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Functional evaluation of posterior lumbar interbody fusion using single oblique titanium cage and local morselized bone graft

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Introduction

Lumbar spine Interbody fusion is one of the most common surgeries performed in the spine for various indications like spondylolisthesis, spinal canal stenosis and recurrent disc prolapse with instability. There are different approaches to access and perform lumbar interbody fusion like anterior, posterior, lateral and oblique approaches each with its own advantages and disadvantages. Posterior approach is the oldest and still the commonest approach for performing lumbar interbody arthrodesis even today because of relatively easy surgery with a quick learning curve and no major important vital structures nearby and can access any lumbar spine. PLIF and TLIF are the two techniques used to perform lumbar interbody fusion via posterior approach. PLIF is posterior lumbar interbody fusion which is done by doing laminectomy and retracting neural structures. TLIF is transforaminal lumbar interbody fusion (introduced by harm in 1998), done by doing unilateral facetectomy and reaching the interbody level. First described by Dr. Ralph Cloward[1] in the 1940s, PLIF is one of the most popular surgeries though there are many proponents for TLIF which has been reported to have less neural complications. Interbody fusion was done by using tricortical iliac graft in initial days and then changed to double cages and recently to single banana cage filled with local bone graft. There are also different materials used to make cages like titanium, carbon and peek. The carbon and peek cages have the advantage of radiolucency so that interbody bone fusion can be visualized better but its cost is high and sometimes local tissue reaction can occur with peek cages.

With this background we conducted a retrospective observational study on PLIF surgery supplemented with pedicle screws using a single titanium banana cage with

local bone graft obtained from laminectomy to assess functional and radiological outcome of patients.

Materials and methods

This retrospective study was conducted in our hospital between 2016 to 2020.

Thirty patients presenting with low back ache and radiculopathy nonresponding to conservative treatment for at least 3 months were included in the study.

Inclusion criteria: Patients between 20 and 60 years of age with degenerative Spondylolisthesis, Spinal canal stenosis and recurrent Intervertebral disc herniation with instability

Exclusion criteria: Patients with uncontrolled diabetes or advanced medical illnesses, Female patients suspected of having osteoporosis (DEXA T score >3.5), Infection, Trauma, Anomalous neural anatomy (conjoined nerve root), Severe Fixed kyphosis, scoliosis or tumor.

Age of patients in the study ranges from 37 to 68 with mean age being 53. There were 14 male and 16 female patients in the study. All patients were evaluated clinically and radiologically with standing lumbosacral spine x-rays with flexion and extension views and MRI of the whole spine. Preoperative and postoperative VAS and ODI scores were assessed for all patients 6 weeks, 12 weeks, 6 months and 1 year.

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. Radiological fusion at lumbar interbody level was assessed using X rays and was quantified using Brantigan & Steffee criteria[2].

Surgical technique

General anesthesia was used in all cases. The patient was positioned prone on the operation table after induction of anesthesia over two transverse pillows. One below the chest and one at the level of the pelvis such that the abdomen was not compressed. One more pillow was kept below the legs such that the knees slightly flexed to minimize tension on the lumbar nerve roots. Eyes were protected with cotton pads and all bony prominence were adequately padded. Shoulders were placed on abduction over arm boards. Sequential compression devices were used for prevention of Deep venous thrombosis. Levels were identified by Image intensifier with radio opaque markers such as Spinal needle after positioning the patient. Infiltration was given with Adrenaline and Lignocaine solution down to the level of lamina to minimize bleeding. Posterior midline incision was made centered over the spinous process of the forwardly slipped vertebra extending one above and one below it. The Exposure was made using Sharp Cobbs up to the tips of transverse processes so that intertransverse fusion can be done. Exposure was made along a subperiosteal plane to minimize bleeding. Levels were confirmed again with Image intensifier. The starting point for pedicle screw entry was identified by the Intersection method. A Starting point probe was used to make the initial entry. Guide wire was inserted, and the entry point was checked with image intensifier in AP and lateral views. Once position was confirmed, the guide was removed, and the entry point was enlarged with a pedicle probe with care not to penetrate the pedicle walls. All the 4 walls of the pedicle screw path were then assessed with a ball tipped probe for its intactness. The hole was then tapped with Cancellous tap and Polyaxial Pedicle screws were placed as per length measured with guide wire assistance. The remaining three pedicle screws were inserted in the same manner. The position and length of the screws were confirmed with Image intensifier in AP and lateral views. Decompression of the spinal canal and nerve roots done

