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Intercorporal lumbar spondylodesis

312 patients followed for 2–20 years

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Intercorporal spondylodesis was performed for low back pain in 120 patients with spondylolisthesis and 192 patients with disc degeneration; the latter group had all had previous surgery. The operations were carried out with retroperitoneal access, in most cases using iliac grafts, and additional posterior screw fixation in a number of patients substantially shortened the postoperative immobilization time. Complications were one death from pulmonary embolism, one case of possible genital disturbance, four inconsequent infections and three vessel injuries. In each group less than 10% had an additional operation for early signs of non-fusion.
In cases without concomitant spinal problems, the overall fusion rate was 95–98 per cent. Clinically, the spondylolisthesis group was superior with 75 per cent without low back pain and 95 per cent without radicular pain posteoperatively versus 55 per cent and 77 per cent for the disc degeneration group.

Fusion from behind was less successful in patients with mechanical instability from spondylolisthesis or previous facetectomy. This led to interest in an interbody spinal fusion, first proposed by Capener (1932) for spondylolisthesis. The first operations were done by Burns (1933), Mercer (1936) and Friberg (1939) by the transperitoneal approach with an iliac graft fixed with a screw. Merle d'Aubigné & Gerard (1959) obtained fusion in only half of their cases and had such severe complications that they would not recommend the operation. On the other hand, Debeyre & Delforges (1959), who used the same technique as Merle d'Aubigné but without screw fixation, thought the operation suitable for spondylolisthesis and patients with disc generation who had had operations from behind. Taylor (1970) found no correlation between fusion rate and clinical response, which, according to Stauffer & Coventry (1972) could be explained by the evaluation of the degree of fusion and different criteria for grading the clinical results.

Reports published in 1951–1979 of this operation for 688 cases of spondylolisthesis and for 1636 cases of disc degeneration with mechanical instability from laminectomy and facetectomy show a fusion rate of 19–98 per cent, a similarly wide range of clinical results, and a variety of complications, notably injury of big vessels, pulmonary embolism, and genital problems (Table 1).

I can now report on 312 patients followed for 2–20 years after intercorporal lumbar spondylodesis for spondylolisthesis or disc generation.

Patients

Three hundred and twelve patients were operated on by the author from 1962 to the end of 1978, including 120 patients with spondylolisthesis and 192 with disc degeneration. The patients have been followed clinically and radiographically for 2–20 years after the operation.

The clinical evaluation, based on information from the patients about pain in the low back and radicular pain in the legs, has been obtained by personal examination; recently the results have been confirmed by telephone contact and in some cases by questionnaire.

The spondylolisthesis group consisted of 79 males and 41 females with average age 30 years. Table 2 shows the location and degree of olisthesis as well as the duration of pain preoperatively, and other operations prior to anterior fusion.

The disc degeneration group consisted of 73 males and 119 females with average age 44 years. Table 3 shows level(s) of fusion, duration of pain, occurrence of low back pain and radicular pain preoperatively, and other operations prior to anterior fusion.

The main indication for the operation was persistent and disabling low lumbar pain. Some of the young patients with spondylolisthesis of severe degree did

Table 1. Results of intercorporal spondylodesis for spondylolisthesis (sp), disc degeneration (dd) and slipped discs (sd).

		Patients	Fusion rate (per cent)	Follow-up	Clinical results (per cent) Excell.	Good	Excell. or Good	Complications[a] Number, type
1951	Gjessing	2 sp 5 dd		7		100		
1953	Ingebrigtsen	5 sp	80	4	40			
1959	Merle d'Aubigné and Gerard	32 sp	50	26	40		25	3A, 3G, 4K
1959	Debeyre & Delforges	25 sp 10 dd	62	25 10		72		2C
1961	Harmon	244 dd	98			93		7A, 1C
1963	Raney Jr. & Adams	55 dd	83	46	23	51		3A, 1B, 1C, 3F, 1D
1963	Harmon	5 sp 177 dd	95	177	100	70		
1964	Calandruccio & Benton	6 sp 13 dd	19	16		56		2C, 1F
1965	Nelson	4 sp 20 dd	62	24		70		
1965	Sacks	150 dd		150	26		62	2C, 2D, 1H, 2L
1966	Hodgson	9 sp 47 dd	90 77	56	100 93			
1967	Goldner et al.	35 sp 62 dd	90	97		81		1B, 6C, 1D, 1F, 1G, 2H, 4L
1968	Hoover	6 sp 40 dd	66 87	46	50		20	
1969	Zimmermann	18 sp 18 dd	96	28	87 38		7 15	
1969	Debeyre & Dorat	79 sp 71 dd	76	142	43 33	77		2D, 4L
1970	Taylor	226 dd	44	210				2E
1970	Goutallier	83 sp	73	79	54		18	
1970	Cauchoix	26 sp	34	26	38			
1970	Mazas	53 sp	68	50	42			3K
1971	Freebody et al.	167 sp 76 dd	81 79	243	77 75		17	11C, 2D, 1E
1972	Stauffer & Coventry	8 sp 69 dd	56	77	14		32	3C, 1D, 2F, 1I
1972	Weber	62 sp 120 dd	90 95					2A, 1B, 1G, 1L
1977	Crook	150 sp	95					
1978	Sørensen	42 sp 56 dd	86 94	98	34		34	11C, 4D, 2E
1979	Flynn	16 sp 34 dd	56	50	52		87	

