



## Anterior lumbar inter-body fusion with instrumentation compared with posterolateral fusion for low grade isthmic-spondylolisthesis

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Spondylolisthesis presenting as low back pain is not an uncommon condition. Many of such patients are treated conservatively. For those that require surgical management, various treatment options are in vogue e.g. Postero-lateral fusion (PLF) with decompression or posterior fusion with instrumentation and anterior lumbar inter-body fusion (ALIF). Each technique has produced satisfactory outcome with benefits and disadvantages.

**Aim of the study :** To compare the outcome of surgical management of low grade spondylolisthesis with two treatments modalities – Postero-lateral fusion (PLF) and Anterior lumbar inter-body fusion (ALIF) with posterior instrumentation in similar patient profile.

**Settings and Design :** Prospective study to compare the results of two surgical treatment modalities.

**Material and Methods :** The selected group of patients for surgery based on definite criteria was operated by the same surgeon by two modalities : Postero-lateral fusion with decompression and Anterior Lumbar Inter-body fusion with posterior instrumentation. The outcomes were compared.

**Statistical analysis used :** Analysis of variance (ANOVA) test.

**Results :** Follow up was done at twelve weekly intervals up to 2 years. Both groups showed good recovery in pain as seen in Visual analogue scale (VAS) and Oswestry low back pain scoring. Intra-operative bleeding was observed to be higher in Postero-lateral fusion group. Average length of hospital stay for the patients of PLF group was 6.6 days (Range : 4-7 days) as compared to 12.5 days (Range : 10-16 days) in case of ALIF group. Treatment cost was found to be high-

er in patients who undergone ALIF with instrumentation.

**Conclusions :** ALIF with posterior instrumentation in low grade isthmic spondylolisthesis provides satisfactory outcome in patients requiring surgical treatment. The results of pain relief and disability index are comparable to time tested posterolateral fusion. ALIF shows a tendency to faster pain relief and return to activity with less intraoperative blood requirement in low grade isthmic spondylolisthesis.

**Keywords :** ALIF ; instrumentation ; low grade isthmic spondylolisthesis.

### INTRODUCTION

Spondylolisthesis is not an uncommon condition which presents with low back pain. The incidence in western countries is nearly 5-8% (5). There are no comparable data in our country. Though more common in males it is more symptomatic in females.

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In the initial phase of the study those patients who required surgical treatment were operated by posterolateral fusion in situ with neural arch decompression. However for last 4 years they are being treated with instrumented stabilization and anterior lumbar body fusion by us.

In this prospective study the results of the two treatment modalities are compared and discussed.

### SUBJECTS AND METHODS

All the patients with low back pain were initially screened with antero-posterior, lateral and flexion-extension radiographs of lumbo-sacral spine for spondylolisthesis or lysis. They were subjected to comprehensive clinical examination including that of spine, hips, sacroiliac joints and abdomen. Radicular pain and neurological deficit if any were evaluated and in such patients MRI Scans or CT Scans were also done. Initially all except those with significant neurological deficit were treated conservatively for 6 months which included short periods of rest for 4 to 5 days durations and when required, rigid braces and life style modifications. If they did not improve they were offered surgery.

The following criteria were used for surgical management among the patients who consented for surgery.

- low grade isthmic spondylolisthesis (< 50% slip)
- persistent or recurrent pain in lower back, buttocks and thighs with conservative treatment
- radicular signs and symptoms
- no history of previous spinal surgery

During early phase of our study surgical management done was in the form of postero-lateral fusion with removal of loose lamina and root decompression where required. The surgical exposure was done up to tips of transverse processes and fusion was done from L4 to S1 in all cases of listhesis. Facet joints were denuded and transverse processes decorticated. Autologous cancellous bone grafts were obtained from posterior iliac crest and occasionally from ribs (Fig. 1, 2).

Post operatively, the patients were provided with a lumbo-sacral brace as soon as they could ambulate. This was used for 5-6 weeks only. Progress of fusion mass was assessed by 12 weekly radiographs.

With the view to improve the functional outcome and early recovery we planned to bring in instrumented stabilization and fusion in our surgical management protocol. During last 4 years we have been doing posterior stabilization with pedicular screws and rod combinations fol-



*Fig. 1.* — Immediate post operative radiograph of decompression and PLF.



