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ORIGINAL ARTICLE

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Posterior reduction and anterior lumbar interbody fusion in symptomatic low-grade adult isthmic spondylolisthesis: short-term radiological and functional outcome

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Abstract The aim of this study was to evaluate the short-term radiological and functional outcome of surgical treatment for symptomatic, low-grade, adult isthmic spondylolisthesis. Twelve patients underwent a monosegmental fusion for symptomatic spondylolisthesis. Posterior reduction with pedicle screw instrumentation was followed by second-stage anterior interbody fusion with a cage. All patients underwent a decompressive laminectomy. At an average of 2.1 (range 1.4–3.0) years following surgery, all patients completed the Oswestry questionnaire, VAS back pain score and a questionnaire detailing their work status. Radiographs were evaluated for maintenance of reduction and fusion. The patients (nine male, three female; mean age 42, range 22–54 years) had experienced preoperative symptoms for an average of 38 (range 6–96) months. An average preoperative slip of 21% (range 11–36%) was reduced to 7% (range 0–17%). Reduction of slip was maintained at latest follow-up, at which time the average VAS score was 2.8 (range 0–8) and the average Oswestry score was 13 (range 0–32). All patients achieved a successful fusion. There were no postoperative nerve root deficits. All patients stated that they would be prepared to undergo the same procedure again if required. Seventy-five percent returned to their pre-symptom work status. Our findings suggest that posterior reduction and anterior fusion for low-grade adult isthmic spondylolisthesis may yield good functional short-term results. A high fusion rate and maintenance of reduction with a low complication rate may be expected. Further follow-up is necessary to evaluate long-term outcome.

Keywords Adult spondylolisthesis · Spinal fusion · Prostheses and implants

Introduction

Several options for surgical treatment of adult isthmic spondylolisthesis are available. Decompression alone [11], decompression and fusion [13, 18, 30, 34], and fusion alone [3, 7, 18, 26, 39] have been recommended. Good clinical results have been achieved with posterior fusion alone without instrumentation [18, 22, 36], with instrumentation [4, 13, 21, 30, 34, 39, 44] as well as with anterior fusion alone [5, 6, 20, 21, 40, 41] or with circumferential fusion [40, 41]. Circumferential fusion reduces the pseudoarthrosis rate [22, 40], and Kim [22] has shown a strong correlation between successful fusion and successful functional outcome. The literature on this subject is, however, confusing, because of differences in patient groups, etiology and the severity of the spondylolisthesis that was treated. The discussion on how to surgically treat adult isthmic spondylolisthesis has not reached any conclusion. In our clinic we treated patients for low-grade, adult isthmic spondylolisthesis with posterior reduction using pedicle screws followed by second-stage anterior lum-

bar interbody fusion. The anterior interbody fusion was added to treat the disc degeneration, to create a stable construct, to stabilize reduction and lordosis, and to improve fusion rates.

The purpose of this study is to evaluate the short-term radiological and functional outcome of this treatment for low-grade isthmic spondylolisthesis. The treatment should yield good short-term results to justify this aggressive surgical approach.

Materials and methods

Between March 1997 and September 1998, 12 patients had monosegmental posterior and anterior fusion for adult isthmic spondylolisthesis. Patients were reviewed postoperatively with permission from the hospital's ethical committee. The inclusion criteria for the study are listed in Table 1.

Surgical technique

Patients underwent a posterior decompressive laminectomy of the lytic lamina, pedicle screw instrumentation, and reduction using the Universal Spine System (USS, Synthes/Mathys Medical, Bettlach). In a second-stage procedure 1 week later, an anterior interbody fusion with SynCage (Synthes/Mathys Medical, Bettlach) filled with the autologous lamina bone graft was performed (Fig. 1, Fig. 2). This standard technique was used in all procedures by three different surgeons (M.S., P.P., M. d K.).

