) were males and 7(70%) were females.

2. Average age of patients in BG group was 46.3 years and in cage group was 47.4 years respectively. The overall sex ratio males: females was (7:13), the mean age was 46.85 years (28 to 68 years).

**Table 1: Sex distribution**

	BG group	Cage group	Total
Males	4 (40%)	3 (30%)	7 (35%)
Females	6 (60%)	7 (70%)	13 (65%)

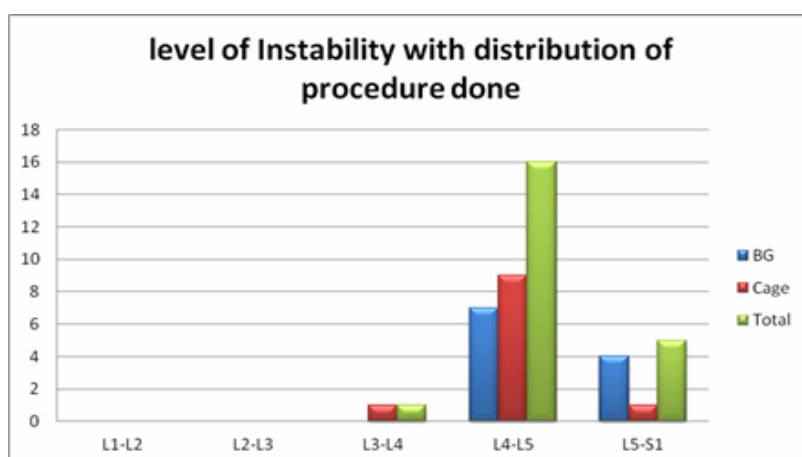


3. **Level of instability:** In our series, we had 1(4.5%) L3-L4 level instability, 16(72.7%) L4-L5 level instability and 5(22.7%), L5-S1 level instability.

In both the groups, 1 person had L4-L5, L5-S1(2 level) instability.

**Table 2: Showing level of instability with distribution of procedure done.**

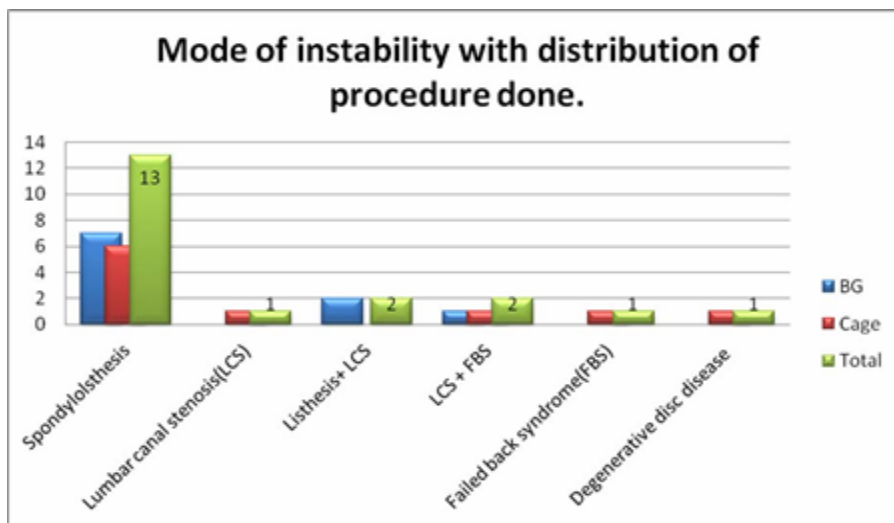
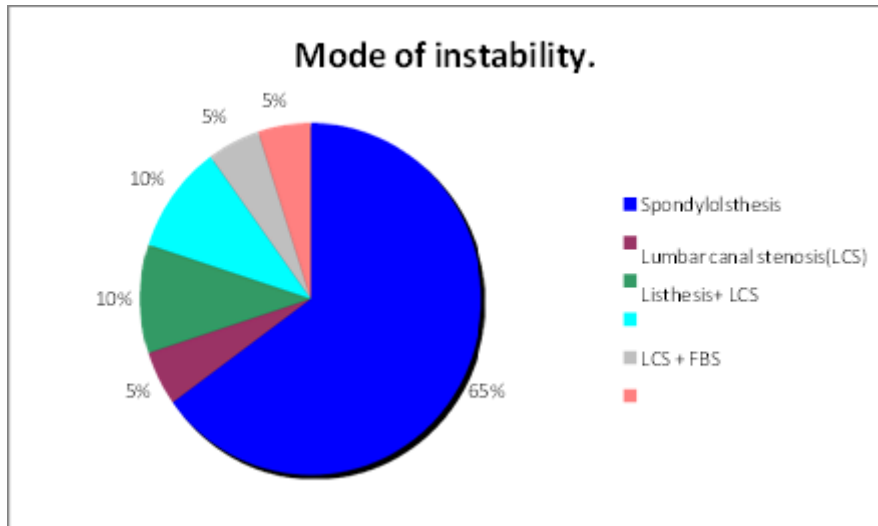
Level	BG	Cage	Total
L1-L2	0	0	0
L2-L3	0	0	0
L3-L4	0	1	1
L4-L5	7	9	16
L5-S1	4	1	5



