Posterolateral Fusion Versus Posterior Lumbar Interbody Fusion (PLIF) for Treatment of Lumbar Spondylolisthesis; A Comparative Study

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Abstract

Introduction

This is a retrospective comparative randomized clinical study reviewing the outcome of pedicle screws with lateral intertransverse fusion and pedicle screws with posterior lumbar interbody fusion (PLIF) fusion in 132 patients had Spondylolisthesis.

Patients and methods

Between May 2006 and April 2011 there were 132 patients with various degrees of lumbar spondylolisthesis 58 (43.9 %) patients treated by pedicle screws and PLIF and 74 (56.1%) patients treated with just pedicle screws and intertransverse fusion. This study including 87 patients (65.9 %) are female and 45 patients (34.1 %) are male with average age 52.2 (age ranged from 43-62). There were 69 patients (52.2 %) had one segment fusion and 63 cases (47.8 %) had 2 segments fusion. All patients evaluated clinically by Japanese Orthopedic Association Score (JOAS) for preoperative and postoperative and follow up evaluation. Radiological assessment using plain X-ray and MRI was obtained for assessment before and after. However for fusion we depend on flexion extension films to assess fusion.

Results

There is significant improvement at the final outcome of the group as there is mean IR for Group A 89.08 % (ranged from 60-100 %) SD±10.6. However Group B had mean Improvement Rate (IR) at the final outcome IR = 81.8% ranged from (45-100) with SD± 13.8. Fusion rate were 82% for group A compared to 89% for group B. Patients satisfaction was 82% for Group A while Group B has 94% of patients were satisfied.

Conclusion

There are no significant differences in results between lateral intertransverse fusion and PLIF regarding clinical outcome or fusion rate. Cost effectiveness may be considered as an important factor for decision making in treatment of degenerative spondylolisthesis.

Keyword

PLIF; Lumbar spondylolisthesis; pedicle screws fixation.

Introduction

Spondylolisthesis normally occurs in adolescence possibly leading to increased deformity, pain and neurological compromise due to the slip of the upper vertebral endplate which is in majority seen at L5 [1]. Degenerative lumbar spondylolisthesis is a common condition in the elderly. The main cause is disc degeneration and facet joint arthrosis[2]. Spondylolisthesis can also be caused by ligamentous laxity and trauma, and it occurs in people of all ages in up to 5% of the general population. [3] Indications for surgery after failure of conservative treatment including progressive neurological deficits, intractable low-back pain associated with radiculopathy, claudication, or symptomatic spinal instability with the goal of achieving spinal stabilization, fusion, and resolution of symptoms. [4] Use of instrumentation in spinal fusion operations has received increasing attention in the surgical literature, appearing as the treatment of choice because of its association higher fusion rate as well as better clinical results [5]. Posterior lumbar interbody fusion (PLIF) technique with pedicle screw fixation has shown satisfactory clinical results, solid fusion had been reported [6]. Inter body cage was designed to improve fusion success of interbody fusion by separating the mechanical and biologic functions of PLIF. The cage implant provides an actual device designed to meet the mechanical requirements of PLIF and to allow bone graft to grow from the vertebral body through the cage and into the next vertebral body. [7]

Patient and Methods

Between May 2006 and April 2011 there were 132 patients with various degrees of lumbar spondylolisthesis 87 patients (65.9 %) are female and 45 patients (34.1 %) are male with average age 52.2 (age ranged from 43-62). There were 69 patients (52.2 %) had one segment fusion and 63 cases (47.8 %) had 2 segments fusion. Before the surgery, all patients had been suffering from disabling low back pain or neurological deficits with a limited walking distance caused by spinal claudication. The symptoms persisted for a minimum of 3 months of continuous specific conservative therapy with muscle strengthening and muscle control training. All patients underwent posterior lumbar spinal decompression and instrumented fusion for a single or multiple levels.

