© J ORTHOP TRAUMA SURG REL RES
16(6) 2021
Research Article

Comparative study of posterolateral fusion versus combination of posterolateral and posterior lumbar interbody fusion in spondylolisthesis treated with posterior decompression and pedicle screw fixation

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Received: 01.07.2021
Accepted: 16.07.2021
Published: 25.07.2021

Abstract

Background: Spondylolisthesis is defined as forward slippage of cephalad vertabra on a caudal vertebra. It is a combination of 2 greek words-Spondylos (Vertebra) and Olisthanein (to slip or fall). Spondylolysis is the most common cause of low back pain in adolescents and about 15% to 25% of patients of spondylolysis will ultimately develop spondylolisthesis.

Methods: The study was conducted to compare the Clinical and the Functional outcome of Posterolateral fusion versus combination of Posterolateral and Posterior lumbar interbody fusion in spondylolisthesis treated with posterior decompression and pedicular screw fixation performed between March 2015 and March 2016,first 13 patients consecutive patients underwent Posterolateral Fusion (PLF) while last 13 patients underwent combination of posterolateral fusion and Posterior Lumbar Interbody Fusion (PLIF). The clinical outcome was evaluated according to the Visual Analogue Scale (VAS) and functional outcome was evaluated according to Oswestry Disability Index (ODI).

Results: Maximum patients were in age group of 51-60 years in both groups with mean age of presentation being 47.3 years. Low backache was the most common symptom being present in 100% of patients. Radicular pain and claudication were the next most common symptoms.

This study shows that in group 2 where patients were treated with combination of PLIF and PLF 76.9% of patients had Grade 2 fusion while only 38.5% of patients in group 1 had Grade 2 fusion ($p=0.025$). ODI and VAS also improved more in group 2 and this difference was statistically significant ($p<.001$).

Conclusion: Combination of posterolateral and posterior lumbar interbody provides good clinical,functional and radiological outcome with less complications as compared PLF alone.

Keywords: Spondylolisthesis; Posterolateral Fusion; Pedicle Screw Fixation; VAS; ODI; fusion rate; interbody fusion; spondylosis; Meyerding ; body slippage

INTRODUCTION

The term Spondylolisthesis comes from combination of two greek words-Spondylos (Vertebra) and Olisthanein (to slip or fall) [1].

Spondylolysis is the most common cause of backache in adults [2-4]. The incidence of spondylolisthesis in the general adult population is 4% to 8%, depending upon the race, age, and sex of the population. Approximately 8% to 14% of adolescent athletes' suffere from spondylolysis .In general, women are at greater risk than men [5]. Lower back pain, sciatica, paraesthesia, weakness and intermittent claudication are the main symptoms.

Spondylolisthesis can manifest anywhere in the spine with the lumbosacral region being most commonly affected. L5 region is involved in with almost 70% to 95% cases.

Treatment of spondylolisthesis depends on the severity of symptoms which the patients have. Most patients who present with spondylolisthesis are asymptomatic or have minor symptoms like pain [6]. Conservative measures include no steroidal medications, selective nerve/pars injections; brace therapy, restriction of athletic activities, and bed rest. If patients fail to respond to 3-6 months of non-surgical treatment, surgical intervention is considered [7].

Many surgical techniques are available including Posterolateral Fusion (PLF), posterior lumbar interbody fusion (PLIF), Transforaminal Lumbar Interbody Fusion (TLIF), Anterior Lumbar Interbody Fusion (ALIF) with or without posterior instrumentation. The simplest surgical procedure is to do arthrodesis without instrumentation, but this has been found to be associated with a high rate of non-union. Addition of pedicle screw to the above provides stability to the spine and improves the fusion rate.

PATIENTS AND METHODS

This is a prospective study of 26 cases (13 in each group) operated between March 2015 to March 2016 conducted in Balaji Institute of Surgery,Research and Rehabilitation for the Disabled to Compare posterolateral fusion versus combination of posterolateral and posterior lumbar interbody fusion in Spondylolisthesis treated with Posterior Decompression and Pedicle screw fixation. Informed consent was taken from the patients and ethical committee approval was taken.

Patients diagnosed with spondylolysis and spondylolisthesis with failed conservative treatment between age group of 30-70 years of both sexes were included in this study. Patients with Meyerding Grade-V spondylolisthesis and those who did not have a regular follow up for a minimum period of 3 months were excluded. A total of 26 consecutive patients were taken which divided into 2 groups:

- Group 1: Underwent Posterolateral fusion.
- Group 2: Underwent the Combination of Posterolateral and Posterior lumbar interbody fusion.