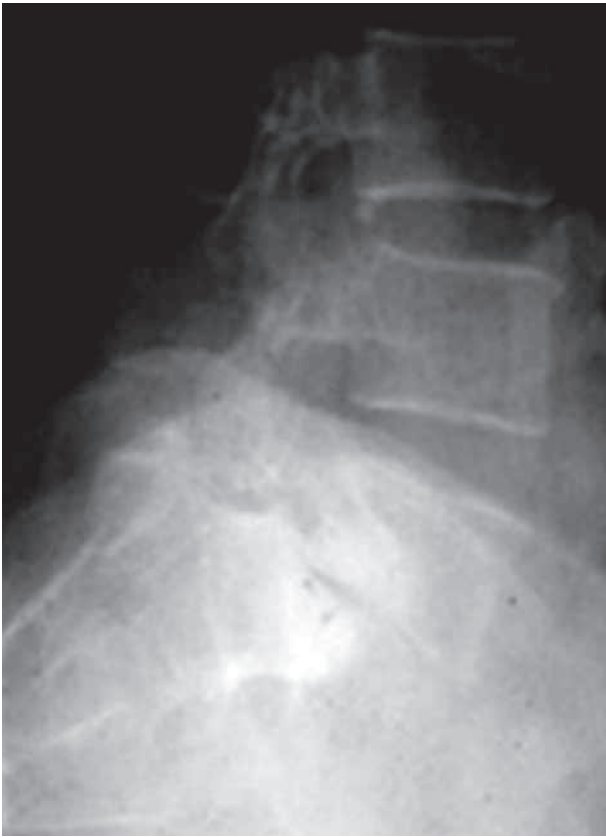
*Fig. 2.* — Follow up radiograph of posterolateral fusion and decompression.

lowed by anterior lumbar interbody fusion (ALIF). ALIF was done in an attempt to treat disc degenerations, to create a stable construct and to increase fusion rates.

Posterior reduction prior to ALIF helps to restore sagittal alignment, decompresses the spinal canal effectively and maintains reduction.

By those patients who did not show radicular sign and symptoms, loose neural arch was not removed in view to avoid thecal scarring and no attempt at reduction of listhesis was done (Fig. 3, 4, 5, 6, 7).

Patients presenting with radicular pain were subjected to instrumented reduction mostly with Moss-Miami pedicular reduction technique and we instrumented one level above and below. Neural arch decompression as



*Fig. 3.* — Grade- 2 isthmic listhesis L5-S1

well as root decompression was done where deemed necessary. Where reduction was not planned due to no root symptoms or where reduction came spontaneously, only one mobile segment was stabilized.

No gross attempt at posterior fusion was done except whatever grafts could be obtained from spinous processes were used for facet joint fusion. Transverse processes were not exposed. Where the neural arch had to be removed, we put the graft to bridge the gap between inferior articular process of the upper segment and superior articular process of the lower segment.

After about a week, a second stage anterior lumbar inter-body fusion was performed by a para-rectus longitudinal incision and extra-peritoneal exposure of L5-S1 or L4-L5 discs (Fig. 8, 9, 10, 11). After disc excision and creating a bleeding grating surface of end plates, tricortical shaped grafts obtained from iliac crest were impacted in the space. These grafts were obtained 5cm. away from anterior superior iliac spine and resultant gap in the crest was supported on the inner table by a proline mesh. We had done two stage operations (9) in an attempt to reduce



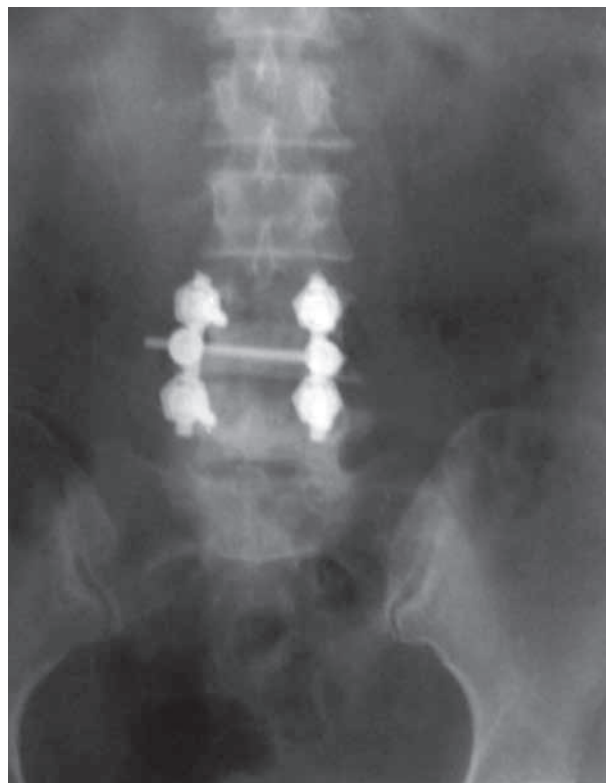
*Fig. 4.* — Grade- 2 listhesis instrumented with reduction and ALIF.



