Sacrospinalis muscle-pedicle bone graft in posterolateral fusion for spondylolisthesis

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Summary. *Twenty three patients with lumbar spondylolisthesis (6 Grade I, 14 Grade II and 3 Grade III) with low back pain, and radicular pain in 14, were treated surgically when they failed to respond to conservative treatment. Their average age was 33.2 years. Bilateral posterolateral spinal fusions with autologous iliac bone chips, supplemented by a sacrospinalis muscle-pedicle bone graft on the left side, were undertaken after laminectomy and foraminotomy in all except in two adolescents, where laminectomy and foraminotomy were avoided. The period of follow-up varied from 26 to 126 months (average 65.3 months). The results in 11 (48%) patients were excellent, 9 (39%) were good, 2 (9%) fair and one (4%) poor. There was a higher incidence (87%) of good quality of osseous fusion on the left side, where the sacrospinalis muscle-pedicle bone graft was used, compared to the right, where 70% of fusions were satisfactory. Function improved in 91% of the patients. Neither scoliosis nor weakness of the extensor muscles of the back developed due to reanchorage of the sacrospinalis muscle to the lumbosacral spines.*

Résumé. *Une greffe osseuse pédiculée sur les muscles paravertébraux dans l'arthrodèse postéro-latérale pour spondylolisthésis. Vingt trois cas de spondylolisthésis lombaires (6 stade I, 14 stade II et 3 stade III), avec lombalgie et pour 14 d'entre-eux, radiculalgie ont été opérés après échec d'un traitement conservateur. L'âge moyen était de 33,2 ans. Une arthrodèse postéro-latérale bilatérale avec greffe iliaque autologue, augmentée par une greffe pédi-*

culée sur les muscles sacro-spinaux du côté gauche a été faite après laminectomie et foraminotomie dans tous les cas, sauf chez 2 adolescents où lminectomie et foraminotomie ont été évitées. La période de suivi va de 26 à 126 mois (moyenne 65,3 mois). Les résultats ont été évalués en appréciant la disparition des douleurs, la fusion radiologique et la fonction. 11 patients (48%) ont eu un résultat excellent, 9 patients (39%) un résultat bon, 2 patients (9%) un résultat médiocre et 1 (4%) un résultat mauvais. La fusion osseuse a été constatée dans 87% du côté où la greffe pédiculée a été faite comparé au 70% de fusion de l'autre côté. Les résultats fonctionnels se sont améliorés dans 91% des cas. Il n'y a pas eu de faiblesse musculaire des muscles extenseurs ni de développement de scoliose secondairement à la réinsertion des muscles sacrospinaux aux apophyses épineuses voisines.

Introduction

Surgical treatment for spondylolisthesis in adolescents and young adults is indicated in patients who have persistent pain in the lower back, buttock or thigh with or without sciatica, if the pain is resistant to conservative treatment. Surgery is also indicated in asymptomatic patients where the vertebral slipping is 30% or more [2, 3, 16]. In general, about 20% of patients with symptomatic spondylolisthesis require operation. The results of in-situ arthrodesis have been reported to be excellent even after long term follow up [5, 6, 8, 9].

Posterolateral fusion [14, 15] implies placement of autogenous iliac bone chips in the region of the transverse processes, the alae of sacrum and lateral part of the laminae. Biomechanical studies have shown that

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Table 1. Details of 23 patients