The decompressive laminectomy was performed to decompress the spinal canal and nerve roots, to facilitate reduction of the spondylolisthesis, and to help identify the pedicle of the lytic vertebra from within the spinal canal. The pedicle screw instrumentation used permits reduction through posterior translation of the lytic vertebra and distraction of the vertebral segment.

The autologous lamina was cleaned of all soft tissue and stored in the freezer until the second surgery. The anterior procedure was performed through a retro-peritoneal approach using a left paramedian incision. A SynCage filled with the autologous lamina bone graft was introduced into the intervertebral disc space under distraction. Meticulous removal of disc material using long sharp curettes and preservation of the strong vertebral endplates by avoiding the use of mechanical instruments like burrs is recommended to enhance fusion and prevent subsidence of the interbody cage [32, 38].

The surgical procedure was staged to avoid one long surgical session and to be able to check patients for possible root compromise due to pedicle screw malposition and distraction. While waiting for the anterior procedure, patients were mobilized with a lumbar support. After the anterior procedure, patients were mobilized with the same lumbar support on the first postoperative day, and they left the hospital 3–5 days after the second procedure. The lumbar support was used for 3 months.

Table 1 Inclusion criteria for monosegmental posterior reduction and anterior fusion for low-grade adult isthmic spondylolisthesis

1.	Low-grade isthmic spondylolisthesis (less than 50% slip)
2.	Age >18 years
3.	Normal discography of adjacent discs
4.	No previous lumbar spinal surgery
5.	Failure of conservative treatment (after 6 months)
6.	Minimum 1-year follow-up