*Fig. 5.* — Grade-1 isthmic listhesis L4-5



**Fig. 6.** — Follow up radiograph lateral view of instrumentation and ALIF in L4-5 listhesis.



**Fig. 7.** — Follow up radiograph anteroposterior view of instrumentation and ALIF in L4-5 listhesis.

long operative time of one sitting operation and to prevent complications related to prolonged anesthesia. Time interval between the two procedures also gave us the opportunity to check for possible root compromise due to pedicle screw mal-position.

Assessment and follow-up was done at 12 weekly intervals.

In the follow up, AP and lateral view x-rays were done. On x-rays, we assessed the fusion mass and the maintenance of reduction. Radiological assessment of fusion mass in PLF group was done. In ALIF with instrumentation group, fixation and position of graft were assessed. Radiological assessment of fusion was done according to Bridwell and Lenke's grading (13) in ALIF cases. PLF was assessed by defining continuous inter-transverse bony bridging (6). We also looked for any fracture of graft considering it to be failure of fusion. Relief of pain was assessed by Visual Analog scores. At the latest follow up, patients were asked to complete Oswestry low back pain questionnaires and any improvement in functional activity was recorded.

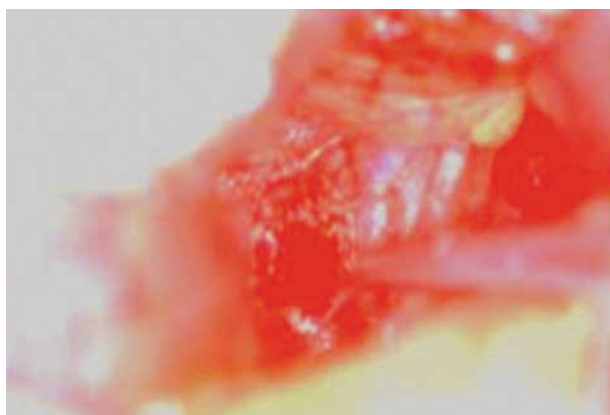
## RESULTS

We recorded 263 symptomatic patients of Isthmic spondylolisthesis/lysis out of 4307 patients presenting with LBP and/or radicular pain in Out Patient Department as well as indoors during last 9 years. However this is not a representative sample of general population.

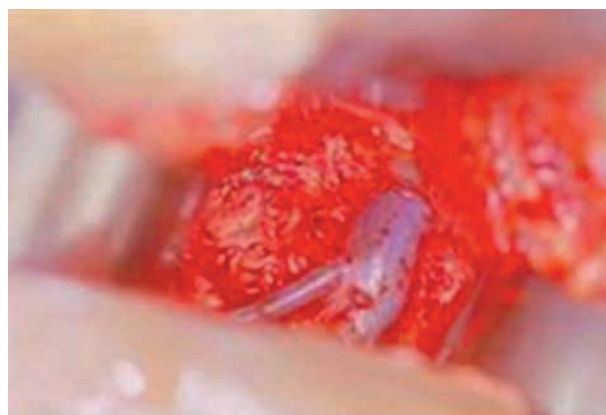
In the operated group, the patients were essentially in the age group between 31 to 50 years (Table I) and all the 48 patients except 2 were females.

In this series 20 were L4-L5 and 28 were L5-S1 listhesis cases. All were up to Grade 2 displacement and all were of Isthmic type. The mean follow-up of Postero-lateral fusion group of 27 patients was 7.25 years with maximum and minimum being 9 years and 5 years respectively.

The mean follow up of patients undergoing Instrumentation and Anterior Lumbar Inter-body



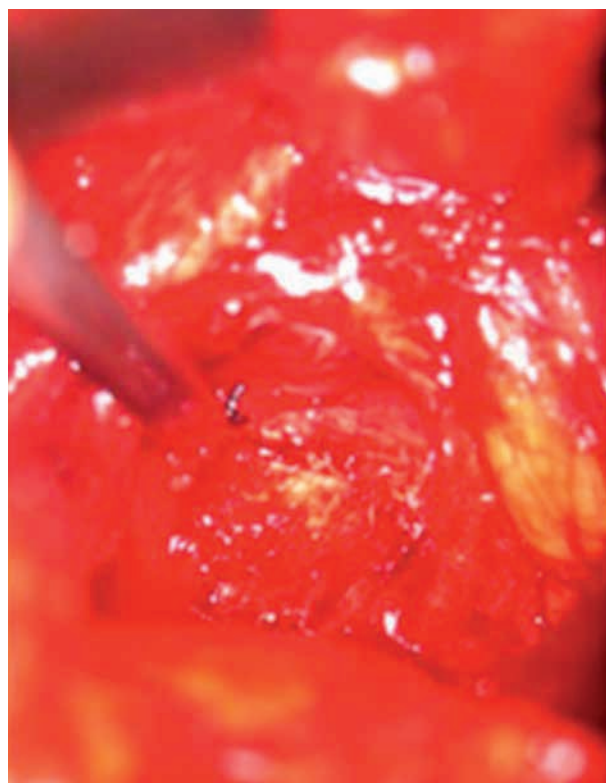
**Fig. 8.** — Anterior exposure and discectomy L5-S1 between bifurcation of aorta.