C/No.	Age/ sex	Level/grade	Preoperative		F.U. (months)	Postoperative		Radiology				Results (subjective)	
			Pain (back/rad.)	Neurodeficit M/S/R		Pain (back/rad.)	Neurodeficit M/S/R	Preoperative		Postoperative			
								Slip (mm/%)	Disc space Ht (mm)	Slip (mm/%)	Disc space Ht (mm)		Fusion LT/RT
1.	40 M	L ₅ S ₁ /II	+/-	-/-/-	126	-/-	-/-/-	6 (30%)	6.0	8 (37%)	6.0	+/+	Good
2.	26 M	L ₄ L ₅ /II	+/+ (Bilat)	-/-/-	118	-/-	-/-/-	7 (43%)	6.3	8 (49%)	4.3	+/+	Excellent
3.	28 F	L ₅ S ₁ /II	+/-	-/-/-	104	+/+	-/-/-	9.5 (40%)	7.0	9 (38%)	6.3	+/+	Good
4.	16 M	L ₄ L ₅ /II	+/-	-/-/-	94	-/-	-/-/-	8.0 (27%)	5.8	8 (27%)	5.8	+/+	Excellent
5.	35 F	L ₅ S ₁ /II	+/-	-/-/-	86	-/-	-/-/-	6.0 (26%)	6.0	5 (22%)	5.6	+/+	Excellent
6.	37 F	L ₄ L ₅ /I	+/+	-/-/-	82	-/-	-/-/-	8.0 (20%)	8.0	12 (27%)	5.0	+/+	Excellent
7.	39 F	L ₄ L ₅ /I	+/+ (Bilat.)	+/-/-	78	-/-	-/-/-	5 (14%)	5.0	4 (13%)	4.0	+/+	Good
8.	35 F	L ₅ S ₁ /II	+/-	-/-/-	74	-/-	-/-/-	7.5 (31%)	6.2	7 (29%)	5.6	+/+	Excellent
9.	48 M	L ₄ L ₅ /I	+/+	-/-/-	70	-/-	-/-/-	4 (13%)	4.7	8 (25%)	4.7	+±	Good
10.	17 M	L ₅ S ₁ /I	+/-	-/-/-	71	-/-	-/-/-	7 (21%)	7.0	8 (24%)	7.0	+/+	Excellent
11.	24 M	L ₄ L ₅ /I	+/+ (Bilat.)	-/-/-	68	-/-	-/-/-	4 (10%)	9.0	5 (13%)	9.0	+7±	Good
12.	37 M	L ₅ S ₁ /II	+/-	-/-/-	64	-/-	-/-/-	16 (43%)	4.0	3 (8%)	3.3	±/-	Fair
13.	24 F	L ₄ L ₅ /III	+/+	-/-/-	62	-/-	-/-/-	21 (56%)	6.4	21 (56%)	6.4	+±	Good
14.	21 M	L ₅ S ₁ /III	+/+	-/-/-	61	-/-	-/-/-	27 (70%)	6.0	20 (51%)	2.6	+/+	Excellent
15.	45 M	L ₅ S ₁ /II	+/+	-/-/-	54	+(const)/+	-/-/-	15 (47%)	4.6	17 (53%)	3.0	-/-	Poor
16.	26 M	L ₄ L ₅ /III	+/+ (Bilat)	+/-/-	50	-/-	-/-/-	24 (64%)	3.2	21 (56%)	3.0	+/+	Excellent
17.	30 F	L ₅ S ₁ /I	+/+	-/-/-	46	-/-	-/-/-	5 (15%)	9.0	7 (20%)	7.0	+±	Good
18.	35 F	L ₅ S ₁ /II	+/+	-/-/-	40	-/-	-/-/-	8 (28%)	5.0	9 (33%)	5.0	+/+	Good
19.	40 F	L ₅ S ₁ /II	+/+	+/-/-	37	-/-	-/-/-	14 (35%)	4.0	11 (28%)	2.5	+/+	Excellent
20.	45 F	L ₅ S ₁ /II	+/+	-/-/-	32	+/+	-/-/-	13 (38%)	6.0	18 (45%)	4.0	±±	Fair
21.	55 F	L ₅ S ₁ /II	+/-	-/-/-	30	-/-	-/-/-	12 (38%)	2.0	9 (26%)	3.0	+/+	Excellent
22.	20 F	L ₄ L ₅ /II	+/+	-/-/-	29	-/-	-/-/-	7 (26%)	8.0	7 (26%)	9.0	+/+	Excellent
23.	40 F	L ₄ L ₅ /II	+/+	-/-/-	26	-/-	-/-/-	10.5 (26%)	3.7	10 (25%)	3.5	+/+	Good

