Correlation between postoperative increment in disc height and improvement in vas score in PLIF operated cases of grade I and II degenerative and isthmic spondylolisthesis: A non –randomised prospective clinical trial

A Qayum, V Saradhi, M Panigrahi

Citation

Abstract

Study design
A prospective clinical trial of PLIF in grade I and II degenerative and isthmic spondylolisthesis was conducted in Mar2007-Aug2008

Objective
To assess the effect of PLIF for Restoration and maintenance of intervertebral disc height for indirect neural foraminal decompression and its consequences on the VAS score

Summary of Background data
Earlier Literature is showing the safety and reliability of PLIF procedure in reducing the pain and claudication symptoms of degenerative spondylolisthesis by achieving reduction, and reducing the segmental instability by fusion. We studied the relationship of change in postoperative disc height to reduction in pain.

Methods
This study involved (n=14) patients. Inclusion criteria required the following: age of 30-70 years, symptomatic patient with disturbed ADL, single level L4/L5 or L5/S1 Grade I or grade II degenerative spondylolisthesis. Patients with osteoporosis, recent spondylodiscitis, subchondral sclerosis, visual and cognitive impairment, and all other types of spondylolisthesis were excluded. All the patients underwent short segment posterior fixation using CD2 or M8 instrumentation, laminectomy discectomy, reduction and distraction of the involved vertebral space. In 57.1% (n=8) patients snugly fitted local bone chips were used while in 42.9% (n=6) patients Cage was used. Among Cage group, titanium cage was used in 4 (28.5%) and PEEK cages in 2 (14.2%) patient. In one patient unilateral PEEK cage was used. The mean follow-up period was 18 months.

Results
Among (n=14) patients, 71.5% (n=10) were females and 28.5% (n=4) were males. 71.5% (n=10) were having L4/L5 and 28.5% (n=4) L5/S1 spondylolisthesis. 42.9% (n=6) were of grade I and 57.1% (n=8) were of grade II spondylolisthesis. There was a statistically significant correlation (p<.012 and p<.027) between the increment in disc height we achieved and the improvement in VAS score in both graft group and cage group. The increment in disc height and VAS score were significantly better in Cage group (2mm +/- S.D visa-viz 7.2(88%)) than the graft group (1.2mm +/- S.D visa-viz 5(62%) ). There was one
Correlation between postoperative increment in disc height and improvement in vas score in PLIF operated cases of grade I and II degenerative and isthmic spondylolisthesis: A non–randomised prospective clinical trial

Case(7.1%) of superficial MRSA infection, one case(7.1%) of pedicle wall breakage (technical error) and two cases(14.2%) of loose rods. One patient with loose rod was reoperated while other is waiting for hardware removal.

Conclusion

Maintenance of disc height by structural graft is preferred over the non-structural graft. Using snugly fitted local bone chips avoids donor site morbidity besides yielding good fusion rates.

Abbreviations used: VAS–visual analogue score. PLIF–posterior lumbar interbody fusion