Preoperative investigations included hemoglobin, blood grouping, others tests depending on co-morbidity and to rule out infection total leucocyte count, differential count, Erythrocyte Sedimentation Rate (ESR), C Reactive Protein (CRP) were done. Radiographic evaluation consists of standard anteroposterior, lateral, oblique, flexion and extension views were taken in standing position. An MRI scan of lumbosacral spine was also done to determine the extent of the nerve root involvement.

The percentage of vertebral body slippage was measured by Meyerding classification [8].

- Grade I - 0-25 %
- Grade II - 25-50 %
- Grade III - 50 -75 %
- Grade IV - 75-100 %
- Grade V - 100 % - Spondyloptosis

Clinical outcome was determined on the basis of Visual Analogue Score (VAS) [9]. Functional outcome was calculated on the basis of Oswestry Disability Index (ODI) [10]. Radiological outcome was determined by Radiological fusion scale [11]. Improvement in symptoms including low backache, radicular pain, Claudication, sphincter disturbance, numbness and weakness were assessed at each follow up. Fusion was then assessed by plain lumbar spine radiographs at 6 weeks, 3 months, 6 months and 12 months after operation.

Operative Procedure

After the administration of general anaesthesia, the patient was placed on Spinal frame in prone position (this decreases intra-abdominal pressure resulting in decreased venous pressure and bleeding in the epidural plexus) on the operating table, with hips in as much neutral as possible (an attempt to reduce the listhesis) and knees in flexion (to prevent undue stretching of nerve roots). Proper padding of the pressure points was done.

A standard posterior midline incision was made and the paraspinal musculature detached subperiosteally and freed to the outer margins of the transverse processes on either sides. Haemostasis was achieved by means of bipolar electro cauterization and packing. Care was taken to identify and cauterize the dorsal branches of lumbar arteries. Decompression by laminectomy and facetectomy was done. Each nerve root was followed out past its nerve root canal to ensure adequate decompression and release of the adhesions, scar tissue or any other bony or soft tissue impingements. Osteophytes, previous fusion masses from pseudoarthrosis, if present were removed.

Entry point

At the junction of the lateral to facet and the transverse processes or intersection of the vertical line through the facet joints and a horizontal line through the transverse process. The facet joints of the involved segments were identified and the joint surfaces excised. A posterior decortication was performed at this stage. K-wires were put through the entry point and exact placement was confirmed under fluoroscopic guidance. Pedicle screws were inserted under fluoroscopic control, using a standard "free hand targeting" technique. Decompression was commenced via the midline, removing adjacent borders of the spinous processes of the vertebrae above and below. Interspinous ligaments and ligamentumflava were excised to enter the neural canal. The spinal fenestration was enlarged with sufficient decompressivelaminotomy superiorly and inferiorly to expose and mobilise the nerve roots on both sides. These were then retracted to expose the disc space. A cruciate incision was made on both sides of the annulus and the disc material was removed with pituitary rongeurs. Two longitudinal rods were bent to maintain the lumbar lordosis and were put in the head of pedicle screws, and the construct was tightened and distraced to achieve the normal disc height and vertebral alignment. In group 1, the removed spinous process and laminectomy bone chips was taken as graft and was put in between the transverse processes along with tricalcium phosphate granules.

In group 2, The spinous process and laminectomy bone chips and tricalcium phosphate granules was taken as graft and was put in between the transverse processes and intervertebral disc space [12-14]. Free fat graft was put over exposed dura mater to prevent postoperative adhesions. Closure was done in layers over a sub fascial suction drain in both groups.

RESULTS

The age of presentation ranged from 31 years to 65 years. Maximum patients were in age group of 51-60 years in both groups with mean

age of presentation being 47.3 years. 20 out of 26 (76.9%) patients were females with 11 females in group 1 and 9 females in group 2. (38.4%) out of the 26 patients were light workers whereas 7 (26.9%) were heavy workers. Maximum no. of patients 5 (38.4%) in both groups were light workers.

All patients included in this study were symptomatic. Low backache was the most common symptom being present in 100% of patients. Radicular pain and claudication were the next most common symptoms. None of our patient had sphincter disturbances in form of bowel and bladder involvement. 6 patients in each group had neurological deficit in form of numbness and weakness of lower limbs.

