A STUDY OF POSTERIOR LUMBAR INTERBODY FUSION WITH LOCALLY HARVESTED SPINOLAMINECTOMY BONE GRAFT AND PEDICLE SCREW FIXATION IN SPONDYLOLISTHESIS

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ABSTRACT

BACKGROUND

Posterior Lumbar Interbody Fusion (PLIF) and Transforaminal Lumbar Interbody Fusion (TLIF) create intervertebral fusion by means of a posterior approach. Successful results have been reported with allograft, various cages (for interbody support), autograft and recombinant human bone morphogenetic protein-2. Interbody fusion techniques facilitate reduction and enhance fusion. Corticocancellous laminectomy bone chips alone can be used as a means of spinal fusion in patients with single level instrumented PLIF. This has got a good fusion rate. PLIF with cage gives better fusion on radiology than PLIF with iliac bone graft, but no statistical difference in the clinical outcome. Cage use precludes complications associated with iliac bone harvesting. The reported adjacent segment degeneration was 40.5% and reoperation was 8.1% after 10 years of follow up.

MATERIALS AND METHODS

30 cases of spondylolisthesis who attended the Orthopaedic Outpatient Department of Andhra Medical College, Visakhapatnam, from 2014 to 2016 were taken up for study. All the cases were examined clinically and confirmed radiologically. The patient's age, sex, symptoms and duration were noted and were examined clinically for the status of the spine. Straight leg raising test was done and neurological examination of the lower limbs performed. All the patients were subjected to the radiological examination of the lumbosacral spine by taking anteroposterior, lateral (flexion and extension views), oblique views to demonstrate spondylolysis and spondylolisthesis. MRI and x-rays studies were done in all the cases to facilitate evaluation of the root compression disk changes and spinal cord changes.

RESULTS

In our study, we followed all the 30 patients after the surgery following procedure of removal of loose lamina, spinous process and fibrocartilaginous mass, PLIF with only the laminectomy bone mass and CD screw system fixation up to 2 years. 12 patients (40%) had excellent results, 15 patients (50%) had good and 3 patients (10%) had fair results.

CONCLUSION

We conclude that our procedure has fared equally effective when compared with short-term results of cage with PLIF and iliac crest bone grafting technique with respect to achievement of fusion at the intended intervertebral space. This procedure eliminates the cost of cage and substantially reduces the financial burden on the patient, which makes the procedure amicable in rural areas.

KEYWORDS

Spinal Fusion E04.555.100.700, Bone Transplantation E04.555.130, Spine A02.835.232.834.

HOW TO CITE THIS ARTICLE: Pardhasaradhi M, Babu SK, Manikumar CJ. A study of posterior lumbar interbody fusion with locally harvested spinolaminectomy bone graft and pedicle screw fixation in spondylolisthesis. J. Evid. Based Med. Healthc. 2017; 4(66), 3936-3941. DOI: 10.18410/jebmh/2017/787

BACKGROUND

The word spondylolisthesis was derived from the Greek words, "spondylo" meaning vertebrae and "listhesis" meaning to slip. It is defined as the slippage of one vertebra over another. Although, it was Kilian who first coined the word "spondylolisthesis" in 1854, it was actually first described by Herbiniaux, a Belgian obstetrician, in 1782 when he reported complete dislocation of the L5 vertebral body over the sacrum causing narrowing of the birth canal and consequent difficulty with labour and delivery. Forward slippage is called anterior or forward listhesis and backward slippage is called retrolisthesis, the former is most common. Spondylolisthesis has two physical components; the first is a defect in the neural arch through Pars interarticularis, which alone is termed as spondylolysis. The second component is the slip of the affected vertebra over the lower vertebra with the entire vertebral column above. Both these put together,