**Fig. 9.** — Anterior tricortical graft impacted in L5-S1 disc space.



**Fig. 10.** — Anterior exposure and discectomy at L4-L5



**Fig. 11.** — Anterior tricortical graft impacted in L4-5 space

Fusion was 2.85 years with longest follow-up of 4 years and minimum of 1.5 years.

In addition to these two groups we performed postero-lateral fusion with instrumentation in 2 cases at L5-S1 level.

In instrumented cases, reduction was done by using pedicle reduction screws in 5 patients (20 percent) who had radicular pain symptoms extending into calf. In one patient Synthes sleeve reduction screw technique was used but reduction was lost

Table I. — Age incidence of symptomatic patients

Age	No. of patients
21-30 years	2
31-40 years	18
41-50 years	17
51-60 years	11

postoperatively due to loosening of screw anchorage due to osteoporosis. This was a poor case selection for instrumentation and was salvaged by second stage ALIF and bracing. This patient went on to become pain free. ALIF was also done as a salvage procedure successfully in 2 cases with posterolateral fusion along with failed instrumentation i.e. breakage of screws noticed after 10 months, causing recurrence of pain. These cases were other than these two groups and were not considered for comparisons. On latest radiological assessment in follow up we achieved 100% fusion in both ALIF as well as PLF groups according to the criteria mentioned in methods above.

Out of 8 patients of L4-L5 disc exposure, anterior sub-aortic tributary to Inferior Vena Cava from ascending lumbar vein needing careful ligation was seen in only 1 patient (12 percent). In one patient with higher aortic bifurcation L4-5 disc could be exposed within it.

Average intra operative blood loss in PLF group was 410 ml (Range : 300 ml-700 ml) as compared to 330 ml (Range : 150 ml-600 ml) in ALIF group. All patients undergoing posterolateral fusion needed intra operative or post operative blood transfusion of 2 to 3 units (1 unit = 250 ml). In comparison only 3 patients out of 21 who received instrumentation and subsequent ALIF procedure needed blood transfusion. In pre operative period, we took all measures including blood transfusion to improve patients hemoglobin levels if low. It was observed that bleeding was higher in well muscular individuals especially when dissection was deep down to transverse processes. When dissection was done only to facet joint level, blood loss was minimum.

Average length of hospital stay for the patients of PLF group was 6.6 days (Range : 4-7 days) as compared to 12.5 days (Range : 10-16 days) in case of ALIF group.

Treatment cost was found to be higher with an average increase 117% in patients who undergone ALIF with instrumentation as compared to PLF group. This was because of two operative procedures, longer stay at the hospital and cost of the implants.

All the patients in both groups except those with posterolateral fusion with instrumentation failure showed improvement in pain relief. Average pain scores on visual analog scale (Table II) appeared to show faster recovery in ALIF with instrumentation group but this was not found to be statistically significant. At the latest follow up, average pre operative Oswestry disability index (ODI) of 30 (Range : 26-33) in PLF group was reduced to 12 (Range : 9-15). Average preoperative ODI of 32 (Range : 28-36) in ALIF group was reduced to 9 (Range : 7-13).

ANOVA tests showed that differences in ODI were not statistically significant.

The patients were females with sole occupation of being housewives except for 2 male patients. Among PLF group, all female patients and one male patient noticed some functional improvement due to pain relief. They started doing their day to day work without experiencing any pain. One male patient went on to retain his occupation of factory worker.

However among ALIF with instrumentation group, all patients noticed functional improvement, 9 patients (43 percent) became pain free and started doing their same household work comfortably while 12 patients (57 percent) became fairly active and could do additional activities apart from their routine household work. There was no metal failure or loosening of screws other than in one patient mentioned above. There were no nerve root deficits postoperatively. There were no sexual dysfunction / sympathetic chain injury in ALIF group. There was no visceral and vascular injury in our series. One patient of ALIF group had superficial surgical site infection which subsided with antibiotics.