Permission was taken from institutional ethics committee

No financial benefits were involved

INTRODUCTION

Spondylolisthesis is a disease of mankind not known in quadrupeds. It is a penalty for erect posture. Incidence is “zero” in newborn. Original description was of lytic listhesis, later degenerative was described. It causes various degrees of morbidity. It is classified based on etiology into 5 types: congenital or dysplastic, isthmic, degenerative, traumatic, and pathologic (Wiltse, 1976). Many cases can be managed conservatively. However, in persons with incapacitating symptoms, radiculopathy, neurogenic claudication, postural or gait abnormality resistant to nonoperative measures, and significant slip progression, surgery is indicated. The goal of surgery is to stabilize the spinal segment and decompress the neural elements if needed. In 1854, Killian coined the term spondylolisthesis to describe the gradual slippage of the L5 vertebra due to gravity and posture. In 1858, Lambi demonstrated the neural arch defect (absence or elongation of pars interarticularis) in isthmic spondylolisthesis. Albee and Hibbs separately published their initial work on spinal fusion. Their methods were applied quickly to cases involving trauma, tumors, and, later, scoliosis. In the latter half of the 20th century, spinal fusion was used increasingly to treat degenerative disorders of the spine, including degenerative spondylolisthesis and degenerative scoliosis. The incidence of isthmic type of spondylolisthesis is believed to be approximately 5% based on autopsy studies. Degenerative spondylolisthesis is observed more frequently as the population ages and occurs most frequently at the L4-L5 level. Up to 5.8% of men and 9.1% of women are believed to have this type of listhesis. The etiology of spondylolisthesis is multifactorial. A congenital predisposition, posture, gravity, rotational forces, and high concentration of stress loading all play parts in the development of the slip. Spondylolisthesis can be graded based on the amount of vertebral subluxation in the sagittal plane, as adapted from Meyerding (1932): Grade 1 - Less than 25% of vertebral diameter Grade 2 - 25-50% Grade 3 - 50-75% Grade 4 - 75-100% Spondyloptosis - Greater than 100%. Medical therapy: Conservative measures are aimed at symptomatic relief. Surgical therapy The goal of surgery is to decompress the neural elements and immobilize the unstable segment or segments of the spinal column. Fusion: Multiple methods exist to achieve intersegmental fusion in the lumbosacral spine. Following are most widely used methods: Posterolateral (intertransverses): This may be performed over one or multiple levels with high success rates (up to 90%) of fusion. Segmental spinal instrumentation allows rigid fixation of the fused segments and the possibility of performing reduction of the segment with listhesis. Lumbar interbody fusion: Biomechanically interbody fusion increases the stability of the spinal segment by placing structural bone graft in compression in the anterior and middle columns and increases the overall surface area of the bony fusion. It can be done with posterior (ie, posterior lumbar interbody fusion [PLIF]) or anterior (ie, anterior lumbar interbody fusion [ALIF]) approaches. A growing number of surgeons use interbody grafts to augment their posterolateral fusion techniques to achieve higher rates (>95%) of arthrodesis. Cages have far more better results in terms of disc height maintenance and indirect neural decompression than bone grafts alone. It should be noted that grade 2 or higher slips are predisposed to higher rates of graft complications. Pars repair: In low-grade lytic slips the pars can be directly repaired with a Scott wiring technique or the Van Dam modification. This preserves segmental motion and has successfully been used to fuse the pseudarthrosis at the pars in selected patients. Fixation: Although the use of spinal instrumentation in skeletally immature patients is considered optional by some surgeons for some patients with isthmic-type spondylolisthesis, most spinal surgeons believe that rigid fixation is needed to achieve a solid fusion.
Correlation between postoperative increment in disc height and improvement in vas score in PLIF operated cases of grade I and II degenerative and isthmic spondylolisthesis: A non-randomised prospective clinical trial

reliably.