Abbreviations: M, Motor; S, Sensory; R, Reflexes; Rad., Radicular; ±, Doubtful; Const., Constant; Case 4, 10, Laminectomy not done; Occas., Occasional; Interm, Intermittent

the stabilisation provided by posterolateral or anterior interbody fusion is superior to that of pure posterior fusion [7]. Posterolateral fusion is the best method for achieving good stabilisation of the fused segment and has little effect on the adjacent unfused spine [7]. The rates of union for posterolateral fusions are variable, having been reported as 80% [1], 79–84% [4], 68% [10], 80% [11] and 94% [13]. The clinical results of posterolateral fusion do not always correlate with the radiographic appearances but the outcome is certainly better if fusion is achieved [12].

An attempt at improvement of the quality of posterolateral spinal fusion was made by the use of a sacrospinalis muscle-pedicle bone graft (MPBG) composed of the attachment of the sacrospinalis muscle to the iliac crest and the adjacent bone.

Materials

Twenty three patients with symptomatic lumbar spondylolisthesis (lytic variety) were treated surgically between 1986 and 1994 (Table 1). Ten lesions were between L₄ and L₅ and 13 between L₅ and S₁. Six were Grade I, 14 Grade II and 3 Grade III. The patients were aged between 16 and 55 years (average 33.2 years). Ten were male and 13 female. Every patient had low back pain and 14 (60.8%) also had radicular pain, of whom 4 (17.4%) had bilateral symptoms. Three patients had motor weakness and 7 experienced occasional tingling sensations but did not have a neurological deficit. Three patients with gradual progression of the slip were considered for surgery. Six showed reduction of SLR of less than 60 degrees. Eight had tightness of the hamstrings and one had a lumbar scoliosis. Every patient was evaluated radiographically by anteroposterior, lateral and oblique views and those with radicular pain were investigated by CT. The patients were subjected to operative treatment only when they failed to respond to adequate conservative measures such as rest, restriction of activities, stabilising spinal exercises and the use of a spinal brace.

Methods

Laminectomy and foraminotomy were carried out in addition to bilateral posterolateral spinal fusion supplemented by a sacrospinalis muscle-pedicle bone graft on the left in all patients with low back pain, with or without radiation, except in adolescence, where laminectomy and foraminotomy were avoided.

Technique of operation

The patient lies prone in the jack-knife position under general anaesthesia. A slightly curved transverse incision with convexity downward is made along the highest point of iliac crest, extending from the level of the right sacrospinalis to one inch lateral to the lateral margin of the left sacrospinalis (Fig. 1, inset). The skin, superficial fascia and deep fascia are incised and retracted proximally and distally as far as possible in order to expose the spinous processes and sacrospinalis muscles (Fig. 1).

For laminectomy and foraminotomy, a midline longitudinal incision is made extending from one spinous process above to one below the level of the affected region (Fig. 1). Subperiosteal

Fig. 1. The line of the transverse skin incision is shown in Fig. 1 (inset). Exposure of lower lumbar spines and sacrospinalis muscles with the line of incisions for laminectomy, splitting of sacrospinalis muscle-fibres and the line of the osteotomy over the iliac crest for preparation of sacrospinalis MPBG are indicated

Fig. 2. Exposure of the cauda-equina and intervertebral foramina after laminectomy and foraminotomy. A sacrospinalis muscle-pedicle bone graft, composed of iliac crest attachment of sacrospinalis muscle including the corresponding part of the iliac crest, with vicryl threads passed through it, is shown. Sacral fibres of the sacrospinalis muscle are retracted medially for preparation of the posterolateral osseous bed for bone grafting. Free bone chips are placed in between the transverse processes

teal exposure of the corresponding vertebral spines and laminae is carried out and the loose neural arch of the affected vertebra along with the fibrocartilagenous tissues overlying the intervertebral foramina are excised (Fig. 2) to release the nerve roots and for exploration of any prolapsed disc. The right paraspinal muscles are then retracted laterally and the soft tissues cleared. The articular cartilages of the facets of the articular processes, the bases of the transverse process and the adjacent lamina are denuded in order to create an osseous bed for placement of free iliac bone chips.