by laminectomy. Perineural adhesions if present were released. Ligamentum flavum incised. Medial facetectomy was done on symptomatic side. Mobility of nerve roots assessed under direct vision. The lamina, spinous processes which were removed during decompression were morselized with nibbler. Tissues attached to it were removed and graft taken for placement. Discectomy Nerve root retractors were used to protect and retract the dura and the traversing nerve root medially thereby exposing the disk. A bipolar cautery was used over the epidural venous plexus to provide good visualization and reduce blood loss. Using a 15- or 11-blade, the annulotomy was then performed over the disc. Disk fragments can then remove with a combination of disc space shavers and pituitary rongeurs. Connecting rod was fixed to the pedicle screws on the opposite side and temporary distraction applied. Vertebral end plates were curetted, and cartilage was removed. Care was taken to avoid violation of anterior ligaments during preparation of disc space. A trial cage was introduced to assess cage height. Before insertion of the cage, the local morselized bone graft was inserted into the disc space and impacted as much as possible. A titanium cage was filled with bone graft and inserted diagonally from the symptomatic side. Connecting rods were fixed and compression of the pedicle screws were done, which increases lumbar lordosis and enhances stability. The position of the cage was confirmed with Image intensifier with both AP and lateral views. Hemostasis was achieved. Wound was closed in layers with a negative suction drain and sterile dressing was applied.

statistical methods

All continuous variables will be represented by mean + or – SD. Categorical variables will be represented by percentage %. Comparison of pre and post continuous variables like oswestry index, VAS score will be done by paired t test, if they are normally distributed. Non normally distributed continuous variables (pre and post) will be done by WILCOXON signed rank test. Comparison of continuous variables between two groups will be done by independent sample t test. Data analysis was carried out by SPSS version 25.0. All p values < 0.05 were considered statistically significant.

Results

Our study had 30 patients of Lumbar disc disease who underwent PLIF supplemented with pedicle screws with unilateral cage and local morselized bone graft, operated by a single surgeon. • The average operating time was 105±11 min for skin-to-skin surgery. The average blood loss in post operative drain was around 129 ml, the average decrease in Hemoglobin was 1.11 +/- 0.60 g/dl. Two patients required blood transfusion post operatively. Interbody fusion in PLIF was done at L4-L5 level in 17 patients (56.67%) and at L5-S1 level in 13 patients (43.33%). In our study of 30 patients, 19 patients had Degenerative Spondylolisthesis (63.33%) and 11 patients had Recurrent disc herniations (36.67%). Majority of the patients had Degenerative spondylolisthesis.

In our study the mean VAS score decreased from 7.0 to 1.8 at 3 months post op. The Oswestry disability index also decreased from 66.9 preoperatively to 17.3 at 6 months follow up which was statistically significant(P=0.001). • In our study the mean preoperative disc height was 6.5±0.9mm and postoperatively there was significant increase in disc height with a mean of 9.3±0.9mm. The difference in disc height was found to be statistically significant(P=0.0001). The average decrease in Hemoglobin was 1.11 +/- 0.60

g/dl. Two patients required blood transfusion post operatively.

In our study we had two patients with complications. One patient had a dural tear (3.33%) which was sutured intraoperatively and postoperatively the patient did not have any complications. One patient had superficial wound infection, which was treated with oral antibiotics.

• In our study we found no correlation between decrease in Oswestry scores and medical Comorbid conditions.

Follow up of patients at 5 years showed that one patient underwent revision surgery at another hospital three years after index surgery and later the patient expired, and another patient had severe back pain with an ODI score 77. Excluding those two patients, the remaining patients had a mean ODI score of about 23 at 5 years.

Discussion

Though posterolateral fusion of lumbar spine was the classical technique, Interbody fusion provides several theoretical advantages over the other fusion techniques [3,4,5] by restoring the optimal disc height and sagittal balance and creating a higher fusion rate by placing the graft under compression with an extensive blood supply from the adjacent vertebral endplates. Posterior lumbar interbody fusion is the popular approach for achieving lumbar interbody fusion. Though there are other approaches like anterior approach which has the advantage of achieving better interbody fusion rate and good lumbar lordosis correction. But it has also got complications like visceral, vascular injury which are life threatening and retrograde ejaculation and there is limited access to L2L3 and L3L4 level because of adjacent main vessels[6].