Posterior Lumbar interbody fusion[PLIF]: PLIF is a procedure that has enjoyed popularity over past 50 years. Ralph Cloward who pioneered and popularized the procedure first performed this operation in 1940, saying that ideal fusion procedure would be an interbody fusion.[3.4.]procedure has always been technically demanding. Recent advances in spinal instrumentation and minimal access techniques have revitalized interest in PLIF. His first patient was a school teacher and in whom he noticed that a hole was created that could be filled to restore the normal mechanics of stability. Cloward was the only neurosurgeon available for duty in the Pacific theatre during the early phases of world war II. The physical effort needed to build defense structures resulted in many lowback injuries1. By October 1947 Cloward had treated 100 patients and had presented his results to the Harvey Cushing Society...Since then PLIF has become more widely accepted and numerous variations of the procedure have been developed. The indications of PLIF and variants of it as TLIF have expanded and include numerous pathologic. A surgical technique of PLIF with the use of autogenously posterior elements cut into 2-4 mm as graft material has distinct advantages.8 James Walter, Simmons et al studied about 113 patients treated between 1974-1980 and noted good objective results as high as 79%. Chip PLIF appears to decrease the morbidity associated with taking autogenously bone from the other sites. The posterior elements have been carefully removed, cut into corticocancellous pieces and ensure that each chip has a cancellous side8. They preffered to use corticocancellous chips which would allow far more bone to be put into the intervertebral disc space and provide less dead space for the fibrous tissue. The corticocancellous chips would also be packed more firmly and provide for a more uniform load distribution. Anie F., Mannion MD et al studied the importance of neurogenic claudication in the diagnosis of spondylolisthesis and as such assessed the pain in these patients. Pain is a major cause of morbidity, with the lowback ache being one of the most common symptoms. LBP, pain has been described as one of the cardinal domains to be assessed along with back-specific function, generic health status, work disability, and patient satisfaction. Pain is one of the best determinants of disability due to LBP and is predictive of work resumption within the year following related short term absence. Pain being an important presentation and one of the best determinant of disability due to LBP needed to be weighed in terms of patients satisfaction pre and postop. As a result VAS scoring pre and post surgery is a good indicator of subjective as well as objective assessment 1 Cloward et al studied the various merits and advantages of interbody fusion technique over the previous conventional posterior and posterolateral fusion techniques. Interbody fusion being near the centre of axis of rotation close to the weight bearing column, they noted fusion rates of 97% in their series of about 167 patients with clinical outcome of about 87% satisfaction and considered it as a superior technique for fusion in comparison to previous conventional methods3,4

MATERIAL AND METHODS

In the present study all patients were asked history and subjected to thorough clinical examination. The preoperative VAS scores were noted down. The preoperative dynamic x-rays were taken[fig 3 and Fig 4] and the Disc Heights[fig 2, Fig 2a], Meyerding grade[fig 1] and the slip angles were measured.

Figure 1

Patients written and informed consent was taken. All the investigations relevant from the point of view of anaesthesia
Correlation between postoperative increment in disc height and improvement in vas score in PLIF operated cases of grade I and II degenerative and isthmic spondylolisthesis: A non-randomised prospective clinical trial

were done and the Pre-Anaesthetic clearance was taken. Patients were taken then for the said surgical procedure. Operative technique: After satisfactory induction of anaesthesia, the patient was positioned prone on a four-poster frame and all pressure points were well padded. A standard midline posterior approach was used to expose the spine as per the level of involvement. Laminectomy and decompression was done [Fig 5] to [Fig 7].

**Figure 2**

The spinous processes and the laminae were made into chip grafts. Total discectomy was performed at the degenerated level.

The level involved was fixed using transpedicular monoaxial/polyaxial screws with reduction screws put into the listhessed vertebra.

**Figure 3**

The interbody spacer was placed [Fig 15] and the reduction maneuver performed [Fig 13] by lifting the upper body in a cranial and posterior direction.

**Figure 4**

The screws were connected with rods and disc space gradually distracted to achieve lordosis along with the good reduction. The final construct was tightened in compression. After completion of the discectomy and the transfixation, cancellous bone chip grafts were used as interbody graft and well packed snugly into the level for an interbody fusion. We did not perform any SSEP during the procedure. Haemostasis was achieved and wound was closed in layers over a suction drain. Patient was subjected to X-ray L/S spine AP & Lateral views on first postoperative day [Fig 14 and Fig 15] and the various measurements were again taken for comparison.

After surgery patients were braced in LSO for a period of 3 months for comfort, patient was discharged on third postoperative day and advised to follow the OPD on tenth day for removal of stitches and subsequently to every month for about 18 months. Fusion was assessed by Digital Lumbosacral X-rays.

The total operative time averaged 3.2 hours (Range 2-5hrs). The estimated blood loss was 200ml (Range 100-350 ml).

**RESULTS**

Among (n=14) patients, 71.5% (n=10) were females and 28.5% (n=4) were males. 71.5% (n=10) were having L4/L5 and 28.5% (n=4) L5/S1 spondylolisthesis. 42.9% (n=6) were of grade I and 57.1% (n=8) were of grade II spondylolisthesis.
Correlation between postoperative increment in disc height and improvement in vas score in PLIF operated cases of grade I and II degenerative and isthmic spondylolisthesis: A non-randomised prospective clinical trial

Following were our observations.