a. Complications

A Lesion of big vessels
B Retroperitoneal haematoma
C Thrombophlebitis
D Pulmonary embolism – non-fatal
E Pulmonary embolism – fatal
F Wound infection
G Rupture of the abdominal wall
H Ventral hernia
I Cardiac arrest – recuscitated
K Penetration of screw into sacral canal
L Genital troubles

Table 2. Spondylolisthesis group: 41 females, 79 males. Average age, 30 years

		No.	
Location of olisthesis	L3	4	
	L4	7	
	L5	91	
	L4, 5	18	
Degree of olisthesis	1st	48	
	2nd	41	
	3rd	17	
	4th	14	
		Low back pain	Radicular pain
Duration of symptoms (years)	0	6	55
	<1	34	39
	1–5	28	18
	5–10	29	5
	>10	23	3
Other operations prior to anterior fusion			
McGill		16	
Slipped disc		4	
Kissing spine		2	
Posterior fusion (not healed)		5	

Table 3. Disc degeneration group: 119 females, 73 males. Average age, 44 years

		No.	
Fusion level	L3	1	
	L3, 4	5	
	L4	33	
	L4, 5	91	
	L3, 4, 5	2	
	L5	60	
		Low back pain	Radicular pain
Duration of symptoms (years)	1– 5	56	65
	5–10	48	37
	>10	87	48
Other operations prior to anterior fusion			
Slipped disc Kissing spine Laminectomy	259 operations in 132 patients		
Posterior fusion (failed) Rhizotomy	17 operations in 17 patients		

not complain of low back pain but of pain in the legs, and a few of the younger patients were operated on because of progressive olisthesis only.

Patients complaining of low back pain were in many cases tested with a plaster spica from the trunk to one knee for 2 weeks. If this immobilization of the lumbar spine relieved the low back pain, it was considered an indication for fusion.

The operation

The technique described by Harmon (1961) was modified as follows. After careful dissection of the lumbar-sacral region, with the peritoneum and the ureter pushed to the right, one Steinmann pin covered with a rubber tube was inserted into the body of the fifth lumbar vertebra medial to the common iliac vein. The soft tissues in front of the fifth disc were moved to the right where another Steinmann pin was inserted into the fifth lumbar vertebra. After pushing downwards and to the right, a third Steinmann pin was inserted caudal to the fifth disc. Finally, a fourth Steinmann pin was inserted in the left side of the sacrum caudal to the fifth disc against the left iliac vein. After this procedure, a square field with the disc was uncovered (Figure 1).

The fourth disc was approached from the left side of the iliac artery and the aorta. After insertion of two Steinmann pins in the fourth and the fifth vertebral bodies on the left side, the peritoneum and the aorta were pushed to the right where two other Steinmann pins were inserted to keep the aorta to the right. Again, there was a square field on the front and the left side of the fourth disc.

Saline was injected into the uncovered discs to see if the receptability was more than 1 cc, interpreted as a sign of degeneration of the disc (Harmon 1961). The disc was removed completely to the annular ligament and the endplates of the bodies were chiseled off.

Apart from the early years when tibial cortical grafts were used, we used grafts from the iliac crest. In later cases the author supplemented anterior intercorporal fusion with transarticular screws (Figures 2, 3) in a second operation 14 days later, not only in cases of disc degeneration but also in first and second degree spondylolisthesis. A long vitallium screw served to fix the loose vertebral arch in addition to the transarticular screw fixation of the facet joints.

