Posterolateral lumbosacral fusion with transpedicular fixation

63 consecutive cases followed for 4 (2–6) years

Harri Pihlajamäki[1], Ole Böstman[1], Martti Ruuskanen[1], Pertti Myllynen[1], Jaakko Kinnunen[2] and Erkki Karaharju[1]

We analyzed the clinical, vocational and radiologic outcomes of 63 consecutive posterolateral lumbosacral fusions performed with transpedicular fixation. The indication for surgery was long-standing intractable lumbar and/or radiating pain with spondylolysis-olisthesis in 31 cases, degenerative disc disease and/or facet joint arthrosis in 23 cases and pain after laminectomy/decompression in 9 cases. Radiographic union was finally achieved in 30 out of the 63 cases. Fixation device-related complications, such as screw misplacement, breakage, bending and loosening, occurred in 33 cases. 15 patients underwent refusion. 43 patients obtained good pain relief. There was no correlation between bony healing and a good clinical outcome. 28/49 preoperatively employed patients returned to work. There was no correlation between relief of pain and return to work. 20 patients retired on a full disability pension. The clinical results were best in the spondylolysis-olisthesis group. Only 2/15 patients with markedly reduced spondylolisthesis maintained the reduction. In 3 patients, progressive disc degeneration above the level of fusion was observed. We conclude that posterolateral lumbosacral fusion with transpedicular fixation provides a satisfactory clinical outcome in patients with spondylolysis-olisthesis, but the high incidence of complications related to the fixation device in the other indications studied is a serious drawback of the method.

Departments of [1]Orthopedics and Traumatology, and [2]Diagnostic Radiology, University Central Hospital, Helsinki, Finland
Correspondence: Dr. Harri Pihlajamäki, Töölönkatu 44–48 E 72, FIN-00250 Helsinki, Finland. Tel +358 0-4711. Fax 4717481
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Although the role of fusion in the treatment of many lumbar spine disorders remains controversial (Crock 1982, Dunsker 1988, Esses and Huler 1992), the rate of lumbar fusions performed has increased dramatically during the last few years (Deyo et al. 1991, Esses and Huler 1992, Davis 1994). Lumbar fusions can be performed with posterior, posterolateral, anterior interbody or posterior interbody techniques, but no clear superiority of any technique has not been found (Turner et al. 1992). Some authors have reported that posterolateral lumbar fusion results in a greater fusion rate and a better clinical result than do anterior interbody or posterior bone-grafting techniques (Stauffer and Coventry 1972, Turner et al. 1992). New transpedicular spine fixation devices have been used in performing posterolateral lumbosacral spinal fusions, but their role as an adjunct to spinal fusion is not yet well defined.

Our aim in this retrospective study was to assess the clinical, vocational and radiographic outcomes of posterolateral primary lumbosacral fusion with transpedicular fixation.

Patients and methods

From 1989 to 1993, 63 patients, 32 men and 31 women without previous spinal fusion, were subjected to posterolateral lumbar fusion with transpedicular fixation. The mean age of the patients was 44 (16–70) years. The diagnosis was spondylolysis-olisthesis in 31 cases, degenerative disc and/or facet joint arthrosis in 23 cases (6 had undergone surgery for disc herniation), and pain after laminectomy/decompression in 9 cases. In only 4 patients was the spondylolisthesis 50% or more. 49 patients were preoperatively employed, 7 were retired because of low back pain and 7 patients had reached pensionable age or retired for a medical reason other than the low back disorder.

The indication for surgery was long-standing, intractable lumbosacral and/or radiating pain, resistant to nonoperative treatment. 2 patients had no radiating pain and 61 had radiating pain of some degree. Preoperatively, plain anteroposterior, lateral flexion-extension radiographs were obtained. Myelography

and either a contrast-medium-enhanced CT or MRI were used to demonstrate a possible spinal stenosis at the level of the spondylolisthesis and to rule out other causes of back pain and sciatica.

All patients had a bilateral posterolateral fusion with transpedicular fixation, using cancellous autogenic bone transplantation from the iliac crest. 21 patients with stenosis at the level of the spondylolisthesis underwent concomitant decompressive laminectomy. Reduction of the slip with the transpedicular instrumentation was carried out in 21 patients with spondylolisthesis. In 10 patients with slip, the vertebrae were fused in situ. 41 fusions were performed between L4 and S1, 10 between L4 and L5, 3 between L5 and S1, 8 from L3 to L5, and 1 from L3 to S1. The principal transpedicular fixation device used was the AO Internal Fixator.