Age group 30-70 yrs

Figure 5
Table-1 age group

<table>
<thead>
<tr>
<th>S no</th>
<th>Age in yrs</th>
<th>No of patients</th>
<th>%age</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30-40</td>
<td>2</td>
<td>14.3</td>
</tr>
<tr>
<td>2</td>
<td>40-50</td>
<td>6</td>
<td>43</td>
</tr>
<tr>
<td>3</td>
<td>50-60</td>
<td>5</td>
<td>36</td>
</tr>
<tr>
<td>4</td>
<td>60-70</td>
<td>1</td>
<td>7.1</td>
</tr>
</tbody>
</table>

30-40 yrs (2) 14.3%
40-50 yrs (6) 43%
50-60 yrs (2) 36%
60-70 yrs (1) 7.1%

Gender out of total 14 cases 10 were females while 4 were males with a male female ratio of 2:1

Figure 6
Table 2-Gender

<table>
<thead>
<tr>
<th>S no</th>
<th>male</th>
<th>female</th>
<th>Grand total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>4</td>
<td>14</td>
</tr>
</tbody>
</table>

No of patients as per level involvement:
L4-L5 10
L5-S1 4

Figure 7
Table-3 level wise

<table>
<thead>
<tr>
<th>S no</th>
<th>L4-L5 level</th>
<th>L5-S1 level</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>G.total</td>
<td>10</td>
<td>14</td>
<td></td>
</tr>
</tbody>
</table>

Figure 8
Table-4 Pre,potsop and change in disc heights in GRAFT GROUP

<table>
<thead>
<tr>
<th>S no</th>
<th>Preop DH</th>
<th>Postop DH</th>
<th>change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>84</td>
<td>94</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>93</td>
<td>109</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>91</td>
<td>109</td>
<td>18</td>
</tr>
<tr>
<td>4</td>
<td>95</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>5</td>
<td>94</td>
<td>109</td>
<td>15</td>
</tr>
<tr>
<td>6</td>
<td>89</td>
<td>11</td>
<td>21</td>
</tr>
<tr>
<td>7</td>
<td>93</td>
<td>108</td>
<td>15</td>
</tr>
<tr>
<td>8</td>
<td>95</td>
<td>108</td>
<td>13</td>
</tr>
</tbody>
</table>

In our study we excluded the patients with recent discitis, severe subchondral sclerosis, severe osteoporosis, severe cognitive and visual disabilities and all other types of spondylolisthesis. All the patients were subjected to decompression, instrumentation and fusion by a single surgeon. We used spinous process chip grafts in 8 (57.1%) patients and cage in 6 (42.9%) patients. This is comparable with 8 in which though the number of patients was more, also the spinous processes were used as chip grafts and fusion was assessed. We observed a mean change in disc height of 1.2mm ± S.D in the graft group and 2mm ± S.D in the cage group of patients. This is comparable with the research project of P.gopinathan et al11 in which the mean change in disc height was 4mm. The mean change in VAS score in graft group was 5 (62%) in graft group and that in the cage group was 7.2 (88%). This is comparable with the
Correlation between postoperative increment in disc height and improvement in VAS score in PLIF operated cases of grade I and II degenerative and isthmic spondylolisthesis: A non-randomised prospective clinical trial

research work of P. Gopinathan et al 11 in which 2 points better VAS score improvement than ours was seen. In both the two groups the mean improvement in slip angles was about 3.2 deg+_ S.D. In this series we noted complications in about 4 patients with implant loosening in 2(14.2%) of patients[Fig 17], pedicle wall breakage in 1(7.1%) and wound infection (MRSA) in 1(7.1%) patient[Fig 18]. One patient with implant loosening and another with pedicle wall breakage was reoperated. One patient with implant loosening is having mild backache on movement with improvement in VAS from 9 to 4. She is waiting for the implant removal. One patient with wound infection was managed with superficial wound debridement and her cultures showed MRSA positivity for which she was treated.