Financial or Other, Competing Interest: None.
Submission 22-07-2017, Peer Review 31-07-2017,
Acceptance 10-08-2017, Published 15-08-2017.
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DOI: 10.18410/jebmh/2017/787

the condition is termed as spondylolisthesis. Usually, females predominate over males. Progression of some of the spondylolisthesis results in static low back pain because of the stretch of the surrounding ligaments and secondary spasm of the back muscles. When the nerve roots are affected by pressure, either by the fibrocartilaginous mass, root canal stenosis, herniation of the disk or by osteophyte formation over the margins of the stable lower vertebral body, sciatica results. Although, the initial treatment is conservative (e.g., patient education, exercise, bracing, physical therapy, NSAIDS and steroid injections), surgery is the last resort for symptomatic instability. Spinal fusion procedures are indicated with severe disabling symptoms and radiographic evidence of increased segmental motion that fails to respond to adequate conservative trial. Segmental fusion provides solid fixation, restores the spinal stability and maintains load-bearing capacity of spine. Considering all these advantages, Posterior Lumbar Interbody Fusion (PLIF) has long been the "gold standard" surgical technique for spondylolisthesis. Posterior Lumbar Interbody Fusion (PLIF) has the advantages of spinal canal decompression, anterior column reconstruction, decompression of foraminal stenosis and reduction of the sagittal slips from a single posterior approach.

Aim and Objectives

1. To assess the results of PLIF with autogenous lamina and spinous process as bone graft and stabilisation with pedicle screws.
2. To evaluate the functional status after surgery.
3. To assess the incorporation of graft into the disk space and further consolidation.

MATERIALS AND METHODS

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CRITERIA FOR GRADING RESULTS

Excellent- Able to carry out all activities, no back pain or sciatica.

Good- Able to carry out all activities, but mild occasional pain radiating to leg.

Fair- Back pain improved over preoperative status, ability to perform activities of daily living without pain. But, pain reappearing on source exertion.

Pain was analysed by Visual Analogue Scoring (VAS).

Anaesthesia- All the patients were operated under general anaesthesia. Antibiotics were given to all patients commencing on the day of surgery to third postoperative day (Inj. Ceftriaxone 1 g b.i.d plus Inj. Amikacin 500 mg b.i.d). Bladder was catheterised in all after administration of anaesthesia.

Position of the Patient- Positioned prone on operating table on two bolsters, allowing the abdomen to free for adequate relief of intra-abdominal pressure reduces epidural venous pressure and decrease intraoperative bleeding. Preparation of operating area was done with povidone-iodine scrub and solution and sterile draping was done.

Surgical Approach and Technique- Surgical approach was through posterior midline approach. Skin incision about 10 to 12 cm long centering L5 vertebra was given. Deep fascia incised in the line of skin incision. The spinous process and laminae were exposed subperiosteally, paraspinal muscles retracted on both sides up to the tips of transverse processes. Haemostasis was secured with bipolar diathermy. The freely moving spinous process and lamina of L5 vertebra in cases of L5-S1 spondylolisthesis, L4 lamina and spinous process in cases of L4-L5 spondylolisthesis was removed en bloc and fashioned for grafting. Other loose fibrocartilaginous materials, thickened ligamentum flavum incised and removed, thus spinal canal decompression done. Spinal root canal decompression was also performed. Spinal nerve root was gently retracted towards cord and L5-S1 disk space (in cases of L4-L5, the L4-L5 disk space) was approached with sharp knife annular ligament incised and disk material was extracted using disk punch. Vertebral end plates were freshened. Already excised and prepared laminae were placed along with spinous process bony chips into prepared disk space as graft. Under C-arm control through the pedicles on either side of L5 vertebra, pedicle screws were placed into vertebral body. Same procedure was done for S1 vertebra. In L4-L5 listhesis, CD screws placed through L4 and L5 vertebral pedicles. Screws on either side were connected with connecting rods and nuts. Surgical wound was closed in layers after haemostasis and sterile occlusive dressing was applied. All patients except one who developed superficial surgical site infection were discharged on tenth postoperative day. All the patients were followed up at regular four monthly intervals up to 2 years period. In this follow up period, postoperative complications were documented and necessary treatment was given.

Inclusion Criteria

1. Patients with grade 1 and 2 spondylolisthesis.
2. Who had severe low backache, severe symptoms of root compression restricted, straight leg raising test.

3. Who did not have alleviation of the symptom with conservative methods for 6 weeks were subjected to surgery.
4. Patient who have given consent for the study.

Exclusion Criteria

1. Spondylolisthesis with severe comorbidities.
2. High grade 3 and 4 spondylolisthesis.
3. Patients with listhesis, but no clinical symptoms.
4. Who are not willing to participate in the study.