## DISCUSSION

Postero-lateral fusion in low grade listhesis provided satisfactory pain relief in this series and this has been reported extensively in literature as well.

Table II. — VAS score

DURATION	PLF Group (Total : 27 patients)			ALIF Group (Total : 21 patients)		
	Average Score	Patient wise Score		Average Score	Patient wise Score	
Pre-op period	7.14	4 Patients	8	7.09	19 Patients	7
		23 Patients	7		2 Patients	8
12 Weeks	4.77	21 Patients	5	3.23	16 Patients	3
		6 Patients	4		5 Patients	4
24 Weeks	2.77	12 Patients	2	2.47	11 Patients	2
		12 Patients	3		10 Patients	3
		2 Patients	4			
36 Weeks	1.77	9 Patients	1	1.47	11 Patients	1
		15 Patients	2		10 Patients	2
		3 Patients	3			
48 Weeks	1.7	11 Patients	1	1.38	13 Patients	1
		13 Patients	2		8 Patients	2
		3 Patients	3			
60 Weeks	1.55	12 Patients	1	1	17 Patients	1
		15 Patients	2		2 Patients	2
					2 Patients	0
2 Years	1.55	12 Patients	1	0.8	14 Patients	1
		15 Patients	2		1 Patient	2
					5 Patients	0

A significant difference was not shown at any time between the two groups.

Our results of PLF in terms of pain relief are similar to published studies (1,3). However PLF cannot provide reduction of listhesis on its own. In addition removal of loose lamina as well as root decompression was required to be undertaken wherever radicular symptoms were suspected. Instrumented reduction on the other hand can also provide root decompression. However combining instrumented fixation with PLF is probably a mismatch of concept as explained later. Christensen *et al* found PLF alone good enough in a 5 year follow-up and opined that instrumentation increased operative time, blood loss and early reoperation rates and that routine use is not needed. They found better outcome by use of PLF without supplemental instrumentation (2). In combination of instrumented fixation and PLF, loss of reduction in more than 50% was noticed by Suk *et al* (12) though it was not necessarily symptomatic. Schnee *et al* (8) found good outcome in only 60% with this combination.

Instrument breakage with this combination has been reported by Suda *et al* in 6 out of 101 patients and has been salvaged by ALIF (10). In the present series also we encountered two failures of posterior instrumentation which required to be salvaged by ALIF. Duggal *et al* (4) also found ALIF as a safe and effective procedure for failed back surgeries.

During PLF with Posterior instrumentation, bulk of instrumentation takes away part of space where fusion mass has to develop. Secondly, in the absence of anterior column stabilization, this doesn't provide a biomechanically stable construct. Moreover, instrumentation protects the strain on whatever fusion mass develops, it doesn't mature into strong bone as per Wolff's law. When instrumentation gives way due to repeated stress, small posterolateral fusion mass doesn't support leading to failure.

Suk *et al* (11) found no significant differences in 2 groups in terms of blood loss, pain relief, fusion and complication rate but ALIF with Pedicle Screw

Fixation (PSF) superior to PLF with PSF in terms of prevention of reduction loss.

However in our hands, blood loss was significantly less with ALIF and PSF combination procedure. Visceral and vascular complication from ALIF have been described in a retrospective study on 60 patients by Rajaraman *et al* (7) in 38.3 per cent. In our series, there were no ALIF related complications including sympathetic or sexual dysfunction. The reasons could be smaller series and essentially female patients.

In our opinion, Postero-lateral fusion requires wider and more traumatic exposure up to transverse processes involving more muscle stripping and blood loss requiring invariably blood transfusion.

In comparison limited posterior exposure barely up to facet joints facilitates less blood loss and also anterior retroperitoneal exposure of lumbar discs being in tissue planes causes little bleeding.

Instrumentation has added advantage also of restricting fusion requirement to single motion segment especially in L4-L5 listhesis. Moreover there is no need to provide any external brace in initial weeks.

For the sake of two procedures in ALIF group, length of stay and treatment cost of hospitalization was higher.

## CONCLUSION

ALIF with Posterior instrumentation provides satisfactory pain relief with early recovery of function in low grade isthmic spondylolisthesis with added advantages of lower blood requirements and possible neural decompression when reduction is also included. The anterior column fusion provides sufficient stability to the construct so that instrumentation failures do not happen. ALIF can also be used as salvage procedure when there is a state of failure of stability associated with other surgical procedures. As our patient group is essentially of female patients, these remarks can be made for such patient population only.

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