All 63 patients were evaluated by a physical and a radiographic examination after a minimum follow-up time of 2 years. To avoid bias, the evaluation was made by 2 orthopedic surgeons (HP and MR) who were not involved in the previous treatment of the patients. The final radiographic assessment was performed without knowledge of the clinical outcome of the patient. The average follow-up time was 4 (2–6) years. Relief of back and leg pain was graded by the patient into 3 categories: good (little, if any, residual pain), fair (some pain relief, but residual pain) and poor (unchanged or worse than preoperatively), according to Stauffer and Coventry (1972) and Axelsson et al. (1994). The need for analgesics was recorded as daily and regular, infrequent or nonexistent. The preoperative occupation and data about the patients' return to work or definitive disability pension were registered.

In addition to routine anteroposterior and lateral radiographs, lateral flexion-extension radiographs and anteroposterior views with a 20° caudocranial tilt were taken to obtain a perpendicular view of the fusion. CT scans through the lumbar fusion, and two-dimensional parasagittal CT reconstruction images were made to visualize the whole length of the fusion. If the two-dimensional CT images were not unequivocal, three-dimensional oblique posterolateral CT images were also reconstructed. Fusion was considered to be achieved when continuous bony bridging could be verified on all intended sites and there was no movement in the flexion-extension radiographs. Nonunion was judged to have taken place, if any discontinuities in the bony bridging on plain films, axial CT, two-dimensional parasagittal or three-dimensional oblique posterolateral images were observed or if any movement was detected in the flexion-extension radiographs.

The disc height in the fused levels and the level proximal and distal to the fusion level were assessed and classified semiquantitatively into 4 groups: normal disc height, disc height decreased by less than 50%, disc height decreased by at least 50% and disc height effaced (Pope et al. 1977, Saraste et al. 1985).

In patients with spondylolisthesis, the percentage of slipping of the vertebral body/bodies was measured on preoperative, immediate postoperative and final follow-up radiographs in relation to the anteroposterior diameter of the slipped vertebra (Boxall et al. 1979). A change of over 10% in relative slip value was considered a marked correction (or progression) (Seitsalo et al. 1990).

For statistical analysis the chi-square test was used.

Results

The average postoperative hospital stay was 8 (4–34) days. 1 deep wound infection occurred, but it did not necessitate early removal of the device. Altogether 5 patients underwent a subsequent reoperation for early complications within a couple of days postoperatively. The indications for these reoperations were screw misplacement in 3 cases, loosening of the clamp of the fixation device in 1 case and peroneal palsy in 1 patient. In 26 patients, screw breakage, loosening or bending were radiographically observed during the follow-up. 15 patients underwent refusion for pseudarthrosis or incomplete fusion. 1 of these 15 patients had a refusion performed twice. Transpedicular fixation devices were used in 11 refusions and 4 patients were subjected to noninstrumented posterolateral refusion. After primary fusion, the transpedicular fixation device was removed from 41 patients as a routine procedure at the earliest after one year. 3 patients developed permanent foot drop, probably caused by an iatrogenic radicular lesion during the fusion.

Relief of back pain was commoner in the spondylolysis-olisthesis group than in the other two diagnosis groups (p 0.03). Return to work was commoner in the spondylolysis-olisthesis group than in the other two groups (Table 1). In the patient series as a whole, a good clinical result was not associated with the presence of radiographic fusion (Table 2). When comparing the single-level fusion group with the multi-level fusion group, there was a difference in the clinical outcome (p 0.05), but there was no significant difference in the radiographic healing and return to employment between the groups. In the multi-level fusion group, there was no association between a good clinical result and radiographic fusion (Table 3).

Table 1. Pain relief, fusion healing, consumption of analgesics and return to employment at follow-up related to diagnosis

	Relief of back pain n 63			Relief of leg pain n 63			Consumption of analgesics n 63			Radiographic healing n 63		Return to employment n 49 [a]	
	Good	Fair	Poor	Good	Fair	Poor	None	In-frequent	Regular	Solid	Pseud-arthrosis	Yes	Disability pension [b]
Spondylolysis-olisthesis	27	1	3	22	6	3	24	4	3	13	18	24	6
Degeneration [c]	12	6	5	8	9	6	11	7	5	13	10	4	12
Pain postlaminectomy	4	2	3	3	3	3	4	2	3	4	5	0	3

[a] Preoperatively retired patients were excluded.
[b] Including partial disability pension.
[c] Including facet joint arthrosis.