RESULTS

In this present study, average age range was 21-60 years. Among 30 cases, 6 (20%) cases were in 21-30 years age group, 14 (46.66%) cases were in 31-40 years age group, 4 (13.34%) cases were in 41-50 years age group and 6 (20%) cases were in 51-60 years age group. Mean age group was 40.03 years. Median age group was 38 years. Most common affected age group was 31-40 years (Table 1). Most of the recorded cases were in the 3rd and 4th decades and males accounting for 26.66% of cases (8 nos.), females accounting for 73.34% of cases (22 nos.). A female predominance with male-to-female ratio of 1:2.75 was noted (Table 2). In the present study, level of lesion was L5 over S1 seen in 70% cases (21 nos.). At this level, first-degree listhesis was seen in 66.66% (14 nos.) and second-degree listhesis was seen in 33.34% (7 nos.) of cases. Listhesis of L4 over L5 was seen in 30% (9 nos.) of cases. At this level, first-degree listhesis was seen in 55.56% (5 nos.) and second-degree listhesis was seen in 44.44% (4 nos.) of cases (Table 3). In total, first-degree spondylolisthesis was seen in 19 (63.34%) of cases and second-degree spondylolisthesis was seen in 11 (36.66%) of cases. All the cases presented with pain in the low back 100% (n=30). 20% of cases with radiation of pain to both lower limbs (6 nos.). One case (3.33%) presented with numbness in the S1 root area. On examination, EHL weakness found in 13.33% of cases (4 nos.). Duration of the symptoms varied from 6 months to 4 years. 6 patients had radiating pain and the rest had static pain (lumbago). Four of the patients in our study had claudication type of pain. SLR test was positive in six cases on the right side and the remaining had normal SLR test. One case had diminished sensation over S1 dermatome and 4 cases presented with extensor hallucis longus weakness. Only six cases had associated prolapsed intervertebral disk with compression of right root as revealed by MRI scan. In all the patients subjected to surgery, L5 laminae were loose in 21 cases and rocking was demonstrable on the operating table. 9 cases had defect at L4 laminae, which were loose and the rocking was also present. The defect in the pars interarticularis was occupied by fibrocartilaginous mass. There was associated prolapsed disk in 6 cases. Ligamentum flavum thickening was found in all cases. We report no mortality or morbidity. All the patients were made ambulant at fourth postoperative day. All the patients were relieved of the symptoms on the third postoperative day except one patient who had postoperative skin wound infection and took 20 more days for wound healing. Clinically, this study has shown 12 patients (40%) had excellent results, 15 patients (50%) had good and 3 patients (10%) had fair results (Table 4). At the end of the follow up period, one case showed nonunion at listhesis site and one case presented with implant failure (Table 5).

Age in Years	Number of Cases/Percentage
1 to 10 years	-
11 to 20	-
21 to 30	6 (20%)
31 to 40	14 (46.66%)
41 to 50	4 (13.34%)
51 to 60	6 (20%)

Table 1. Age Distribution

Number of Cases	Males	Females
30	8 (26.66%)	22 (73.34%)

Table 2. Gender Distribution

Level	1st Degree	2nd Degree	
L5 over S1	14 (66.66%)	7 (33.34%)	21 (70%)
L4 over L5	5 (55.56%)	4 (44.44%)	9 (30%)
Total	**19**	**11**	**30**

Table 3. The Level Verses Degree of Spondylolisthesis

Results	Total
Excellent	12 (40%)
Good	15 (50%)
Fair	3 (10%)

Table 4. Clinical Results

Age Group	Level of Listhesis		Degree of Listhesis		Sound Union	Nonunion	Implant Failure
	L4-L5	L5-S1	1st	2nd			
21-30	-	6	4	2	6	-	-
31-40	6	8	12	2	12	1	1
41-50	3	1	1	3	4	-	-
51-60	-	6	2	4	6	-	-

Table 5. Follow Up Results

DISCUSSION

The concept of using cages for interbody fusion evolved with the aim of restoring disk height in situations of collapsed degenerated disks and spondylolisthesis and to afford immediate anterior load-sharing construct without the morbidity of iliac crest site bone grafts. However, cages have many intrinsic disadvantages, the addition of a non-biological "bulk" to the fusion area reduces the contact area available for bony fusion. Studies prove that the surface area of the endplate in contact with the local bone should be more than 30% of local bone.[1] In the presence of interbody cage, visualisation and assessment of spinal fusion status become