On examination, 21 (80.8%) of patients were having no motor deficit. 4 (15.4%) patients were having grade 4 power in EHL either on one side or both sides. 17 (65.3%) patients were having no sensory loss. 9 (34.6%) out of the 26 patients were having either unilateral or bilateral L5 radiculopathy .

The commonest level involved was L4-L5 in 13 patients (50%) followed by L5-S1 level (12 cases, 46.2 %) and L3-L4 level (1 case, 3.8%).

In group 1 in which posterolateral fusion of vertebra was done, pre operatively 4 (30.8%) patients had Meyerding Grade 1, 8 (61.5%) had Grade 2, whereas 1 (3.4%) patient had Grade 3 vertebral body slippage. In combination of posterolateral and posterior lumbar interbody fusion, pre operatively 6 (46.2%) patients were having Grade 1, 4 (30.8%) was in Grade 2, 2 (7.7%) were having grade 3 whereas 1 (3.4%) patient was having Grade 4 slippage according to Meyerding classification.

Post operatively, symptoms improved in all patients. 6(46.1%) patients were asymptomatic after surgery. Only 6 patients were left with low backache and only 4 patients had radicular pain which was low intensity as compared to pre-operative pain. In combination of posterolateral and posterior lumbar interbody fusion, there was significant reduction in pain. Only 2 (7.7%) of patients were left with pain after surgery and 50% of patients had no numbness or weakness after surgery.

10 (76.9%) of patients in group 2 had Grade 2 fusion while only 5 (38.5%) of patients in group 1 had Grade 2 fusion. In group 1, 11 (84.6%) patients had grade 0 or 1 while only 2 patients (15.4%) had grade 2 or 3 post operatively. In group 2, 10 patients (76.9%) had grade 0 or 1 fusion. (Tables 1-3)

Visual Analogue Scale (VAS) was used to quantify the amount of pain patient was having. VAS difference which was calculated by subtracting pre and post-operative VAS, it was more in group 2 than group 1 and this difference was highly significant (p=0.008)

Table 1. Table showing distribution of patients according to age group

AGE GROUP (YEARS)	GROUP 1	GROUP 2	TOTAL
31-40	4 (30.7%)	3 (23.1%)	7 (26.9%)
41-50	3 (23.1%)	4 (30.7%)	7(26.9%)
51-60	5 (38.4%)	6 (46.1%)	11 (42.3%)
61-70	1(7.7%)	0	1 (3.4%)
TOTAL	13	13	26 (100%)

Table 2. Showing distribution according to pre-operative symptoms

SYMPTOMS	GROUP 1	GROUP 2
NO SYMPTOMS	0	0
LOW BACKACHE	13 (100%)	13 (100%)
RADICULAR PAIN	11 (84.6%)	13 (100%)
CLAUDICATION	11 (84.6%)	7 (53.8%)
SPHINCTER DISTURBANCE	0	0
NUMBNESS	2 (15.4%)	4 (30.7%)
WEAKNESS	3(23.1%)	3(23.1%)

Table 3. Comparison of our study with previous studies in terms of good functional outcome and fusion rates

	NO OF CASES	PLF	PLF+PLIF	FUSION RATE FOR PLIF+ PLF
Rosa GL et al [22]	35	0.667	0.765	0.95
William Abdu et al [23]	380	0.6724	0.8567	0.875
Our Study	26	0.615	0.846	0.923

Clinical outcome was defined according to difference between pre and post-operative VAS. The difference was divided into 3 categories which were as following:

If the difference was 0-2 then outcome was poor.

If the difference was 3-5 then outcome was fair.

If the difference was >5 then outcome was good.

According to this classification, 7 (53.8%) patients each had a good outcome in group 1 while in group 2, 11 (84.6%) patients had good outcome (p=0.180).

Oswestry Disability Index (ODI) is a clinical assessment of low back pain. It includes ten categories: pain intensity, personal care, lifting, walking, sitting, standing, sleeping, sex life, social life and travelling. Each category is assigned 5 points. The post-operative ODI improved in both groups but it was more in group 2 and it was highly significant (p<0.001).

The functional outcome was decided according to difference in pre and post-operative ODI. The difference of ODI was then divided into 3 categories for predicting the functional outcome which was as following:

If difference was <6%, the outcome was poor.