Table 2. Clinical outcome in terms of back pain related to fusion healing

	Spondylolysis-olisthesis		Degeneration/facet joint arthrosis		Pain postlaminectomy		Total	
	Solid fusion	Pseud-arthrosis	Solid fusion	Pseud-arthrosis	Solid fusion	Pseud-arthrosis	Solid fusion	Pseud-arthrosis
Good	12	15	8	4	2	2	22	21
Fair	0	1	2	4	0	2	2	7
Poor	1	2	3	2	2	1	6	5

Table 3. Pain relief, fusion healing, consumption of analgesics (n 63) and return to employment (n 49) [a] at follow-up related to the extent of the fusion

	Relief of back pain			Relief of leg pain			Consumption of analgesics			Radiographic healing		Return to employment [a]	
	Good	Fair	Poor	Good	Fair	Poor	None	In-frequent	Regular	Solid	Pseud-arthrosis	Yes	Disability pension [b]
Single-level fusion	8	3	2	8	3	2	7	4	2	6	7	7	2
Multi-level fusion	35	6	9	25	15	10	32	9	9	24	26	21	19

[a] Preoperatively retired patients were excluded
[b] Including partial disablity pension

In the spondylolysis-olisthesis group, all 21 patients with attempted reduction at the operation showed some correction of the slip on the first postoperative radiographs taken within a week after surgery. In 15 of these patients, the change was described as "marked", but in only 2 of the patients was the correction maintained during the whole follow-up period. In 3 patients, progressive disc degeneration proximal to the fusion was observed (cases 34, 53, 63). Among those 17 patients with a free intervertebral disc space below the fusion level, progressive disc degeneration was radiographically detected in 2 patients. In 24 cases progressive decrease in the disc height was seen in at least one of the intervertebral disc spaces at the fusion level.

Figure 1. Case 12. A 46-year-old woman with a spondylolisthesis of the 5th lumbar vertebra 2 days after reduction and posterolateral fusion with transpedicular AO fixation from L4 to S1.