Figure 12

There was a statistically significant correlation (p<0.012 and p<0.027) between the increment in disc height we achieved and the improvement in VAS score in both graft group and cage group. The increment in disc height and VAS score were significantly better in Cage group(2mm+_ S.D visa-viz 7.2(88%)) than the graft group(1.2mm+_ S.D visa-viz 5(62%)). There was one case(7.1%) of superficial MRSA infection, one case(7.1%) of pedicle wall breakage (technical error) and two cases(14.2%) of loose rods. One patient with loose rod was reoperated while other is waiting for hardware removal.

DISCUSSION

PLIF has become a standard treatment modality for the symptomatic and severe grades of spondylolisthesis resulting in both clinical and radiological improvement with high amount of patient satisfaction. As the working area here, in PLIF is the disc space which is the site of FSU bearing the stress of weight transmission, as it is well known fact that weight transmission is the sole culprit for the progression of listhesis, so this entity is not seen in quadrupeds. Disc space height maintainance or increment Indicates total discectomy, as good distraction is possible

only after total discectomy. As a result it, increases neural foraminal height, thus larger the height, stronger graft (volume) can be inserted increasing the strength of construct, larger the disc height better will be the chance of reduction. Larger post op disc space has better chances of correcting kyphotic deformity of FSU. Advantages of the PLIF over posterior or Posterolateral fusion(PLF) 24 1 Fusion occurs at the centre of axis of rotation 2 Graft is under the compressive, not the tensile forces 3 wide surface area of bone is available for fusion. 4 Blood supply is via cancellous vertebral bodies. 5 Vertebral disc height is maintained. 6 Lateral spinal canal patency is maintained. 7 Intervertebral anatomical relationship is improved. 8 Mechanical nerve traction is relieved after fusion 9 Arrests microinstability and hypertrophic degenerative changes In our study we operated fourteen patients in the age group of 30-70 years out of which 2 patients(14.3%) were in the age group of 30-40 yrs, 6(43%) of 40-50 yrs, 5(36%) of 50-60 yrs and 1(7.1%) was in the age group of 60-70 yrs. Among 14 cases 10(71.5%) were females and 4(28.5%) were males. In this series 10(71.1%) were having involvement of L4L5 level while 4(28.5%) had involvement of L5S1 level. About 6(42.9%) were having grade I while 8 patients(57.1%) had grade II spondylolisthesis. Out of The total 14 patients included in this study, all of them presented with LBA while 8(57.1%) had neurogenic claudication as the presenting symptom and 6(42.9%) patients had additional radiculopathy. Associated symptoms appeared at approx. 1 km distance in 3(21.4%), 2 km distance in 2(14.3%) and 3 km distance in 3(21.4%) patients. Disc height restoration: Some advocate radical excision of the intervertebral disc to help with the reduction as well as placement of an interbody graft. The risk of transient nerve root injury is slightly higher with this approach; however, the immediate support afforded by the anterior column support increases the rate of fusion, helps with distraction and reduction, and relieves the acute course of the exiting root 11. Reduced Disc height is a vital parameter in the pathogenesis of the disease process of degenerative spondylolisthesis. As a result its restoration is of paramount importance. Various methods used in the literature for this purpose include bone dowels, rectangular or threaded bone plugs, local bone chips or bone or metallic cages. In our series we used snugly packed local bone chips obtained from the spinous processes and the laminae in 8 patients, Cages in 6 patients. We noted mean increment in disc height of about 1.2 mm in eight patients within graft group while mean