The left sacrospinalis muscle is split longitudinally for about 6.5 cm proximally from the level of the iliac crest (Fig. 1), at the junction of its attachment to the iliac crest (iliocostalis part) and the sacral attachment (longissimus superficialis

Fig. 3. The sacrospinalis muscle-pedicle bone graft, after being placed and anchored around the transverse processes, is secured further in position by stitching it to the lateral margin of the sacral fibres of the sacrospinalis muscle. The medial margins of the sacrospinalis muscles are sutured in midline

and multifidus at a deeper plane). The fleshy attachment of sacrospinalis to the iliac crest, usually about seven cm in length and two cm in breadth, and the corresponding part of the iliac crest, compose the muscle-pedicle bone graft (MPBG) and is based on the lumbar artery (Fig. 2). Whenever L_4 to S_1 fusion is desired, an additional 1.5 cm of the lateral part of iliac crest is included in the prepared MPBG, and is then mobilised proximally for placement over the transverse processes. An osseous bed is prepared deep to the sacral fibres of sacrospinalis for the posterolateral fusion. Vicryl threads or occasionally stainless steel wires are then passed through the muscle-pedicle bone graft (Fig. 2) and also around the exposed transverse processes. Free iliac bone chips prepared from the posterior iliac crest are placed between the transverse processes and over the prepared osseous bed on the left side (Fig. 2) where the MPBG is then placed and anchored. This is further secured in position by stitching it with the lateral margin of the sacral fibres of the sacrospinalis muscle (Fig. 3).

Most of the remaining free iliac chips are then placed on the osseous bed prepared for posterolateral fusion on the right side, to equalise the same quantity of bone graft as on the left. The medial margins of separated sacrospinalis muscles are then approximated and sutured in the midline (Fig. 3). When laminectomy is not indicated, bilateral posterolateral spinal fusions are carried out through bilateral sacrospinalis muscle splitting incisions, and free bone grafts are placed on both sides, in addition to the sacrospinalis muscle-pedicle bone graft on the left. Bleeding from the donor site at the iliac crest is minimised by the application of bone wax. Gelfoam is placed in the depth of the left paraspinal dead space, which is then approximated around a suction drain. The wound is closed in layers.

Post-operative care

The patient lies supine for about four weeks and is then mobilised using a lumbosacral corset for four to six months, the duration depending upon radiographical evidence of consolidation of the graft.

Results

The post-operative results are shown in Table 1. The follow up period varied from 26 to 126 months (average 65.3 months). The results were analysed as follows.

Pain relief

Excellent indicates complete relief of pain in the back and in any site of radiation. *Good* implies that pain is either absent or occasional in the back, with or without stress. *Fair* means that there is intermittent pain in the back, with or without radiation. *Poor* means constant pain in the back, with or without radiation, requiring analgesics.

Preoperatively all patients had low back pain and 14 (61%) had additional radiation of pain; of these, 4 (17%) had bilateral symptoms. Postoperatively, complete relief of low back pain was obtained in 20 (87%) patients of whom 4 experienced occasional back pain only on stress. Occasional pain occurred in one patient (4%) while intermittent pain in another (4%) was experienced even at rest. One patient (4%) had a recurrence of radicular pain which was experienced as constant low back pain after the operation.

Fusion

The radiological status of fusion was divided into four categories. *Excellent* means satisfactory osseous fusion was obtained on both sides. *Good* means satisfactory osseous fusion was present on one side and either satisfactory or doubtful fusion on the other. *Fair* indicates doubtful fusion on one side and either doubtful or no fusion on the other. *Poor* means no fusion on both sides, with displacement of the MPBG.