Patients divided into 2 groups: **Group A:** which including 74 patients (56.1%) 56 females (42.4%) and 18 male (13.7%) and treated with just pedicle screws and lateral intertransverse fusion (Fig. 1). **Group B**: including 58 patients (43.9 %) 27 males (20.4 %) and 31 females (23.5 %) whom treated by pedicle screws and PLIF (Fig. 2, 3) randomly chosen. All patients treated in 3 hospitals (AL-Zahraa Univ. Hospital, Al-Rahmah Specialized Hospital and Heliopolis Hospital) by the same team of surgery. All patients had been treated either by ordinary decompression, pedicle screws fixation and intertransverse fusion or posterolateral Interbody fusion (PLIF). PLIF procedures were performed with various pedicle screws system. Surgery for group B (PLIF) were treated by technique that described by Brantigan and Steffee [7].

Indication for surgery was severe lumbar discogenic pain because of degenerative spondylolisthesis that had been not improved with conservative treatment. Before surgery routine plain and standardized lateral flexion-extension radiographs and MRI had been performed for all patients.

This study including 69 patients (52.2 %) had one segment fusion and the other 63 cases (47.8 %) had 2 segments fusion. According to Myerding's scale we have 64 patients (48.5%) had GI, 42 patients (31.8%) had GII and 26 patients (19.7 %) had GIII. All patients evaluated clinically by Japanese Orthopedic Association Score (JOAS) for preoperative and postoperative and follow up evaluation.

Group A clinical evaluation according to JOAS shows that the main complaint was low back pain which had mean 1.4 with SD ±.0.4, leg pain had mean 1.2 and SD ± 0.4. The mean score for gait was 1.3 SD ± 0.4, sensory disturbance mean score was 1.2 with SD± 0.4 however motor disturbance had mean 1.5 with SD ± 0.5. Regarding objective symptoms SLRT had mean score preoperative 1.1 with SD ± 0.3 and Activity day living (ADL) had mean score 8.0 and SD ± 1.3 all data of the Group A is detailed in (table 1)

For group B the main complaint was back pain and evaluated as other group by JOAS, they had back pain mean score was 1.2 with SD ±0.6, for the leg pain mean score was 1.1 with SD ± 0.3, gait mean score was 1.2 with SD ± 0.4. SLRT mean score was 1.0 with SD ± 0.2 detailed Items for JOAS in Table 1. Group B including post-surgical instability in 12 cases (9.1%) , this instability is well defined in the plain x-ray after standing and dynamic views.

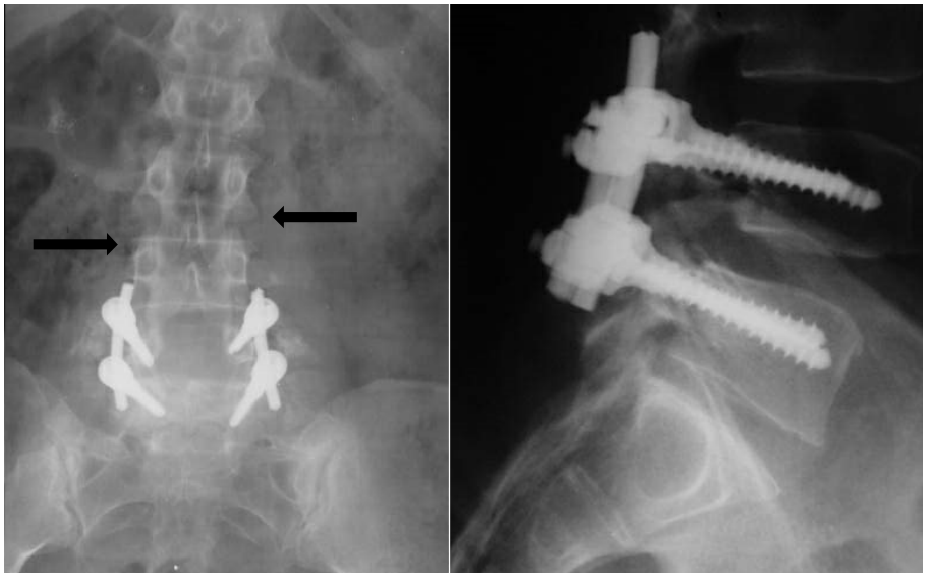

Fig. 1: Plain X-ray on L-S Spine AP and Lateral at final follow up. shows Spondylolisthesis L4-5 treated by wide neural decompression, transpedicular screws and intertransverse fusion. There is fusion mass in the intertransverse space (Black arrow).