If difference was 6-12%, the outcome was fair.

If difference was >12%, the outcome was good.

12 (92.3%) had good functional outcome in group 2 while 69.2% had good functional outcome in group 1.

22(84.6%) had no complications during and post-surgery. 1(7.7%) patient had dural tear while 2(15.3%) patients had screws broken in group 1, while only 1 (7.7%) patient had infection in group 2.

DISCUSSION

In our study, the youngest patient was 31 years old and eldest patient was 65 years. Mean age of patients was 47.3 years. 20 patients were female (76.9%) and 6 were male (23.1%). Two males and 11 females comprised Group I (PLF). In Group II (PLF+PLIF) there were 9 females and 4 males indicating female preponderance in this condition (F:M-2:1). Similar results have been obtained in the previous studies. This can be due to the reason that most operated had degenerative lumbar spine and the osteoporosis is one of the definitive signs of degeneration. In Indian scenario, osteoporosis is a highly prevalent in females and the progression of spine degeneration is more severe and earlier in females [15,16].

The various signs and symptoms were present for months to years with 50% of patients were having these symptoms for less than 6 months, 9 (34.6%) had symptoms for more than six months whereas 4 (15.4%) of patients had complaints lasting for more than one year.

In our study 13 patients underwent PLF with PLIF and there was significant reduction in pain. Only 2 (7.7%) out of the 13 patients were left with pain after surgery and 50% of patients had no numbness or weakness after surgery.

In group 2, no patient had poor outcome. 2 patients had fair outcome

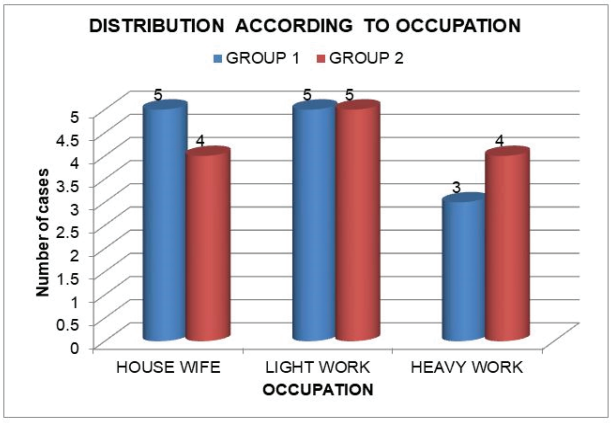

Fig. 1. Bar Graph showing distribution of patients according to the occupation

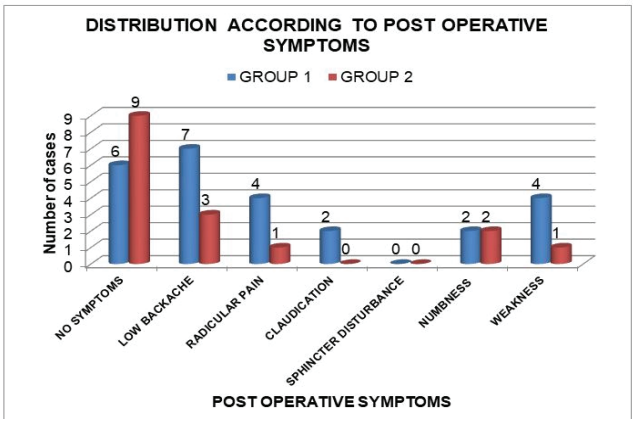

Fig. 2. Distribution according to post-operative symptoms

whereas 11 patients had good outcome based upon ODI score. Salah Fallatah et al. in 2013 showed a slight but not significant trend toward a better functional outcome in the Posterior interbody fusion group [17].

Post operatively grading was done after 6 months. 3 (23.1%) and 6 (46.2%) patients were having Grade 0 in xray in group 1 and 2 respectively. In group 1, 8 (61.5%) had grade 1 while 1 (7.7%) patient each had grade 2 and 3. In group 2, 4 (30.8%) and 3 (23.1%) had grade 1 and 2 respectively. None of the patient had grade 4 postoperatively.