General table

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	24	M	1	4	1	1	1	3	2	1	1	1,–	6	0	1	1	1,–	0	2	1	1	1
2	57	F	2	1	5	2	1	1	1	–	2,3	2,1	0;0	0;0	2	2,3	2,2	0;0	2	2	2	2
3	38	M	1	4	1	1	1	1	2	1	3	1,–	29	19	2	3	1,–	19	2	1	1	2
4	39	M	1	4	2	2	2	3	2	1	2,3	1,–	4;30	4;30	2	2,3	1,–	4;30	3	1	1	1
5	57	F	1	4	3	1	1	3	1	3	2	1,2	10	10	2	3	1,2	10	2	1	2	2
6	61	F	3	2	3	1	1	3	1	–	1	1,1	0;14	0;3	2	1	1,1	0;3	2	1	1	1
7	53	F	2	4	5	2	2	3	1	3	1,2	1,3	0;21	0;15	1	1,3	1,3	0;35	3	3	3	3
8	55	M	2	4	2	2	3	3	1	3	3,4	1,–	0;0	0;0	1	4,4	1,–	0;0	4	1	1	1
9	39	M	1	4	2	2	2	4,3,4,2,3	1	3	1,1	1,–	0;4	0;4	2	1,1	1,–	0;4	4	3	3	3
10	54	M	2	4	2	2	2	5	2	1	2,2	1,–	24;0	19;0	1	3,3	1,–	28;0	4	1	1	1
11	40	M	1	4	2	2	1	3	2	1	1,2	1,–	13;16	13;4	2	2,3	1,–	13;10	3	1	1	1
12	46	F	1	4	2	2	2	2,3	2	1	1,3	1,–	0;44	0;13	1	3,3	1,–	0;40	5	1	1	1
13	31	M	1	4	2	2	1	3,4,3	2	1	1,1	1,–	0;21	0;0	1	1,3	1,–	0;15	6	1	1	1
14	52	F	1	4	2	2	1	3	2	1	1,3	1,–	0;52	0;52	1	1,4	1,–	0;52	4	1	2	3
15	57	F	3	1	2	2	1	3	1	–	1,3	1,–	0;31	0;21	2	1,3	1,–	0;21	5	3	3	3
16	56	M	2	2	2	2	3	3	1	–	2,3	1,–	15;0	15;0	1	3,3	1,–	15;0	4	1	2	2
17	68	F	3	1	2	2	1	3	1	–	3,4	1,–	37;43	0;43	2	4,4	1,–	43;43	5	1	2	2
18	21	F	1	4	2	2	1	3	2	1	1,1	1,–	5;0	0;0	2	1,1	1,–	0;0	4	3	3	2
19	54	F	3	4	2	2	1	4,3	1	3	1,4	1,–	0;51	0;51	1	1,4	1,–	0;51	3	3	3	3
20	42	M	2	4	3	1	1	3	1	3	3	1,3	10	0	2	3	1,3	3	2	2	2	2
21	32	M	2	4	2	2	2	3	1	3	1,3	1,–	11;0	11;0	2	1,3	1,–	11;0	5	2	2	1
22	57	M	2	4	2	2	2	6,3	1	3	2,3	1,–	0;40	0;40	2	2,3	1,–	0;40	2	1	2	2
23	51	F	2	4	2	2	1	5	1	3	2,2	1,–	0;0	0;0	1	3,3	1,–	0;0	3	3	3	3
24	57	F	1	4	5	2	2	5	1	3	1,3	1,4	0;35	0;30	2	1,4	1,4	0;30	5	1	1	1
25	38	F	2	1	3	1	1	3	1	–	3	1,1	0	0	2	3	1,2	0	5	3	3	3
26	57	F	2	2	3	1	2	1	1	–	2	2,1	15	10	2	2	2,1	10	3	2	2	2
27	42	M	1	4	2	2	1	3	1	3	3,2	1,–	11;18	11;7	2	3,2	1,–	11;15	5	2	2	2
28	28	F	1	4	2	2	1	3	2	1	1,1	1,–	0;5	0;5	2	1,1	1,–	0;5	4	1	1	1
29	30	M	1	4	2	2	1	3	2	1	1,1	1,–	10;17	10;14	1	2,2	1,–	10;19	4	1	1	1
30	52	M	1	4	1	1	1	2,3	2	1	3	1,–	17	0	2	3	1,–	13	4	1	1	1
31	22	M	1	4	2	2	1	3	2	1	1,1	1,–	0;23	0;9	1	1,1	1,–	0;16	4	1	1	1
32	40	F	1	4	3	1	1	4,3	2	1	3	1,3	38	0	1	3	1,3	21	5	1	1	1
33	53	F	1	1	4	3	3	4,3	1	–	1,1,4	1,–	0;0;37	0;0;37	2	1,1,4	1,–	0;0;37	4	1	1	1
34	68	F	2	3	5	2	2	3	1	–	3,4	1,3	0;18	0;18	2	3,4	3,3	14;27	4	1	2	1
35	53	F	2	4	2	2	1	3	1	3	3,2	1,–	0;0	0;0	1	3,2	1,–	0;0	5	1	1	1
36	26	M	1	4	2	2	3	1	2	1	3,3	1,–	0;60	0;60	2	3,4	1,–	0;60	4	1	1	1
37	39	F	1	4	2	2	1	3	2	1	1,3	1,–	0;32	0;32	2	1,3	1,–	0;32	4	1	1	1
38	53	M	3	2	3	1	1	3	1	–	3	1,1	19	4	1	3	1,1	14	3	3	3	3
39	26	M	1	4	3	1	1	3	2	1	3	1,4	9;28	0;12	1	3	1,4	0;22	2	1	1	1
40	49	F	2	4	2	2	1	3	1	3	3,3	1,–	0;0	0;0	1	3,3	1,–	0;0	4	1	2	1
41	24	M	2	4	3	1	1	3	2	1	2	1,2	0	0	1	3	1,2	0	5	2	1	1
42	67	F	3	1	2	2	1	3	1	–	3,3	3,–	0;28	0;19	2	4,3	3,–	0;28	5	2	2	2
43	48	F	2	4	2	2	1	3	1	3	2,2	2,–	0;17	0;5	2	3,2	2,–	15;26	4	3	3	3
44	70	F	3	3	5	2	1	3	1	–	3,3	2,3	15;33	0;22	1	3,3	2,3	9;28	5	1	1	1
45	36	F	1	4	2	2	2	3	2	1	1,3	1,–	0;32	0;28	2	1,3	1,–	0;30	4	1	1	1
46	46	F	2	4	5	2	2	3,4,3	1	2	1,2	1,3	0;23	0;12	2	1,3	1,3	0;23	3	1	3	2
47	43	M	1	4	2	2	2	3	1	3	3,3	1,–	16;19	13;10	2	3,3	1,–	15;18	5	1	2	1
48	53	F	3	4	2	2	1	3	1	3	1,4	1,–	0;37	0;37	2	1,4	1,–	0;37	2	2	1	1
49	34	F	2	4	3	1	1	3	2	1	3	1,2	26	12	1	3	1,2	16	3	1	1	1
50	43	F	1	4	2	2	1	3	2	1	1,2	1,–	0;22	0;14	1	1,2	1,–	0;18	4	1	1	1
51	31	M	1	4	2	2	1	3,4	2	1	1,3	1,–	0;20	0;18	2	1,3	1,–	0;18	4	1	2	1
52	45	F	2	4	2	2	1	3	1	3	3,3	1,–	0;0	0;0	1	3,4	1,–	0;0	3	2	2	2
53	46	M	2	4	5	2	2	3	1	3	3,3	1,3	0;0	0;0	2	4,4	2,3	0;0	3	1	1	1
54	34	M	1	4	2	2	1	3	2	1	1,2	1,–	0;18	0;13	2	1,3	1,–	0;22	5	1	1	1
55	34	M	2	4	2	2	2	4,3	2	1	3,3	1,–	0;0	0;0	1	3,3	1,–	0;0	3	1	1	1
56	37	F	2	1	2	2	3	2,3,4	1	–	1,2	1,–	0;0	0;0	1	1,2	1,–	0;0	4	3	3	3
57	39	M	1	4	2	2	1	4,5	2	1	2,3	1,–	0;22	0;22	2	2,3	1,–	0;22	2	1	1	1
58	45	M	3	4	2	2	1	3,4,2	1	3	3,2	1,–	0;0	0;0	1	4,2	1,–	0;0	2	1	2	1
59	25	M	1	4	2	2	1	2,4,3	2	1	1,3	1,–	0;28	0;22	1	2,3	1,–	0;32	4	1	2	1
60	45	M	1	4	2	2	1	3	1	3	2,3	1,–	0;12	0;12	1	2,3	1,–	0;12	3	3	3	3
61	16	M	1	4	2	2	1	1	2	1	1,3	1,–	0;58	0;52	1	1,3	1,–	0;52	2	1	1	1
62	50	M	1	4	2	2	2	3	2	1	2,3	1,–	14;28	10;18	1	3,4	1,–	14;22	2	1	1	1
63	68	M	2	3	5	2	1	3	1	–	2,2	1,1	0;0	0;0	1	2,2	2,1	0;0	2	1	1	1