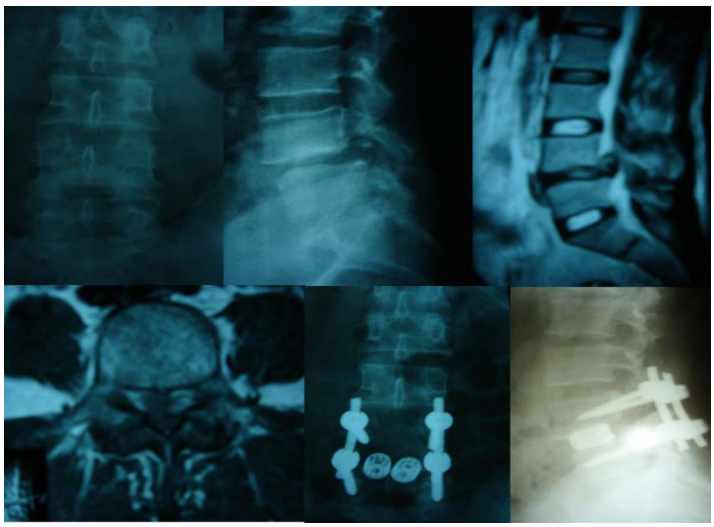

Fig. 2: Spondylolisthesis L4-5 with huge degenerative disc prolapse treated by PLIF and transpedicular screws.

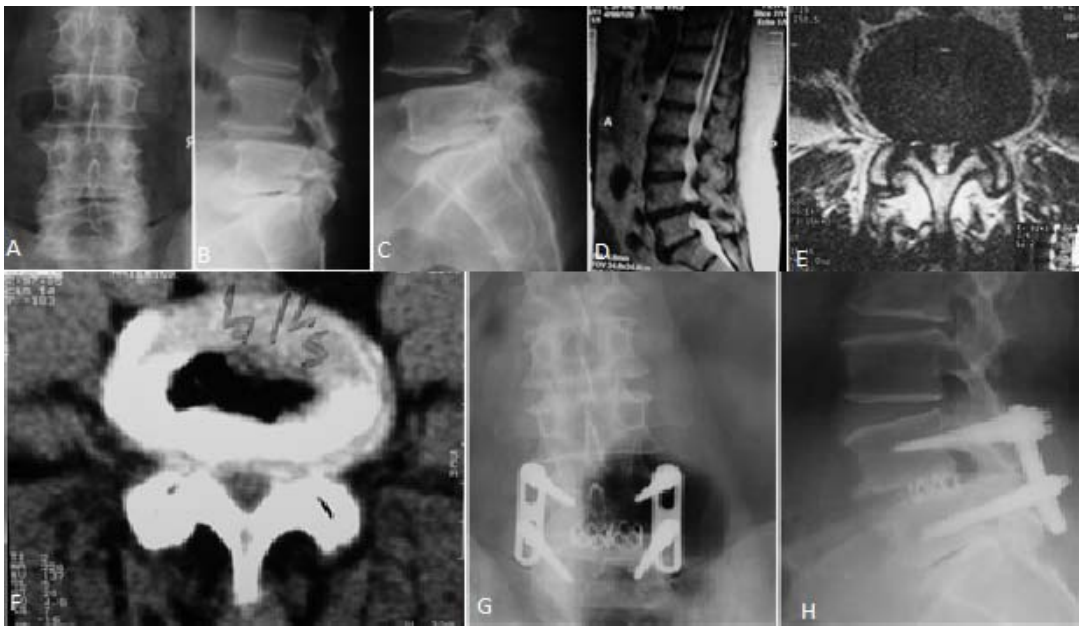

Fig. 3 : L4-5 degenerative Spondylolisthesis treated by PLIF and transpedicular screws. A,B,C: plain X-ray with Dynamic films. D,E: MRI T2WI sagittal and axial cuts. F: C-T scan Shows double egg shadows. G,H: postoperative X ray with PLIF single Pyramish cage.