Lateral approach is through retroperitoneal transpsoas approach. Advantage of this approach is that better sagittal and coronal deformity correction of lumbar spine is possible but not suitable for treatment of severe central canal stenosis and high-grade spondylolisthesis. It also has a risk of injury to lumbar plexus and psoas muscle [6].

Oblique lumbar interbody fusion approach is through retroperitoneal but anterior to psoas muscles. Advantage of this approach is that better coronal and sagittal deformity correction and high fusion rate is achievable and also injury to lumbar plexus and psoas muscle is rare but possible risks of sympathetic dysfunction and vascular injury is present[6].

Miura et al [7] in their study showed 32 patients who underwent PLIF in whom local morselized bone graft was prepared from the spinous process and lamina which were removed during decompression was used. There was 100% radiological union at 12 months follow up. The estimated average blood loss was 245.3 ±132.5 ml.

This retrospective study (Fogel et al [8]) of 26 consecutive patients treated with a unilateral cage asks whether fusion healing and clinical outcome is comparable with that obtained with bilateral cages. In this study, there were no pseudarthrosis, instrumentation failures, or significant subsidence at any of the single cage levels and he concluded that fusion and clinical success rates were not diminished by the use of a unilateral interbody cage rather than the recommended 2 cages.

Chen et al [9] and Zhao et al[10] showed Biomechanical advantages of using a single diagonal cage in PLIF compared to two cage constructs in a standard PLIF. This technique also decreases soft tissue dissection and bone dissection, thereby decreasing the blood loss and operating time. Its primary advantages over the standard PLIF procedure are less risks of injury to neural structures.

Morsi et al [11] in their follow up study of 14 patients who underwent PLIF with unilateral cage and local morselized bone graft showed good results. Their mean follow- up was 15 months. The mean Visual Analog Scale decreased from 7.8 to 2.2 and the mean Oswestry Disability Index decreased from 82 to 28. Postoperative radiographs in their study showed a mean increase in the disc height by 24.4%.

Lee et al [12] reported in their study, 17 patients who underwent PLIF with unilateral cage. The patients were followed up at 3 months and 12 months post operatively. The mean VAS score was 7.5 prior to surgery and had decreased to 2.5 at the 3-month postoperative examination. The disc space height increased from 7.1±3.0mm preop to 9.6±3.0mm at the 3-month postop follow up but dropped to 9.2±2.5mm at the 12-month postoperative follow up. Both the 3- and 12-month values were significantly different from the preoperative value

Compared to TLIF surgical technique, there are reports that PLIF approach has more risk of neurological injury and dural tear but it can be decreased with gentle retraction and handling of neural structures and with experience of operating surgeon. Many studies report neural injuries to be around 10 to 20 % [13,14,15] in PLIF surgery. In our series, one case out of thirty (3.3%) had a dural tear. The reason for low neural injury could be due to the fact that all patients were operated by senior spine surgeons with gentle handling of neural structures. No difference in fusion rate or functional outcome have been found between PLIF and TLIF surgical techniques in many studies.

The average surgical time and intraoperative blood loss were 105±11 min and 129 ml respectively which were comparatively less than that reported in studies like Fan et al[16] , Ntoukas et al [17] and Park et al[18] studies.

In our series statistically significant increase in disc height was achieved (from preoperative 6.5mm to 9.3mm) which is comparable to the results of Lee[7] , Morsi[6] , ching-Hsiao yu [19]and hans trouillier[20] studies but it is prone to decrease marginally at 4% over a period of time as reported by hans trouillier15. . Brantigan [21] also described a comparable loss of height, which was on average 4 mm. The mean vas score improved from 7 to 1.8 and Oswestry disability index also improved from 66.9 preoperatively to 17.3 at 6 months follow up which was statistically significant(P=0.001). These functional improvements are comparable to the results of other studies like ching Hsiao yu et al [19] and other studies [6,7,20]. The ODI score decreased to 23 at 5 years followup as reported by Hans trouillier et al [20]

The lumbar interbody fusion rate has been around 65 to 95% [22,23,24,25] as reported by various studies. In our series fusion rate was found to be 90% at 24 months. Local bone graft obtained from spinal canal decompression was able to achieve reliable fusion. The outcome of the PLIF procedure is comparable to that of combined ventral and dorsal procedures [26].