In cases of severe spondylolisthesis with spondyloptosis, traction on the head and the legs and support below the pelvis was used for 2 weeks in an attempt to reduce the fifth lumbar vertebra. At operation, after uncovering the fifth vertebral body, three Steinmann pins inserted deep into the fifth

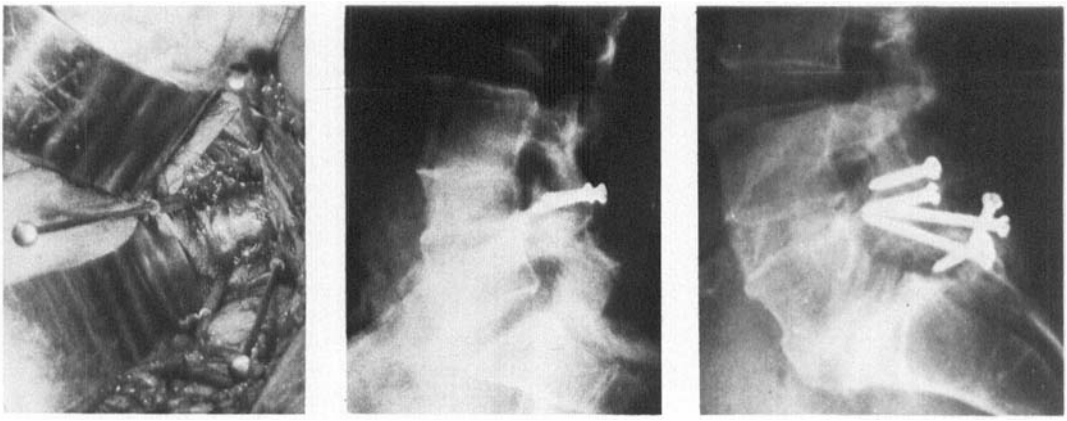

Figure 1. The fifth lumbar disc exposed with the aid of four nails with rubber tube protection.

Figure 2. Transarticular screws behind the intercorporal fusion L4–5. The bone trabecles pass from the iliac graft to the two bodies.

Figure 3. Screw fixation of the spondylolysis L5 and transarticular screws L4–5 and L5–S1. The two fusions are solid.

vertebral body made it possible to turn the front of the vertebral body upwards to facilitate the entrance to the fifth disc.

In the front edge of the sacrum a bed was chiseled for a big iliac graft which was impacted below the fifth body.

Postoperative treatment

The postoperative treatment varied. A plaster jacket and celastic bed followed by a canvas corset for 6–12 months were frequently used initially. Ambulation with crutches after 3 weeks was used in many cases of disc degeneration. After screw fixation the patients were ambulatory without support after a few days.

Complications

Three of the 312 patients had *lesions of the big vessels,* two of the external iliac vein and the ascending lumbar vein, and one of the common iliac artery. These lesions were treated successfully by a vascular surgeon.

Two patients had *pulmonary embolism* shortly after the operation, and one of these died after 14 days. Five patients had *thrombophlebitis* in the left leg; they received anticoagulation treatment and none had post-thrombotic oedema.

Three patients had *superficial infection* in the abdominal wound, one with a fistula which was excised, and one had infection in the tibial wound with fistulation.

Five patients had *weakness of the left abdominal wall.* One of them was operated on for ventral hernia.

Until gastric suction was introduced after the interbody fusion, many of the patients had transient ileus symptoms. Some also had troubles with bladder function for a few days. Only one male had *genital dysfunction*; he had previously had rhizotomy.

Results

The criterion for solid fusion was radiographic evidence of bone trabeculae from the graft to the vertebral bodies; radiographs of the lower lumbar spine in two planes were used. Twenty-two patients (11 in each group) who did not have solid fusion at the 2-year follow-up, had radiographically sound fusion after 7 years.

Spondylolisthesis

The primary fusion rate was 85 per cent (102/120 patients); those operated with iliac graft and screw fixation all fused. A second operation was successful in 12 of 14 cases for an overall fusion rate of 95 per cent. Low back pain was reduced to 33 per cent of the preoperative incidence, and radicular pain from 45 to 13 per cent (Table 4).

In spite of the positive effect on the pain, only 73 per cent had unchanged working ca-

Table 4. Spondylolisthesis group

	No.	Radiographic results Prim. fused		Sec. operation	No.	Sec. fused	Total fused	%	Clinical results	Preop.	%	Postop.	%
Tibial graft	17	13		Ant. fusion	1	1			Low back pain	114	*95*	40	*33*
Iliac graft	86	70		Posterolat. fusion	3	3			Radicular pain	54	*45*	16	*13*
Iliac graft + screws	19	19		Screw fixation	9	8							
				William's plate + screws	1	–							
	120	102	(*85%*)		14	12	114	*95*					

Table 5. Spondylolisthesis group. Working capacity postop.