Table 1: Mean score for Group A and B, JOAS preoperative

	N* Group A	Mean Group A	SD±	**Group B N***	Mean Group B	SD±
LBP	**74**	1.0	0.4	**58**	1.2	0.6
Leg pain	**74**	1.2	0.4	**58**	1.1	0.3
Gait	**74**	1.3	04	**58**	1.2	0.4
SLRT	**74**	1.1	0.4	**58**	1.0	0.2
Sensory dist.	**74**	1.1	0.3	**58**	1.1	0.3
Motor dist.	**74**	1.5	0.5	**58**	1.4	0.5
ADL	**74**	8.0	1.3	**58**	7.3	1.7
Urinary disturb.	**74**	-.2.0	0.9	**58**	-.2.0	0.8
Total Score	**74**	15.4	2.0	**58**	14.0	2.7

Radiological assessments after surgery for placement of the screws and recording the level of fixation; for fusion we depends on Brantigan–Steffee criteria [7] for interbody fusion as follow up X-ray obtained for all patients were regularly obtained at 6 months and after one year of follow up.

All data regarding Blood loss Operative time, and exposure time intraoperative also were recorded for both groups and compared.

Results

All data collected and recorded for all patients in both groups. Clinical outcome JOAS for both groups were compared to the preoperative JOAS. Statistical analysis were calculated by SPSS ver.15 software and standard statistic was recorded in addition to Anova Paired Test and T-paired test and Chi square Test were used to compare results pre and postoperative.

Group A: Mean JAOS for LBP in group A postoperatively was 2.89 (2-3) and SD± 0.31compared to mean Preoperative score 1.04 (0 – 2) SD±0.4. By comparing leg pain outcome it is markedly improved from 1.2 mean score (1-2) SD ± 0.4, to mean 2.9 (2-3) SD± 0.3. Gait also had been improved from mean 1.3 (1-2) SD ± 0.5 to 2.6 (2-3) SD ±0.4. (Table 2 shows all detailed results)

Regarding Improvement Rate (IR), there is significant improvement at the final outcome of the group as there is mean IR for Group A 89.08 % (ranged from 60-100 %) SD±10.6. Return to previous work and activities were recorded as fifty six patients (75.6 %) out of 74 patients who had been disabling pain before surgery had returned to their prior work and were functioning normally without needs for any medications. However 15 patients (20.2%) were able to do their previous work with some limitation of activities and sometimes needs for analgesic with excess load. Three patients (4.2%) were able to light work or at home with needs for medication most of times.

Table 2: Mean postoperative JOAS Item and IR for Group A

JOAS	N*74	Minimum	Maximum	Mean	SD±
LBP post		2	3	2. 9	0.3
Leg pain		1	2	1.2	0.4
Gait		2	3	2.9	0.1
SLRT		2	2	2. 0	0.0
Sensory ist.		1	2	1.9	0.1
Motor Dist.		1	2	1.9	0.1
ADL		11	14	12.9	1.1
Urinary dist.		-3.	.0	-.08	0.4
Total Score		23	29	27.5	1.3
Improvement Rate (IR)		**60**	**100**	**89.0**	**10.6**