6 of 9
increment of 2mm was seen in six patients of cage group. In our series a mean increase in VAS score of 5+ SD was observed in graft group while a mean increase of 7.2+ SD in VAS score was observed in Cage group of patients. This shows that more near the disc height is restored to normal during surgery and maintained well in post op period had better improvement in VAS scores. In both groups a 100% reduction, 3.2% decrease in slip angle and 100% fusion was achieved. It was observed in this series that the values remained higher in the cage group with about 2.2 points higher vas score, 0.8 mm higher increment in disc height. This is a statistically significant difference (p 0.012 and 0.217) between the two groups, obtained using SPSS (Wisconsin) software. The probable reason for better restoration of disc space height is cage group is obvious. The structured graft resists the final compression better than non-structured graft. Though we achieved good distraction before final compression in all patients the only graft group lose some height compared to cage group with the final maneuver. Decompression: We feel that the difference between the isthmic and degenerative does not confound as the causation of pain in both happens to be the disc pathology in both the groups. In degenerative listhesis additionally neurogenic claudication makes its presence due to canal stenosis. Of course this is not measured in VAS scores. Various incriminating factors in the causation of pain in degenerative spondylolisthesis apart from the disc changes are the impingement of already tense neural structures against the intact posterior arch of the above vertebra, traction on the neural structures, neural compression by the superior articular process of listhetic vertebra against posteroinferior border of above vertebra etc. As such the decompression of neural structures are vital. Restoration of disc height removes various incriminating factors, however the decompression by laminectomy helps to relieve impingement against the intact neural arch. In our series we did decompression in all the patients in both the cage and the graft group. In 1942-50 Ralph Cloward [3, 4] his series of 165 patients operated by this technique has in shown fusion rates of 93% [Fig 19] and clinical results of satisfaction in 97%. This is comparable to our series in which fusion rates of 86% and satisfying clinical results in 87% of cases. Neil, Naohisa Miyakoshi et al [10] showed in his series, intervertebral disc as an important cause of spondylolisthesis which is also the case in our series of 14 patients. In these our patients as per Kirkklady Willis, the intervertebral discs were in various stages of dysfunction and instability. The surgical procedure in their series also involved decompression and discectomy to remove the incriminating factor followed by the fusion of the involved spacer. James Walter Simmons MD and Mureyi Y Imagama et al [8] noted the utility of local chip grafts in the fusion and noted a fusion rate of about 100%.

CONCLUSION

Pre-operative duration of the symptoms that the patient presented with do not have any bearing on the postoperative clinical outcome. In this our series of fourteen patients subjected to PLIF procedure it is concluded that maintenance of disc height with the help of structural graft is preferred over the non-structural graft. Using spinous processes not only avoids additional incision and graft site morbidity but also yields good fusion rates. Although a technically demanding procedure, PLIF procedure is a procedure of choice for the grade I, II and Grade III degenerative and isthmic spondylolisthesis.

References

1. Annie F, Mannion MD et al [1] has stressed the importance of pain in the assessment of spondylolisthesis patients. They have compared the pre and postop Vas scores in their patients with mean improvement of 5 + S.D points which is comparable to our series with improvement of 6.1 + S.D. For solid bone union, some investigators recommended PLF + PLIF.
Correlation between postoperative increment in disc height and improvement in vas score in PLIF operated cases of grade I and II degenerative and isthmic spondylolisthesis: A non-randomised prospective clinical trial

Lumbar Interbody Fusion: Techniques of Spine surgery, Benzell pp

11. P. Gopinathan, Anwar Hussain: Jacking of the spine, a better way of treating lumbar spine instability; J. Orthopedics 2005, 2(1) e3
12. Serema S. Hu Cliffore B: Spondylolisthesis and Spondylolysis; JBJS Am 2008, 90; 656-671
16. Suk- Hyung Kang, Young Baeg King: Differences in outcome among various fusion methods of lumbar spine; J of Korean Neurosurgical Society, vol 37, no 1(2005); 39-43
Correlation between postoperative increment in disc height and improvement in vas score in PLIF operated cases of grade I and II degenerative and isthmic spondylolisthesis: A non-randomised prospective clinical trial

Author Information

Abdul Qayum, M.S.
spine fellow, Department of Neurosurgery, Nizam’s Institute of Medical Sciences Punjagutta, Hyderabad

Vijaya Saradhi, MCh
associate professor, Department of Neurosurgery, Nizam’s Institute of Medical Sciences Punjagutta, Hyderabad

Manas Kumar Panigrahi, MCh
professor, Department of Neurosurgery, Nizam’s Institute of Medical Sciences Punjagutta, Hyderabad