Limitations of the study are that sample size is small. It may reduce the statistical power of study, may lead to inability in detecting an effect and also increase the margins of error. It should also be noted that radiographs are not entirely accurate for assessing bony union. • We did not compare the outcomes of the patient groups with a control group in our study, which would have given much more precise results of functional outcomes. The positive points are that all cases were operated by a single senior spine surgeon and were followed up to 5 years.

Conclusion

Posterior Lumbar Interbody Fusion (PLIF) with Unilateral cage with local morselized bone graft is

acceptable alternative method to standard PLIF with two cages for better functional and clinical improvements in patients with degenerative lumbar disc disease and Spondylolisthesis.

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Legend Tables and Figures

Table1: Correlation between ODI and comorbid conditions of the patients

Co morbid conditions did not have a significant effect on pre op Oswestry scores. Post operatively at 12 weeks, diabetic patients had more Oswestry scores compared to others. However, at 6 months, there was no significant difference in scores between co morbid groups.

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval		Minimum	Maximum
						Lower Bound	Upper Bound Mean		
Pre-Op Oswestry	No Comorbidity	9	69.44	5.457	1.819	65.25	73.64	61	75
	DM	8	66.25	7.924	2.801	59.63	72.87	55	78
	HTN	5	66.40	4.159	1.860	61.24	71.56	62	72
	CAD	4	67.25	8.421	4.21	53.85	80.65	57	77

	Hypothyroidism	4	63.00	5.477	2.739	54.28	71.72	59	71
	Total	30	66.93	6.362	1.162	64.56	69.31	55	78
Oswestry 12w POD	No comorbidity	9	19.78	3.734	1.245	16.91	22.65	14	27
	DM	8	24.38	6.116	2.162	19.26	29.49	16	35
	HTN	5	22.60	3.286	1.470	18.52	26.68	20	28
	CAD	4	21.75	5.909	2.955	12.35	31.15	16	29
	Hypothyroidism	4	20.00	8.042	4.021	7.20	32.80	15	32
	Total	30	21.77	5.322	.972	19.78	23.75	14	35
Oswestry 6 months	No comorbidity	9	16.33	2.345	.782	14.53	18.14	12	20
	DM	8	18.88	5.436	1.922	14.33	23.42	11	28
	HTN	5	18.00	4.690	2.098	12.18	23.82	13	25
	CAD	4	16.25	2.062	1.031	12.97	19.53	14	18
	Hypothyroidism	4	16.50	6.351	3.175	6.39	26.61	13	26
	Total	30	17.30	4.195	.766	15.73	18.87	11	28

Table 2: Correlation between ODI and cause of the disease

Patients with degenerative spondylolisthesis had mean ODI scores of 69 and post op scores decreased to 21.3 at 12 weeks and 17.3 at 6 months respectively. Similarly, patients with Recurrent disc herniations had mean ODI scores of 63.4 and post op scores decreased to 22.6 at 12 weeks and 17.3 at 6 months respectively. There was no statistically significant difference between both groups.

Group Statistics					
	Cause	N	Mean	Std. Deviation	Std. Error Mean
Pre-Op Oswestry	Degenerative Spondylolisthesis	19	69.00	6.083	1.395
	Recurrent disc herniation	11	63.36	5.353	1.614
Oswestry 12 w POD	Degenerative Spondylolisthesis	19	21.26	5.352	1.228

	Recurrent disc herniation	11	22.64	5.409	1.631
Oswestry 6 months	Degenerative Spondylolisthesis	19	17.32	4.473	1.026
	Recurrent disc herniation	11	17.27	3.875	1.168

Patient No:47289, Age:68, Sex: Female , Diagnosis: Degenerative spondylolisthesis L5-S1 Preoperative VAS score: 7, Post operative VAS at 3 months: 2 Oswestry score Pre op: 62, Oswestry score at 6 months post op: 20

Figure 1: Preoperative x ray of L5S1 grade 2 spondylolisthesis

Figure 2: MRI image of L5S1 grade 2 spondylolisthesis

Figure 3: Postoperative x ray of L5S1 grade 2 spondylolisthesis treated with L5S1 decompression and stabilization with PLIF using single oblique titanium cage supplemented with pedicle screws.