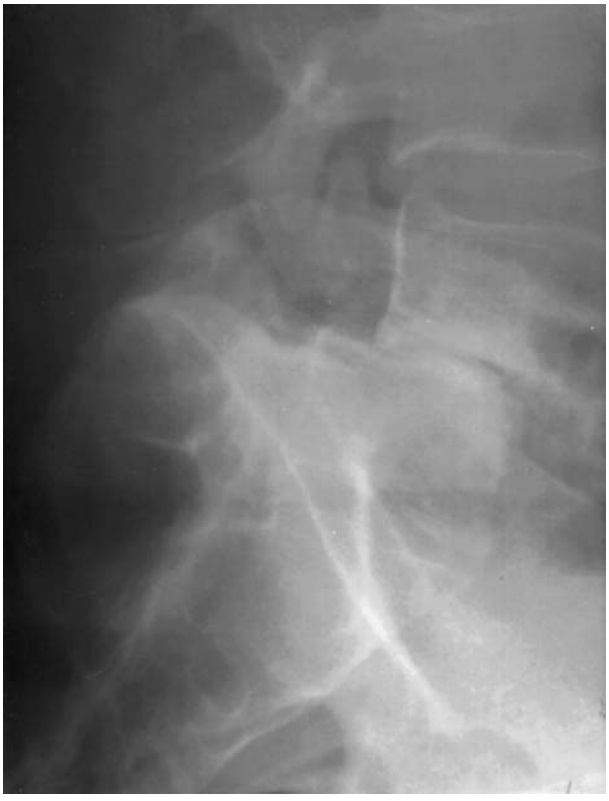

Fig. 1 Spondylolisthesis L4–5 with 24% slip preoperatively

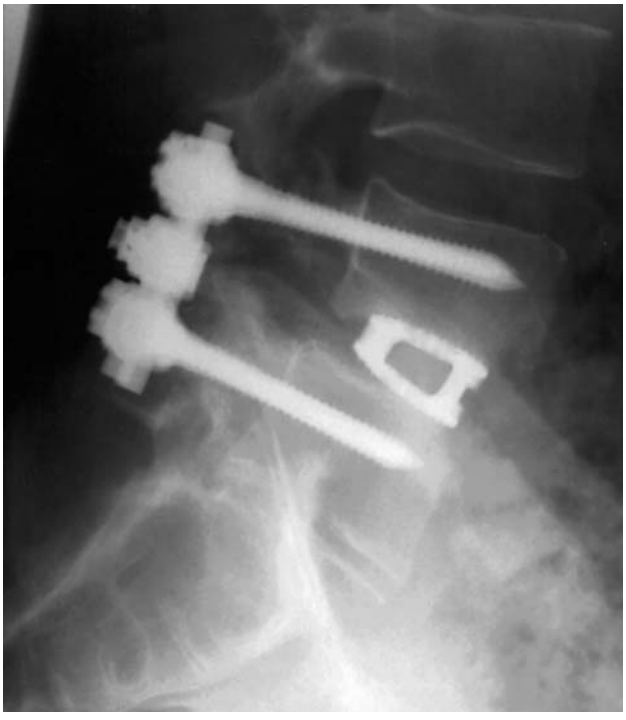

Fig. 2 Reduced spondylolisthesis L4–5 after pedicle screw instrumentation and cage

Table 2 Fusion level, characteristics and length of follow-up per patient (*LO* lumbar orthosis, *Ph* physiotherapy, *M* medication)

Patient	Sex	Age	Fusion level	Preoperative symptoms			Duration of symptoms (months)	Conservative treatment	Preoperative occupation	Follow-up (years)
				Low back pain	Leg pain					
					R	L				
1.	M	54	L4–5	+	+	–	96	LO/Ph	Manager	1.9
2.	M	37	L4–5	+	–	–	36	LO/Ph	Clerk	1.8
3.	M	44	L4–5	+	–	+	48	LO/M	Director	1.6
4.	F	53	L3–4	+	+	+	21	LO/Ph	Housewife	1.7
5.	M	46	L4–5	+	+	–	48	LO/Ph	Carpenter	1.6
6.	M	37	L4–5	+	+	–	6	M	Veterinary surgeon	1.9
7.	M	48	L4–5	+	+	–	6	Ph/M	Laborer	2.2
8.	F	44	L3–4	+	–	–	48	LO/Ph/M	Sales woman	3.0
9.	M	33	L3–4	+	–	+	12	LO/Ph/M	Nurse	2.8
10.	F	23	L4–5	+	–	+	24	LO/Ph/M	Student	2.6
11.	M	43	L3–4	+	+	+	24	LO/Ph	Laborer	2.3
12.	M	54	L4–5	+	–	–	48	LO/Ph/M	Construction supervisor	1.4

Evaluation

For this study, patients were requested to visit the clinic. Patients completed the Oswestry questionnaire and VAS back pain score and answered additional questions about operative procedure satisfaction, return to work at 12 months and at latest follow-up, including hours of work per week, and a current job description.

The operative report was checked for blood loss, operative time and level of fusion. Clinical notes were reviewed for clinical presentation, duration of symptoms, nonoperative management, pre-symptom occupation, and post-operative complications.

All patients underwent routine lumbar spine X-rays and discography preoperatively. Routine radiographs were made at the 3-month follow-up, and at the yearly postoperative follow-up. At the latest follow-up visit, radiographs were taken.

Preoperative and postoperative spondylolisthetic slips were expressed as the percentage of the vertebral body anteroposterior (AP) diameter. More precisely, forward displacement in millimeters was expressed as the percentage of the spondylolisthetic vertebral body AP diameter. The latest follow-up radiographs were used to assess fusion and maintenance of reduction. Because of the transpedicular fixation, flexion-extension radiographs were not obtained, as they would not provide any additional information [25]. Vertebral segments were considered to be fused if there was no visible subsidence of the cage and no halo or sclerosis around the cage. Other criteria for fusion were the absence of slip recurrence, of screw loosening, and of metal failure. All radiographs were evaluated by an independent observer (J.L.), who was not involved in the surgery.