Legend to General table

A Age at operation
B Sex
C Diagnosis
  1 Spondylolysis-olisthesis
  2 Degenerative disc disease/ facet joint arthrosis
  3 Pain postlaminectomy/ decompression
D Employment preoperatively
  1 Disability pension due to low back disorders
  2 Disability pension due to disease other than low back pain
  3 Retired on reaching pensionable age
  4 At work or on temporary sick leave
E Fusion level
  1 L5-S1
  2 L4-S1
  3 L4-L5
  4 L3-S1
  5 L3-L5
F Number of fusion levels
G Concomitant decompression
  1 None
  2 One level
  3 Two levels
H Subsequent surgery before follow-up (if several reoperations are performed, numbers representing them are in chronological order)
  1 No
  2 Reoperation due to implant failure/misplacement
  3 Implant removal
  4 Refusion with transpedicular instrumentation
  5 Refusion without transpedicular instrumentation
  6 Decompression
I Return to employment after fusion
  1 No
  2 Yes
J Definitive disability pension (concerns only preoperatively employed patients)
  1 None
  2 Partial
  3 Full
K Preoperative disc degeneration at intended fusion level (concerning multi-level fusions, the numbers are in craniocaudal order)
  1 Normal disc height
  2 Disc height decreased by less than 50%
  3 Disc height decreased by at least 50%
  4 Disc effaced
L Preoperative disc degeneration above and below (if any) intended fusion level (above first, below second)
  As above (K)
M Preoperative olisthesis of the vertebral bodies concerned, percent (in multi-level fusions, the vertebrae are in craniocaudal order)
N Immediate postoperative olisthesis (observed within 1 week postoperatively)
  As above (M)
O Consolidation
  1 Solid
  2 Pseudarthrosis
P Disc degeneration at fused level at follow-up
  As above (K)
Q Disc degeneration above and below (if any) fused level (above first, below second) at follow-up
  As above (K)
R Olisthesis at follow-up, percent (in multi-level fusions, the vertebrae are in craniocaudal order)
S Follow-up time (years)
T Clinical result, back pain
  1 Good
  2 Fair
  3 Poor
U Clinical result, leg pain
  As above (T)
V Need for analgesics
  1 None
  2 Infrequently
  3 Daily and regular