Group B:- Group B who treated by PLIF their results postoperative had been improved according to JOAS were improved regarding LBP from preoperative mean 1.2 (ranged from 0-2) SD± 0.6 to postoperative mean 2.7 (ranged from 2-3) SD± 0.4. Leg Pain were improved for all patients from mean 1.1 (ranged from 0 – 2) SD± 0.3 into mean 2.8 (ranged from 2- 3) SD± 0.3. Gait improved from mean 1.2 (ranged from 1-3) SD± 0.4; Straight Leg Raising Test also improved from mean 1.0 (ranged from 1-2) SD ±0.2 improved to mean 2.9 (ranged from 2-3) SD±0.2. Neurological deficit were improved as sensory disturbance were improved from mean 1.1 (ranged from 1-2) SD± 0.3 into mean 1.8 (ranged from 1-2) SD± 0.3; and Motor disturbance improved from mean 1.4 (ranged from 1-2) SD± 0.5 into mean 1.8 (ranged from 1-2) SD ±0.3. Activity Day Living (ADL) were mean 7.3 (ranged from 4-11) SD 1.7 improved into mean 12.3 (ranged from 10-14) SD ± 1.2. Table 3 has detailed postoperative data and Total score with Improvement Rate (IR). There is Improvement Rate (IR) at the final follow up of all patients which was 81.8% ranged from (45-100)with SD± 13.8. Thirty eight patients (65.6 %) out of 58 patients who had been in-

capacitated before surgery had returned to their prior occupation and were functioning normally without pain. However 12 patients (20.6%) were able to do their previous work with some limitation of activities and sometimes needs for analgesic with excess load. Eight patients (13.8%) modified their work and their necessity for medication increasing by excess work.

Table 3: Group B, mean JOAS postoperative data and IR

JOAS	N*58	Minimum	Maximum	Mean	SD±
LBP post		2	3	2.7	0.4
Leg pain		2	3	2.8	.0.3
Gait		2	3	2.9	0.2
SLRT		1	2	1.9	0.1
Sensory ist.		1	2	1.8	.0.3
Motor Dist.		1	2	1.8	0.3
ADL		10	14	12.3	1.2
Urinary dist.		-3	0	-.2	0.7
Total Score		22	29	26.3	1.9
Improvement Rate (IR)		45	100	81.8	13.8

There is no statistical significant difference in Blood loss for both Groups as shown in Table 4. Difference in operative time ranged from 40-90 min with mean 70 minutes.

Table 4: Blood Loss in both groups

	N	Minimum	Maximum	Mean	SD±
Group A	74	600	1600	927.9	193.7
Group B	58	800	1400	995.6	118.9

Radiological Outcome: Fusion was assessed simply by standing lateral Flexion extension films. Fused segment was considered radiographically fused if there was bridging bone over the involved disc space and no radiolucency around the cages. Posterolateral fusion also was assessed and the arthrodesis was considered successful if there is bone contact in the intertransverse space (Table 5). There are 82 % fusion rate in comparison to 89 % of group B. Complications were recorded in both groups; pseudoarthrosis in Group A about 28 % radiologicaly without clinical symptoms, while Group B shows less incidence of pseudoarthrosis about 11 %. Adjacent segment stenosis reported in 5 cases (6.7%) in Group A, while Group B had 3 cases (5.1 %) with adjacent segment stenosis. Those cases with adjacent segment stenosis were need additional surgical decompression and extension of fusion for more one level. Broken rods and screws were recorded in different cases, Group A recorded 3 cases with broken rode while Group B including 2 cases with broken rode and screw. Intra operative dural leake were recorded in 6 cases that had of revision back surgery which usually repaired at the time of surgery without neurological complications.

Table 5: Final clinical and radiological outcome

Evaluation points	Group A (N= 74)	Group B (N= 58)	P* value
Fusion rate	82%	89%	0.049
Patient satisfaction	89 %	94%	0.051
Radiculopathy Improvement	85%	89 %	0.541

* **p value** = analysis of difference among groups with chi square test

Discussion

Spinal fusion is a generally accepted procedure for the management of patients with a variety of spinal disorders. The success of every spine fusion procedure depends bone healing. Bone healing process depends on many factors, including the type of graft, host factors, technique, and the rigidity of the

particular surgical construct.[8]

Complete neural decompression, solid fusion and restoration of normal intersegmental alignment in addition to preservation of normal spinal function are the goals of posterior lumbar interbody fusion (PLIF) in the treatment of spinal instability [9]. During the last decades, posterior lumbar interbody fusion (PLIF) has been widely used in arthrodesis for segmental instability of the lumbar spine. [10]

Most of cases Group A (74 patients) in our study with lateral Intertransverse fusion were treated by this technique as cost for PLIF may exceed the fund provided for PLIF. Cost effectiveness is an important factor for treatment of patients in the developing countries. Lee et al; 2011 stated that traditional posterolateral intertransverse fusion still remains a useful procedure with acceptable fusion rates for most degenerative conditions [11].