Results

Relevant demographic data, fusion level, symptoms, occupation, and follow-up are shown in Table 2. The average operative time for the posterior reduction and laminectomy was 82 (range 60–120) min and for the anterior procedure 90 (range 60–160) min. The average blood loss was 188 (range 100–300) ml for the posterior surgery and 306 (range 20–700) ml for the anterior fusion. The mean spondylolisthetic slip of 21% (11–36%) pre-operatively was reduced to a mean postoperative slip of 7% (0–17%). The slip reduction was maintained postoperatively as measured after 3 months and at the latest follow-up (Fig. 3) According to the criteria mentioned above, all patients achieved a successful fusion. There was no metal failure at all, no visible subsidence of the cages, and no loosening of implants.

All patients reported that they would be prepared to undergo the same procedure again, if necessary. The average postoperative VAS score for back pain at the latest follow-up was 2.8 (range 0–8), the Oswestry score was 13 (range 0–32). Correlation of percentage of slip at the last follow-up with the clinical results was not significant either for VAS score for low back pain or for Oswestry score.

Twelve months postoperatively, 58% of patients had returned to their pre-symptom work status; this percentage increased to 75% at the latest follow-up. At the latest follow-up, three patients (patients 1, 7, 10) had received workers' compensation.

There were no nerve root deficits postoperatively, and the male patients did not experience retrograde ejaculation. One patient had a urinary tract infection, which was resolved with antibiotics. One patient had a persistent warm left leg due to sympathic nerve chain injury.

Discussion

We acknowledge the sample size was small and the follow-up short in this study. However, we routinely perform posterior and anterior surgery in our clinic for low-grade adult isthmic spondylolisthesis, and if the results had been disappointing after the short follow-up of 2 years, we would have reconsidered using this surgical treatment regimen. In this small study group with a short follow-up, we found a high fusion rate and good functional outcome with

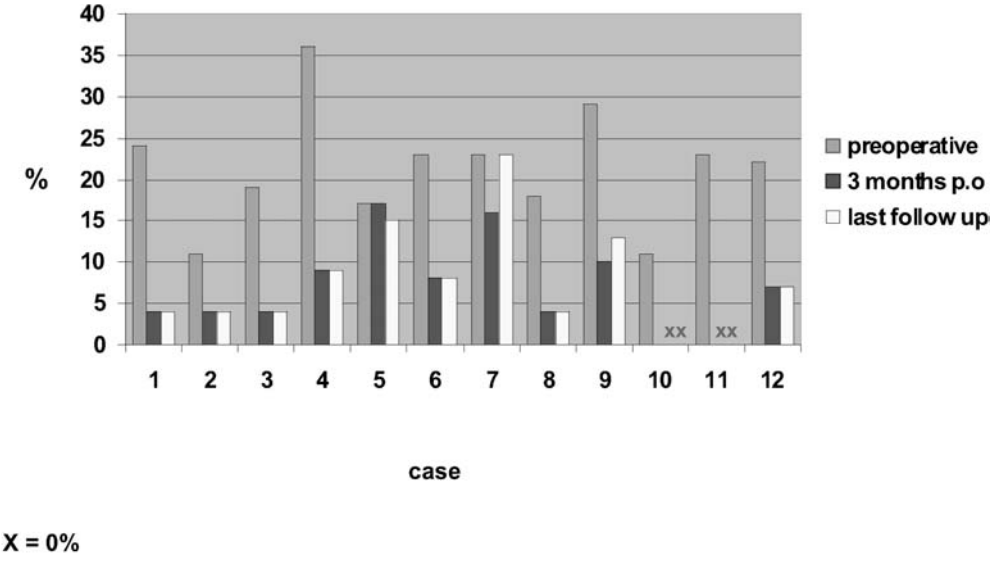

Fig. 3 Percentage spondylolisthetic slip preoperatively, at 3 months and at last follow-up

laminectomy and posterior pedicle screws (USS, Synthes/Mathys Medical, Bettlach) instrumented reduction followed by anterior interbody fusion with SynCage (Synthes/Mathys Medical, Bettlach). Low back pain and leg pain are the usual symptoms of low-grade isthmic spondylolisthesis. The back pain is thought to be due to disc degeneration [19, 23, 31, 43]; the radicular symptoms result from nerve root compression [12, 17]. A prospective randomised study [27] compared surgery versus an exercise program in adult isthmic spondylolisthesis. The authors concluded that surgical management improved function and relieved pain more efficiently than an exercise program. In the second part of this study [28], the clinical outcome for instrumented and non-instrumented fusion was reported. Supplementary pedicle screw instrumentation did not add to the fusion rate or improve the clinical outcome.