Discussion

The use of internal fixation is well established for correction of scoliosis and stabilization of spine fractures and fracture dislocations (Dick 1987, Aebi et al. 1988, Cotrel et al. 1988, Olerud et al. 1988) and is also gaining acceptance for stabilization of nontraumatic disorders. With addition of stable internal fixation to the lumbosacral fusion procedure, it can be assumed that the patient will obtain some relief of pain soon after the operation before the consolidation of the fusion. A recent systematic review of the literature concerning lumbar spinal fusion (Turner et al. 1992) has demonstrated a surprisingly wide range of clinically successful outcomes in different studies, from 11–95%, a high complication rate associated with lumbar spine fusion procedure and no superiority of anyone fusion technique over the others. However, there are only a very limited number of studies dealing with the use of transpedicular devices, such as the AO internal fixator in the fusion of the lumbosacral spine for nontraumatic indications (Dick 1987, Esses 1989, Boos et al. 1992). None of those studies was included in the aforementioned meta-analysis by Turner et al. (1992).

Concerning the indications for fusion, the size of different diagnosis groups and the follow-up times, a fairly similar study was reported by Axelsson et al. (1994). They performed fusion without instrumentation, a fact that makes comparison with our study of particular interest. Our fusion rate was lower, the clinical outcome was about the same, but we had more postoperative complications and performed more refusions. However, according to other publications, complications related to various lumbar spinal fusion techniques, including noninstrumental, are frequent (Boos et al. 1992, Deyo et al. 1992, Turner et al. 1992). The high number of mainly device-related complications observed in our study may partially have been the result of the novelty of the technically demanding method of transpedicular fixation.

No uniform method exists for the radiographic assessment of the fusion (Steinmann and Herkowitz 1992). Thus, the differences between the nonunion rates could be the result of different techniques for radiographic evaluation. Only anteroposterior and lateral plain radiographs were used by Axelsson et al. (1994). In our study there was no correlation between solid bony healing and a good clinical outcome. This accords with previous studies on lumbar spinal fusions using various operative methods (DePalma and Rothman 1968, O'Beirne et al. 1992), whereas it is not consistent with other observations (Turner et al. 1992, Axelsson et al. 1994). Although asymptomatic

pseudarthroses are well documented, in a long-term evaluation of 205 patients with lumbar spine fusion, pseudarthrosis was found to be a contributing factor in 18 of the 23 patients requiring reoperation (Frymoyer et al. 1978). Consequently, the main problem in the treatment of low back pain has been said to be the difficulty in selecting the right patients for operative treatment (Nachemson 1992). However, as long as there is no reliable method of establishing the degree of fusion achieved after these operations, the question remains unsettled.

The number of patients reporting relief of pain is higher in our study than the number of patients returning to work, which accords with the observations of some previous authors (Kiviluoto et al. 1985, O'Beirne et al. 1992). One factor contributing to the fact that most of our patients with spondylolysis-olisthesis returned to work might be the relatively young mean age of the patients.

An important finding was that attempts to reduce spondylolisthesis seem to be meaningless with transpedicular fixation, since the maintenance rate of an achieved reduction was very low. In a previous investigation, 20 out of 22 juvenile patients having anterior interbody fusion using AO lag screw fixation maintained the reduction of the deformity achieved (O'Brien et al. 1994). Spinal lumbosacral fusion does not seem to enhance the disc degeneration above the fusion level. Axelsson et al. (1994) observed progressive disc degeneration above the fusion level in 12/61 cases, which is slightly more than in our study.

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