We have mean improvement rate according to JOAS for group A 81% and for group B 89.8%. There is no significant difference between results of both groups. This result is comparable to the results of posterolateral fusion reported by Agazzi et al 1999 who had reported clinical outcome 67% for 71 patients treated by PLIF, patient satisfaction 76 % and fusion rate 90%. [12]

Although we depend on standing lateral dynamic films to evaluate fusion there is several studies to assess fusion rate in different techniques of spinal fusion [11] [13] [14] [15]. Several investigators [16] believe that flexion-extension radiographs are a reliable indicator of fusion, but there is no consensus concerning the critical value of segmental motion for fusion failure. The pitfall of dynamic radiographs lies in the fact that the absence of any movement does not necessarily correspond with solid fusion [15].

Kim et al 2005 reported approximately 35% of patients who have fusion after a PLIF have some bony bridging forming around the cage after 12 months. They reported also 82% of these patients have bone fusion mass in posterior vertebral cortical margin four years follow up. Patients who do not experienced fusion, bony mass can only be observed inside the cage [17].

In both groups the outcomes of the studies shows that there is no evidence of the superiority of one approach over another one in terms of the fusion rate. As the fusion rates in Group A, were 82%; however Group B had 89% fusion rate.

Fogel GR et al; 2008 [14] Fusion assessment of posterior lumbar interbody fusion using radiolucent cages: X-ray films and helical computed tomography scans compared with surgical exploration of fusion. They concluded that evaluation of fusion rate either by surgical exploration, conventional X-ray, or CT methods performed after PLIF or posterolateral fusion was very similarly and there were no significant differences in accuracy between the two methods. They had results indicate that when plain films show strong evidence of fusion or pseudarthrosis the helical CT is unlikely to provide useful new information [14].

Barbagello et al; 2014 comparing effectiveness and safety of Lumbar lateral inerbody fusion (LLIF), with posterior lumbar Interbody Fusion (PLIF) and Transforaminal Lumbar Interbody Fusion (TLIF). They found that lumbar lateral interbody fusion (LLIF) group experienced less estimated blood loss and lower mortality risk compared with PLIF group. They also concluded that there is insufficient evidence of the comparative effectiveness of LLIF versus PLIF/TLIF surgery [18].

All patients in this studies used autogenous bone grafts mostly from posterior iliac crest from the same incision. Lee et al founded that there is moderate evidence suggesting no difference in fusion rate between posterolateral fusion and PLIF. They suggest also more studies to compare each single approach with circumferential fusion to determine whether a combined approach is necessary to improve the clinical results and fusion rate [11].

Conclusion

Instrumented lateral intertransverse fusion is an effective method for treatment of spinal instability. There are no significant differences in results between lateral intertransverse fusion and PLIF regarding clinical outcome or fusion rate. Cost effectiveness for lateral intertransverse fusion, time of surgery and blood loss may be considered as an important factor when decision making for treating degenerative spondylolisthesis.

References

1. **Konz RJ; Goel VK; Grobler LJ; Grosland NM; Spratt KF; ScifertJL; Sairyo K 2001:** The pathomechanism of spondylolytic spondylolisthesis in immature primate lumbar spines in vitro and difinite element assessments., Spine , 26(4); E38–E49.
2. **Jiang SD; Jiang LY; Dai LS 2011:**Degenerative cervical spondylolisthesis: a systematic review., International Orthopaedics (SICOT), 35; 869-75.
3. **Frymoyer JW, Selby DK 1985:** Segmental instability. Rationale for treatment. Spine, 10; 280-86.
4. **Schnee CL; Freese A; Ansell LV 1997:** Outcome analysis for adults with spondylolisthesis treated with posterolateral fusion and

transpedicular screw fixation. J Neurosurg, 86;56-63.