Satisfactory osseous fusion is characterised by the presence of a dense and consolidated broad bony mass on the left side at an average of four months postoperatively. This outcome was recorded in 20 (87%) patients and also confirmed during a 61 month follow up (Fig. 4c and 4d). The preservation of the size and shape of the MPBG was confirmed by CT (Fig. 5) of patient no. 6 at 82 months after operation. On the right side, satisfactory osseous fusion was present about 5 to 6 months after the operation in 16 (70%) patients. Sixteen patients (70%) had satisfactory radiological osseous fusion on both sides. Four patients (17%) had satisfactory fusion on the left side with doubtful fusion on the right. Two patients had doubtful fusion on the left, while on the right side, one had doubtful fusion and another had no fusion. One patient had no radiological fusion on either side, associated with displacement of the MPBG. Patient no. 15 had poor results and patient no. 20 had fair results, the MPBG being displaced postoperatively due to poor anchorage.

Fig. 4. **a** Preoperative AP radiograph of a male aged 21 years showing spondylolisthesis (Grade III) of L₅ over S₁. **b** Preoperative lateral radiograph of the above patient showing the lytic variety of spondylolisthesis (Grade III). **c** AP Radiograph 61 months after operation of the above patient showing L₅ laminectomy and satisfactory bilateral bony fusions with a consolidated broad bony mass on the left side. **d** Lateral radiograph of the same patient at 61 months showing satisfactory consolidation of bony fusion of the lytic area, as shown in **b**

Fig. 5. Eighty-two months after operation: CT (3D) lateral and oblique views of L₄ and L₅ of patient no. 6, showing viable bone graft attached posterior to the transverse processes of L₄ and L₅, and extending down to the ala of the sacrum

Function

Function may be considered as a composite expression of pain, performance of daily activities and return to previous occupation and also as an indication of the status of spinal fusion. Functional improvement was as follows: *Excellent*, where patients could perform routine daily activities satisfactorily; *Good*, when patients could perform almost normal activities; *Fair*, when there was partial restriction of daily activities; *Poor*, when daily activities were grossly restricted. Overall, 21 (91%) patients were able to carry out their essential daily activities, of whom 19 (83%) returned to the same employment and 2 were able to continue their previous occupations with difficulty. One person had to change his occupation but was able to continue daily activities with difficulty. Another, (4%) had gross restriction of daily activities.

During overall assessment of the patients, functional improvement dominated the radiological criteria. In this context, 11 (48%) patients had excellent (Fig. 4), 9 (39%) good, 2 (9%) fair and one (4%) poor results.

Complications

Complications comprised superficial wound infection in 2 patients, donor site pain in 3, scar tenderness in 2, slipping of the MPBG during the early postoperative period in 2, and pain in the back after postoperative remission in 3 patients. Olisthesis (average 2.3 mm) increased in 10 (44%) patients during the early postoperative period; this did not deteriorate further when the fusion was achieved.

Discussion

Twenty three patients with lumbar spondylolisthesis (Grade I to III) with pain in the back, 14 with radiation, were treated surgically when they failed to respond to conservative measures. The majority were young and had less than 50% slip.

Laminectomy, foraminotomy and posterolateral spinal fusion were carried out in all except two adolescents, where laminectomy was avoided. There was no evidence of any disc prolapse. It was evident that the relief of pain in the early postoperative period was due to laminectomy and foraminotomy, whereas relief at a later stage resulted from spinal stability ensured by satisfactory fusion.

Although the same quantity of bone graft was placed on each side, the 87% satisfactory osseous fusion along with preservation of size and shape of the MPBG on the left (Figs. 4c, 4d and 5), compared to 70% fusion on the right, indicates that a higher frequency and superior quality of fusion results from the additional use of a vascularised bone graft. The improved functional results in 91% of patients in this series was clearly due to solid satisfactory fusion ei-

ther on both or at least on one side. Nevertheless, the clinical outcome did not entirely correlate with the radiographic evaluation.