Figure 4: Oblique titanium cage

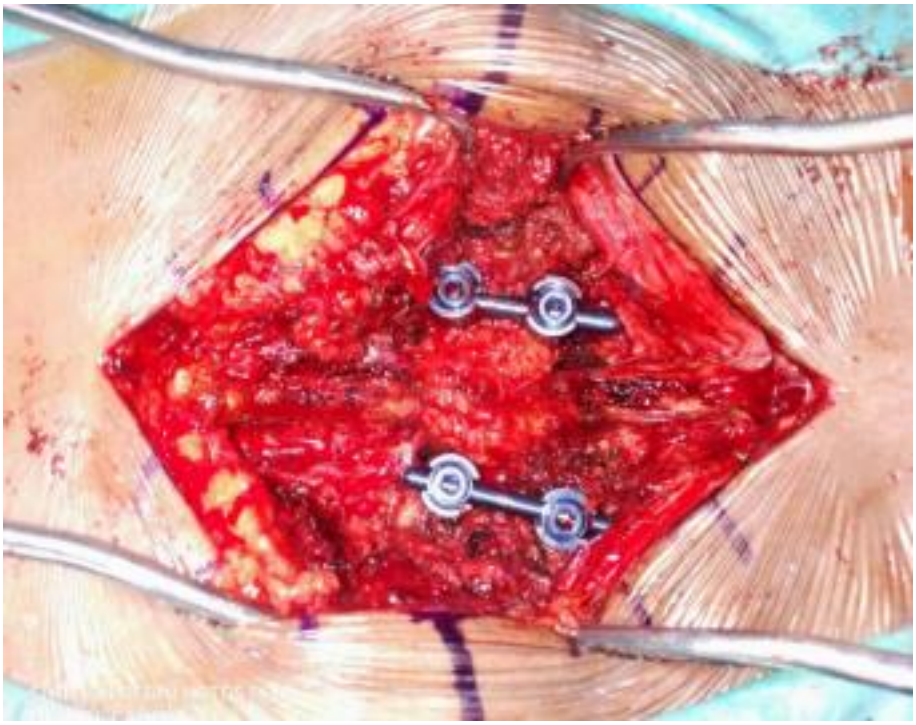

Figure 5: Intraoperative picture of PLIF

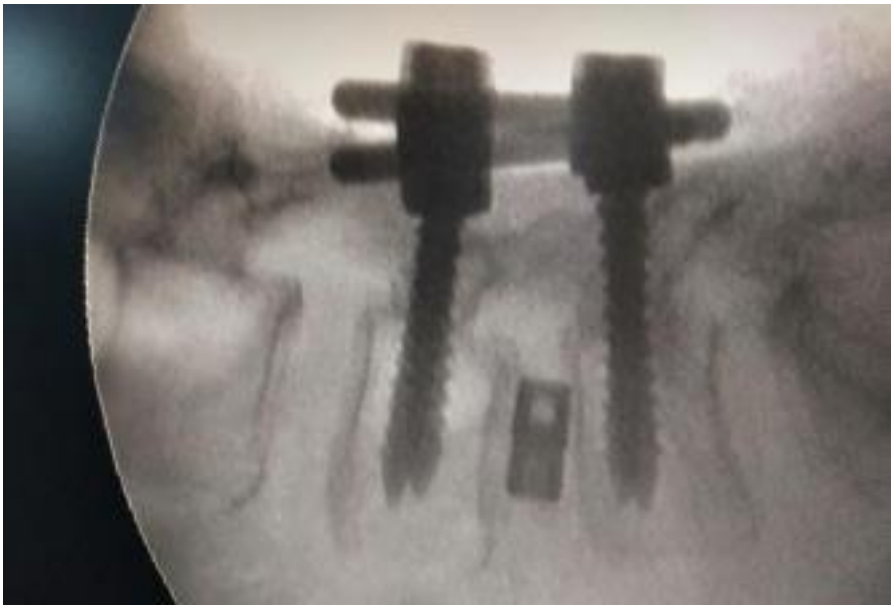

Figure 6: C arm image of PLIF