Our surgical strategy consists of decompression of the spinal canal and nerve roots followed by excision of the degenerated disc. We prefer a two-stage procedure to avoid one long surgical session and to be able to check patients for root compromise. Although this means two operations, the patients seem to tolerate this well, as all patients stated that they would be prepared to repeat the surgical procedure again. Alternatively, the procedure could be planned as a single session. Lumbar interbody fusion using autograft or allograft alone is associated with graft collapse, extrusion and subsidence [29]. Interbody fusion cages, because of their structural integrity, may reduce the incidence of graft collapse [33]. Posterior reduction prior to anterior interbody fusion helps to restore sagittal alignment, will decompress the spinal canal effectively, and will maintain slip reduction.

The alternative technique to achieve similar objectives would be posterior lumbar interbody fusion (PLIF). Although PLIF could save time and prevent further surgery anteriorly, it is associated with a high rate of complications that include dural tears, graft displacement, epidural fibrosis, neurologic deficit and extensive bleeding from the venous plexus [2, 15, 33].

After the anterior surgery, a totally stable construct was achieved, and patients could be rapidly mobilized with a lumbar support. We feel that the stability of the construct will help to rehabilitate patients postoperatively.

In the present study we used the criteria described by McAfee [25] to assess fusion. Using these criteria, indirect evidence of fusion is described. All patients met these criteria for fusion in our study. Various fusion rates for anterior lumbar interbody fusion have been reported, ranging from 56 to 95% [5, 29, 35, 37, 41]; for posterior lumbar fusion, rates of between 77 and 95% [3, 34, 39] have been described. Despite the difficulty of assessing fusion using cage technology, the indirect evidence suggests a 100% fusion rate in our study.

Although satisfactory functional outcome of surgical treatment of adult isthmic spondylolisthesis has been reported extensively in the literature [5, 6, 16, 18, 24, 41], it is difficult to compare our results with these studies, as all authors used different functional outcome criteria. The percentage of patients in our study returning to their original work is almost identical to that reported by Cheng et al. [5] and Tsuji et al. [41], and it is higher than that reported by Chang et al. [4]. Carragee [3], who used inclusion criteria similar to ours, found a postoperative VAS score of 2.2 (range 0–8) for back pain, which is very similar to our postoperative VAS score of 2.8 (range 0–8) for back pain.

Although some studies indicate that fusion may be related to good clinical outcome [22], successful fusion does not appear to be the main criterion for good clinical outcome, as up to 40% of patients with fusion do not have good functional outcomes [9, 37, 42]. We feel that treating the disc degeneration is an essential factor in relieving

back pain in adult patients. In children and adolescents, clinical symptoms are more often the result of instability than of disc degeneration [1, 10, 14, 23]. Although in our study all patients met the criteria for fusion, three had persistent pain. We are, however, encouraged by the results we have obtained with this short-term follow-up, but we are aware of the limitations of this study and a further review at 5 years is necessary. We are satisfied with the low complication rate in the present study. There were no postoperative nerve root deficits, which, in our opinion, indicates that posterior reduction is a safe procedure. We now use this surgical strategy for more severe slips. However, for high-grade spondylolisthesis, more neurological complications have been described [8, 16] and are to be expected.

Conclusion

Symptomatic low-grade adult isthmic spondylolisthesis treated with posterior laminectomy and pedicle screw instrumented reduction followed by anterior interbody fusion with a SynCage may yield a good functional outcome. A high fusion rate and maintenance of reduction may be expected with a low complication rate. A 5-year follow-up evaluation of this patient group is necessary and scheduled.

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