There was no postoperative deterioration of preoperative scoliosis. Equally, weakness of the extensor muscles of the back did not arise, as the detached sacrospinalis muscle had been reanchored to the nearby lumbosacral spine. Weakness of the spinal muscles, even if it developed during the early postoperative period, ultimately improved with spinal exercises.

Olisthesis (average 2.3 mm) in 10 (44%) patients increased during the early postoperative period, perhaps due to removal of the neural arch. As this did not deteriorate further, it seems likely that fusion was satisfactory. The clinical results were good in the presence of adequate fusion, irrespective of any increase or decrease of postoperative olisthesis. On the other hand, the functional outcome was poor wherever the fusion was unsatisfactory and in these circumstances it was associated with a postoperative increase of olisthesis.

Postoperative reduction of intervertebral disc space (average 1.48 mm) was noted in 14 (61%) patients. This reduction of disc space, irrespective of the quality of fusion, had no significance in the functional outcome. The improved functional results of posterolateral fusion in 82% of patients in the presence of solid fusion and 34% in the presence of pseudoarthrosis has been reported [12]. The higher incidence of fusion in our series, together with an improved functional outcome, was probably due to better quality of fusion on the left following the additional use of a sacrospinalis muscle-pedicle bone graft.

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References

1. Axelsson P, Johnsson R, Stromqvist B (1992) Effect of lumbar orthosis on intervertebral mobility. *Spine* 17: 678–681
2. Boxall D, Bradford DS, Winter RB, Moe JH (1979) Management of severe spondylolisthesis in children and adolescents. *J Bone Joint Surg [Am]* 61: 479–495
3. Dandy DJ, Shannon MJ (1971) Lumbosacral subluxation (Group 1 Spondylolisthesis). *J Bone Joint Surg [Br]* 53: 578–595
4. Frennered K (1991) Symptomatic spondylolisthesis in young patients. Dissertation. Goteborg, 1
5. Harris IE, Weinstein SL (1987) Long-term follow up patients with grade III and IV spondylolisthesis. Treatment with or without posterior fusion. *J Bone Joint Surg [Am]* 69: 960–969
6. Johnson JR, Kirwan EO'G (1983) The long term results of fusion in situ for severe spondylolisthesis. *J Bone Joint Surg [Br]* 65: 43–46
7. Lee CK, Langrana NA (1984) Lumbosacral spine fusion. A biomechanical study. *Spine* 9: 574–581

8. Nachemson ALF, Wiltse LL (1976) Editorial comment. Spondylolisthesis. *Clin Orthop* 117: 2–3
9. Seitsalo S, Osterman K, Poussa M, Laurent LE (1988) Spondylolisthesis in children under 12 years of age, long-term results of 56 patients treated conservatively or operatively. *J Pediatr Orthop* 8: 516–521
10. Seitsalo S (1990) Operative and conservative treatment of moderate spondylolisthesis in young patients. *J Bone Joint Surg [Br]* 72: 908–913
11. Stauffer RN, Coventry MB (1972) Posterolateral lumbar spine fusion. *J Bone Joint Surg [Am]* 54: 1196–1204
12. Stromqvist B (1993) Posterolateral uninstrumented fusion. *Acta Orthop Scand [Suppl 251]* 64: 97–99
13. Truchly G, Thompson WAI (1962) Posterolateral fusion of the lumbosacral spine. *J Bone Joint Surg [Am]* 44: 505
14. Watkins MB (1953) Posterolateral bone grafting for fusion of the lumbar and lumbosacral spine. *J Bone Joint Surg* 35A: 1014
15. Watkins MB (1964) Posterolateral fusion in pseudoarthrosis and posterior element defects of the lumbosacral spines. *Clin Orthop* 35: 80
16. Wiltse LL, Hutchinson RH (1964) Surgical treatment of spondylolisthesis. *Clin Orthop* 35: 116