4. **Mode of instability.**

**Table 3: Showing Mode of instability**

Mode	BG	Cage	Total	%
Spondylolisthesis	7	6	13	65%
Lumbar canal stenosis (LCS)	0	1	1	5%
Spondylolisthesis + LCS	2	0	2	10%
LCS + FBS	1	1	2	10%
Failed back syndrome (FBS)	0	1	1	5%
Degenerative disc disease	0	1	1	5%



5. **Blood loss:** In our study average blood loss is 355 ml in BG group and 310 ml in cage group.

**Table 4: Showing Average blood loss during surgery**

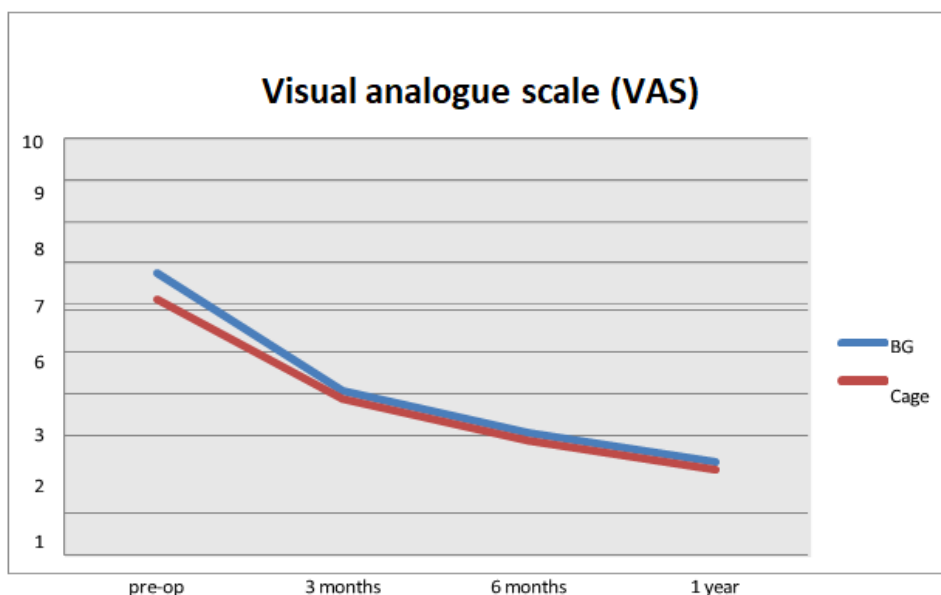
	BG	Cage
Estimated avg blood loss	355 ml	310

6. **Functional result:**

A. **Visual Analogue Scale (Average)**

**Table 5: Showing visual analogue scale scores**

Group	Pre-op	3 months	6 months	1 year	0 vs 3	0 vs 6	0 vs 12
BG	5.9	3.1	2.1	1.4	<0.0001	<0.0002	<0.0002
Cage	5.3	2.9	1.9	1.2	<0.0003	<0.0001	<0.0001
P value	0.053	0.277	0.330	0.302			

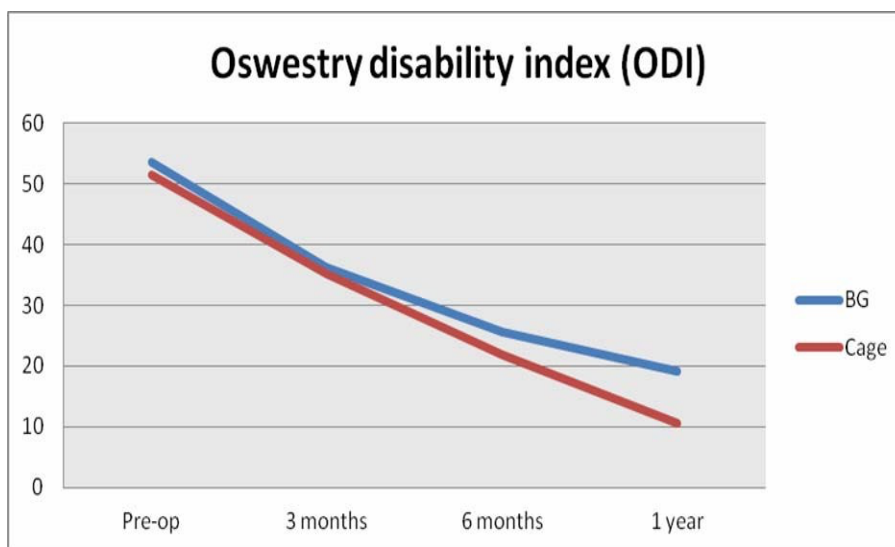


VAS scale (0-10) taken at pre-op, 6 weeks, 3months, 6 months and 1 year showed statistically significant improvement in pain reduction in both the groups after surgery. However there is no significant between the BG and Cage groups.