The fusion grade was studied on x-ray done after 6 months. In group 1, 3 patients did not have fusion whereas 5 (38.5%) patients each had grade 1 and grade 2 fusion. In group 2, 10 (76.9%) had grade 2 fusion, 2 (15.4%) had grade 3 fusion, 1 (7.7%) patient had grade 1 fusion. This showed that fusion rates were more in group 2 as compared to group 1. Similarly Zhou ZJ et al. in 2011 and Yong-Ping Ye et al in 2013 showed that fusion rate was significantly higher in the PLIF-treated group than that in PLF treated group [18].

The overall fusion rates in two groups was 10 (76.9%) and 13 (100%) respectively in the two groups. Emile Dehoux et al in year 2004 also showed that the fusion rate was 68% with PLF and 93% with PLIF [19].

The intra and post-operative complications were more in group 1. 1 (7.7%) patient had dural tear while 2 patients had screws broken while only 1 (7.7%) patient had infection in group 2. This was in concordance with the studies done in past. Lei Cheng in year 2008 showed that the PLIF group had better fusion and fewer complications as compared to PLF group [20]. Similarly, Fernando Luiz Rolemberg Dantas et al. in the year 1999-2001 showed that both surgical procedures were effective. The PLIF with pedicle screws group presented better clinical outcomes. Group I presented more complications when compared with Group II [21].

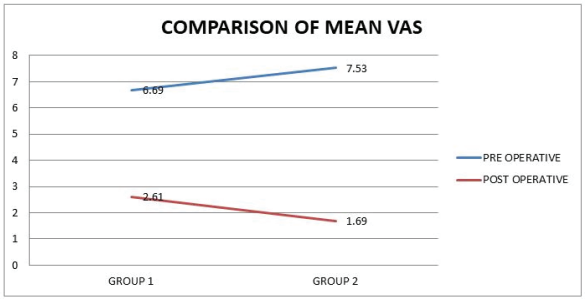

Fig. 3. Line graph showing the difference between pre and post operative vas

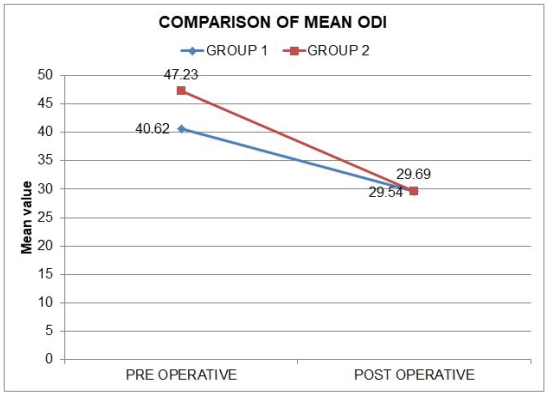

Fig. 4. Line Graph showing the difference between pre and post-operative ODI

In conclusion, Posterior Lumbar Interbody Fusion (PLIF) is an effective method in the treatment of spondylolisthesis, as it provided good spinal fusion, less complication with satisfactory clinical outcome [23].

Periasamy et al. [24] conducted a retrospective study on 75 patients who underwent PLF plus PLIF. Good Clinical outcome was achieved in 85.3% of cases. (Figures 1-4)

Thus, combination of Posterolateral (PLF) and Posterior Lumbar Interbody Fusion (PLIF) is an effective method in the treatment of spondylolisthesis, as it provided good spinal fusion, less complications and gives a satisfactory clinical, functional and radiological outcome.

CONCLUSION

Overall it was concluded that combination of both posterolateral and posterior lumbar interbody fusion technique gives a 360 degree fusion and have apparent mechanical and surgical advantages and gives a good clinical, functional and radiological outcome.

With proper placement of pedicle screws and pre-countouring of connecting rods lumbar lordosis is restored, disc space height is maintained and spondylolisthesis is reduced. In combination of posterolateral and posterior lumbar interbody fusion we used the removed spinous process and laminectomy bone chips as graft for fusion. We did not use iliac bone as bone graft, so donor site morbidity at iliac crest was prevented. We used lamina as interbody graft and did not use interbody cages which lead to a cost effective study.

Posterior decompression of the spinal canal combined with anterior and posterior arthrodesis performed at one stage through a posterior approach is a safe and effective technique in managing spondylolisthesis.

In spondylolisthesis, forward displacement of the vertebra is determined on the lateral view. Meyerding devised a simple method to grade the listhesis according to the percentage of slippage. The anteroposterior diameter of the subjacent vertebral body is divided into four equal parts. A slip in the first quarter of this vertebral body is grade I; one in the last quarter is grade IV.

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