difficult.[2] The cage being a foreign body, thus makes their use controversial in patients with active infections and even in healed spondylodiscitis due to fear of reinfection.[3] The differing modulus of elasticity of cages and the local bone it holds creates an unfavourable situation making way for possible conflict with the adjacent weightbearing endplates and cage.[4] Tricortical iliac crest graft has the comparative quality of a cage in terms of restoring disk height and affording instant anterior column support. The fusion rates achieved with iliac crest bone is as high as 90-100%.[5] In the present study, average age range was 21-60 years. Mean age was 40.03 years. Median age group was 38 years. Most common affected age group was 31-40 years. The age incidence as noted by Amuso et al was maximum during 3rd decade. In the present study, however, the maximum incidence was in fourth decade and the age incidence varied from 21-60 years.[6] Dantas FL et al in their study of two groups reported a mean age of 52.4 years in group 1 and in group 2, it was 47.6 years.[7] Ahmed I Abdelsalam et al showed in their study a mean age of 49.5 years in both groups. Group 1 with cage (mean 48.5 ± 9 years) and group 2 with bone graft (mean 50.5 ± 9.3 years).[8] In Chin-Hsienwu et al study, the median age was 69 (65-79) years.[9] Patil et al in their study reported a mean age of 41.44 years. Age range was 21-62 year[10] (Table 6).

Name of the Study	Age Distribution	Mean Age (Years)
Present study	21-60	40.03
Rolemberg Dantas et al Group 1 Group 2	30-65	 52.4 47.6y
Ahmed I Abdelsalam et al Group 1 Group 2	20-65	 48.5 ± 9 50.5 ± 9
Patil et al	21-62	41.44

Table 6. Age Distribution in Various Studies

In the present study, female predominance was noted with female-to-male ratio of 2.75:1. Amuso et al (1970) studied 49 patients of spondylolisthesis of which 31 were males and 18 females.[6] Out of 37 patients, 16 males and 21 females were evaluated in the study of Hiroyuki Hayashi et al,[11] Henry W. Meyerding et al reported a male preponderance in their study. Among 143 patients of their study, 112 (78.3%) of the patients were males, while 31 (21.7%) were females.[12] In Patil et al study, there were 24 males and 11 females.[10] Chaitanya et al in their study of 86 patients showed a female predominance similar to our study. There were 58 females and 28 males in their study.[13] In the present study, among 30 cases, 21 (70%) cases had spondylolisthesis of L5 over S1 and 9 (30%) cases had spondylolisthesis at the level of L4 over L5. In this study, among 30 cases, first degree of spondylolisthesis were seen in 19 (63.34%) cases, second degree of spondylolisthesis were seen in 11 (36.66%) cases. In Chaitanya et al study, out of total 86 patients, 55 patients had instability at the level of L4-L5 and 31 had L5-S1 instability. Of total 86 patients, 44 patients had grade 1 slip, 34 patients had grade 2 slip and the rest 8 had grade 3 slip.[13] In a study done by Ahmed I Abdelsalam et al, out of 60 patients, 48 (80%) underwent single-level fusion, L4-5 (36 patients), L3-4 (9 patients) and L5-S1 (3 patients). Eleven (18.4%) patients underwent a two level fusion, L3-L5 (6 cases) and L4-S1 (5 cases). One patient underwent a three-level fusion from L3-S1.[8] Amuso et al in their series of 49 patients noticed spondylosis at L4 and accompanying listhesis of L4 over L5 in one case. The degree of spondylolisthesis was first degree in all cases and 2 cases had second-degree spondylolisthes.[6] In Dantas FL et al study, out of 60 patients, 27 patients had spondylolisthesis at L4-5 level and another 27 at L5-S1 level. It affected the L4-L5-S1 levels in 5 cases and the L3-4 level was abnormal in one case[7] (Table 7).