B. Oswestry disability index (ODI)

Table 6: Showing Oswestry disability index scores

Group	Pre-op	3 months	6 months	1 year	0 vs 3	0 vs 6	0 vs 12
BG	53.6	36.2	25.56	19.11	0.002	0.0002	0.0001
Cage	51.4	35.2	21.8	10.6	0.005	<0.0004	<0.0004
P value	0.305	0.437	0.249	0.1123			



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

**Discussion**

Since spinal arthrodesis was first reported 90 years ago, various techniques have been devel-

oped for lumbar spine fusion. The field has evolved from uninstrumented fusion to use of 1 or more of the following: allograft, autograft, metallic cages, carbon fiber cages, BMP, and supplemental instrumentation. Lumbar fusion has been recommended in some patients who did not improve after an extended, multimodality trial of non surgical therapy.

### 1. Age and Sex Distribution:

In our study we had 35% males (40% in BG and 30% in cage group) and 65% females (60% in BG group and 70% in cage group) and mean age of 46.3 yrs in BG group and 47.4 yrs in cage

group. Ching-Hsiao Yu et al [13] in their study had 56% males and 46% females in BG group, 23% males and 77% females in cage group with mean age 59% yrs. [14]

**Table 7: Comparing Age and Sex.**

	Our study (20)		Ching-Hsiao Yu et al <sup>13</sup>	
	BG group(10)	Cage group (10)	BG group(34)	Cage group(42)
Males	4 (40%)	3 (30%)	19 (56%)	10 (23%)
Females	6 (60%)	7 (70%)	15 (44%)	32 (77%)
Mean age(yrs)	46.3	47.4	58.7	59.4

### 2. Level of instability:

In our study, in BG group 6(60%) at L4-L5 level, 3(30%) at L5-S1 and 1(10%) at two level instability. In Cage group 1(10%) at L3-L4, 9(90%) at L4-L5 level, 1(10%) at L5-S1 and 1 at two level instability. Dong yeob lee et al<sup>68</sup>, in their study found 77% instability at L4-L5, 19 % at L5-S1 level and 4% at L3-L4 level.

**Table 8: Comparing level of instability**

Level	Our study		Dong yeob lee et al <sup>14</sup>	
	BG group(10)	Cage group (10)	BG group(34)	Cage Group(42)
L3-L4	0	1 (10%)	2 (6%)	7 (2%)
L4-L5	7 (70%)	9 (90%)	20 (59%)	32 (76%)
L5-S1	4 (40%)	1 (10%)	11 (33%)	3 (7%)

### 3. Clinical outcome:

At 12 month follow-up, of 10 patients in BG group 80 % and of 10 patients in Cage group 90% reported decreased pain and disability as measured by VAS, SF 36 and ODI.

In study by Ching-Hsiao Yu et al [13], the artificial cages provided better functional improvement in ODI and VAS scales, than Bone chip group.

All patients had uneventful motor recovery with 30% paresthesia in BG group and 10% paraesthesia in Cage group. All patients returned to previous

lifestyle except 1(10%) patient in BG group.

Although both BG and cage groups showed significant functional improvement in ODI, VAS and Benzels score after PLIF, the Cage group had greater improvement than the BG group, which is statistically not significant.

Satisfactory outcomes were obtained in Cage group because there is better maintenance of disc space, vertebral height and no collapse. In BG group, bone graft alone is used, which is less rigid and lead to collapse before the fusion occurs. This was attributed to increase pain, disability and less satisfaction even after surgery.

**Table 9: Comparing Clinical Outcome.**

	Our study		Ching-Hsiao Yu et al.[13]	
	BG group (10)	Cage group (10)	BG group (10)	Cage group (10)
<b>Sensory disturbance</b>	<b>3 (30%)</b>	<b>1 (10%)</b>		
<b>Patient satisfaction (SF-36 scores)</b>	<b>8 (80%)</b>	<b>9 (90%)</b>	<b>79.4 %</b>	<b>90.3 %</b>
<b>Return to previous lifestyle</b>	<b>9 (90%)</b>	<b>10 (100%)</b>		

### Conclusion

Addition of an interbody fusion device (Cage) helps in greater stability, lower implant failure, higher fusion rate and better functional outcome in patient treated with PLIF for lumbar spine instability. We conclude solid fusion would correlate with good functional outcomes in patients with unstable lumbar segments. PLIF with Cage is associate with lesser complication rate and better

patients satisfaction in terms of pain relief.

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