5. **Baldwin NG 1996:** Lumbar spondylolysis and spondylolisthesis. [book auth.] Sonntag VHK (eds) Menezes AH. Principles of Spinal Surgery. New York : McGraw-Hill, Vol. 1, 681-03.
6. **Zencica P; Chaloupka R; Hladíková J; Krbec M 2010:**Adjacent segment degeneration after lumbosacral fusion in spondylolisthesis: a retrospective radiological and clinical analysis. Acta Chir Orthop Traumatol Cech. , Vol. 77(2), pp. 124-130.
7. **Brantigan JW; Steffee AD; Lewis ML; Quinn LM; Persenaire JM**. **2000:** Lumbar interbody fusion using the Brantigan 1/F Cage for PLIF and the VSP pedicle screw system: Two year results of a Food and Drug Administration IDE clinical trial. Spine, 25;1437-46,.
8. **Janssen ME; Lam C and Beckham R 2001**: Outcomes of allogenic cages in anterior and posterior lumbar interbody fusion. Eur Spine J, 10; S158–S68. DOI 10.1007/s005860100292.
9. **Keppler L; Steffee AD; and Biscup RS1997:** Posterior lumbar interbody fusion with variable screw placement and Isola Posterior lumbar interbody fusion with variable scews placement and Isola instrumentation. [book auth.] DeWald RL Bridwell KH. The Textbook of Spinal Surgery. 2nd. Philadelphia : Lippincott-Raven ;1601–21.
10. **Enker P; and Steffee AD 1994:** Interbody fusion and instrumentation. Clin Orthop Relat Res, 300; 90–101.
11. **Lee, SC, Lee, SC; JC, Hwang; Lee HD, Kim TY; Lee SH 2011:** Fusion Rates of Instrumented Lumbar Spinal Arthrodesis according to Surgical Approach: A Systematic Review of Randomized Trials . Clinics in Orthopedic Surgery. 3; 39-47. doi:10.4055/cios.2011.3.1.39
12. **Agazzi, S. Reverdine A, and May D. 1999:** Posterior Lumbar Interbody fusion with Cages: an Independent reviwe of 71 cases. J of Neurosurg. (Spine 2) , 91; 186-92.
13. **Kim, HK, YJ, Park and Chin KD. 2009**: Fusion Criteria for Posterior Lumbar Interbody Fusion with Intervertebral Cages : The Significance of Traction Spur. J Korean Neurosurg Soc, 46;328-32. www.jkns.or.kr .
14. **Fogel, RG and Toohey SG, Neidre A, Brantigan WJ 2008:** Fusion assessment of posterior lumbar interbody fusion using radiolucent cages: X-ray films and helical computed tomography scans compared with surgical exploration of fusion., The Spine Journal,8; 570–77.
15. **Kröner, HA; R, Eyb; A, Lange; K, Lomoschitz; T, Mahdi; Engel A 2006:** Magnetic Resonance Imaging Evaluation of PosteriorLumbar Interbody Fusion. Spine, 31(12);1365-71.
16. **McAfee PC, Boden SD, Brantigan JW, Fraser RD, Kuslich SD, Oxland TR, et al 2001:** Symposium: A critical discrepancy- A criteria of successful arthrodesis following interbody spinal fusions. Spine,26; 324-34.
17. **Kim KS; Yang TK and Lee JC2005:** Radiological changes in the bone fusion site after posterior lumbar interbody fusion using carbon cages impacted with laminar bone chips : follow-up study over more than 4 years. Spine, 30; 655-60.
18. **Barbagallo, MVG; Albanese V; LA, Raich; Detton RJ; Sherry N; Balsano M 2014:** Lumbar Lateral Interbody fusion (LLIF) comparative effectiveness ans safety versus PLIF/TLIF and predictive Factor Affecting LLIF Outcome., Evidence Based Spine Care Journal, 8;28-37.