Study	L3-L4	L4-L5	L5-S1	L4-L5-S1
Present study		9 (30%)	21 (70%)	
Ahmed I Abdelsalam et al single level fusion	9 (18.75%)	36 (75%)	3 (6.25%)	
Rolemberg Dantas et al	1 (1.66%)	27 (45%)	27 (45%)	5 (8.33%)

Table 7. Level of Lesion in Various Studies

In the present study, pars defect present in all the cases and pseudomass was present at the defects in all cases and sciatica was present in 6 cases. Gill and Manning et al (1955) consistently observed in their series of 50 patients, bilateral laminar defects at pars interarticularis with fibrocartilaginous mass at the site of defect particularly in the lumbar vertebra.[14] But, the existence of the masses at the side of defect was not recognised by all workers. In this present study, only 6 cases had prolapsed intervertebral disk at listhesis site. In the rest of 24 patients, excision of the laminae did not reveal any type of disk prolapse. Laurent et al (1958) observed prolapse of the intervertebral disk in 2 out of 45 patients.[15] However, Henderson et al (1966) on reviewing 216 patients subjected to laminectomy noted prolapsed intervertebral disk in 46 patients.[16] Patients were followed at regular intervals up to 2 years period. In this follow up period, postoperative complications were documented and necessary treatment was given. We report no mortality or morbidity. All the patients were made ambulant at fourth postoperative day. All the patients were relieved of the symptoms on the third postoperative day except one patient who had postoperative skin wound infection and took 20 more days for wound healing. During the follow up period, one case showed nonunion at listhesis site and one case presented with implant failure. Except these three cases, all other cases showed excellent to good results. Rolemberg Dantas et al studied early and late surgical complications. Early complications consisted of nerve root compression caused by the hardware in 4 cases (2 in each group; surgical repositioning of the construct resolved back pain in all patients); superficial wound infection in 3 cases of group II with 1 patient requiring surgical debridement (case 8); CSF leak in one patient in group I treated conservatively with bed rest. Late

complications consisted of 2 patients in Group I (cases 16 and 30 submitted to a 2 level-6 screw fixation procedure) presented screw fractures with complaints of low back pain, but not requiring reoperation; loosening of the metal construct with slippage of the rods in two cases (cases 8 and 19, group I) that complained of severe back pain and required reoperation and partial displacement in one case (case 22, group II) that was only followed radiologically; patients 27 of group I presented with lumbar stenosis one level below fusion (performed at the L4-5 level) and was submitted to decompression and fusion at L5-S1 3 years after surgery. From the biomechanical standpoint, group I patients presented a higher complication rate with 2 screw fractures, 3 loosening of the construct and 1 spinal stenosis below the fixated segment. No such complications occurred in group II patients. This difference was statistically significant. The overall reoperation rate was 13.6% (8 cases), 6.6% in group I (2 cases) and 20% in group II (6 cases).[7] Yuan et al conducted a multicentric study with 2684 patients lumbar spondylolisthesis compared 2177 patients submitted to fusion with pedicle screws with 507 patients submitted to decompression without pedicle screws. The complications of both procedures were analysed. They noted 1% screw fracture. Peroperative dural tears were present in 7.3% of patients in the pedicle screws group and in 5.7% in the decompression without fusion group. CSF fistula was found in 0.5% in the fusion group and in 0.7% in the decompression group. Reoperation rate was 17.6% and 15%, respectively for the fusion with pedicle screw group and decompression alone group. They conclude the benefits of pedicle screws over its risks.[17] Madan et al compared 23 patients with lumbar spondylolisthesis submitted to a posterior fusion procedure with 21 patients submitted to a posterior fusion procedure and interbody fixation. Three patients in the first group lost surgical correction of the spondylolisthesis, while no patient in the second group presented such complication. However, the overall complication rate was not statistically significant between the two groups.[18] Some authors consider the PLIF procedure difficult due to the increased bleeding, prolonged operation time and more extensive dissection. The reported complications associated with the PLIF procedure include- permanent neurological deficit in 0.4 to 1.7%; CSF leak in 0.4 to 0.5%; radicular pain in 1.1 to 2,5%; posterior displacement of the cage in 0.8 to 0.9%; deep wound infection in 0.6 to 5.0% 27-29.

Limitations of Our Study- All grades of spondylolisthesis were not included in the study. A small sample size with shorter duration of follow up makes the study amenable for a limited conclusion.

CONCLUSION

In this study, the spinal cord decompression, nerve root decompression, spinal fusion and spinal stabilisation all are done under same single incision and more importantly by using the same excised lamina and spinous process as bone graft. "No added morbidity of bone graft harvesting site" is the advantage of our procedure. No additional blood transfusion was required. We concluded that our procedure has fared equally effective when compared with short-term results of cage with PLIF and iliac crest bone grafting technique with respect to achievement of fusion at the intended intervertebral space. This procedure eliminates the cost of cage and substantially reduces the financial burden on the patient, which makes the procedure amicable in rural areas.

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