	No.	Male/Female	%
Unchanged	87	57/30	*73*
Decreased	10	6/4	*8*
None	21	15/6	*18*
Pension	28		*23*
(preop)	27		*23*

pacity. On the other hand, no difference in pension rate was noted (Table 5).

36 patients also had other diseases in the lumbar spine which could cause low back and radicular pain (Table 6). When these patients were eliminated from the 120 spondylolisthesis patients, the remaining 84 patients ("cleaned material") had fused in 95 per cent, no low back pain in 75 per cent and no radicular pain in 95 per cent (Table 7).

Table 6. Concomitant problems of the lumbar spine

	Spondylolisthesis	Disc degeneration
Disc degeneration at other level (s)	14	23
Kissing spine	8	21
Spinal stenosis	7	13
Slipped disc	4	9
Osteopororis	0	5
Scoliosis	3	0
Ankylosing spondylitis	0	1

Table 7. "Cleaned material"

	Spondylolisthesis 84 cases	%	Disc degeneration 119 cases	%
Fusion	80	*95*	109	*92*
No low back pain	63	*75*	66	*55*
No radicular pain	80	*95*	91	*76*

Disc degeneration

As one patient died 2 weeks postoperatively from thromboembolism, 191 patients were assessed. The primary fusion rate was 84 per cent, and additional operations increased the overall fusion rate to 93 per cent (Table 8).

Preoperatively, all patients complained of low back pain, whereas only 54 per cent of them continued to have such problems postoperatively. Radicular pain was encountered preoperatively in 71 per cent of the patients and postoperatively in 27 per cent (Table 8). The working capacity remained unchanged in 53 per cent of the cases, but the pension rate, because of low back pain, was one third higher than before the operation (Table 9).

After the fusion operation, 72 patients in this group disclosed other reasons for low back and radicular pain (Table 6). The remaining 119 patients without other diseases in the lumbar spine, the "cleaned group", had fused in 92 per cent, had no back pain in 55 per cent and no radicular pain in 76 per cent of the cases (Table 7).

Table 8. Disc generation group

	Radiographic results						Clinical results			
	No.	Prim. fused	Sec. fused	Total fused	%		Preop.	%	Postop.	%
Tibial graft	35	27	4	31	*89*	Low back pain	191	*100*	104	*54*
Iliac graft	89	69	13	82	*92*	Radiocular pain	135	*71*	52	*27*
Iliac graft + trans. art. screw	67	64	1	65	*97*					
	191	160 (84%)	18	178	*93*					

Table 9. Disc degeneration group. Working capacity postop.

	Patients	Male/Female	%
Unchanged	102	33/69	*53*
Decreased	25	10/15	*14*
None	63	32/31	*34*
Pension preop.	24		*13*
Old-age pension	4		
Pension postop.			
Other diseases	12		
Low back pain	37		*19*

Discussion

Intercorporal lumbar spondylodesis was introduced as a method for treatment of spondylolisthesis in 1952. Because the grafted material was under compression following intercorporal spondylodesis, this method seemed more sound than posterior fusion. There have been different opinions about the operation: many have found it difficult and some have called it unreliable. Harmon (1961) tried to popularize the operation and described the retroperitoneal approach; he used intercorporal disc excision and fusion, especially for slipped discs. The results of the operation have varied considerably with regard to fusion rate as well as clinical results. According to earlier publications, the complication risk also is not negligible (Table 1).

This report is based on 312 intercorporal fusions with a modified Harmon's technique for retroperitoneal access. Adding posterior transarticular screw fixation in 86 cases substantially shortened the postoperative immobilization time for these patients. In my opinion the operation is neither difficult nor dangerous. Serious complications occurred in only four patients: one fatal pulmonary embolism and three lesions of the big vessels.

Solid fusion was seldom found until 1 or more years had passed. The final radiographic assessment was done 4–20 years postoperatively. The initial fusion rate in the spondylolisthesis group was 85 per cent. The corresponding rate for the disc degeneration group was 84 per cent. A secondary operation in 32 patients gave a total fusion rate of 95 and 93 per cent, respectively.

The clinical evaluation concerned low back pain and radicular pain. Whereas the fusion rates of the two patient groups were comparable, the clinical result at follow-up of the spondylolisthesis group was superior to that of the disc degeneration group. Of the former group 67 per cent no longer had any low back pain postoperatively compared to 54 per cent of the latter group. In 73 per cent of the former group the working capacity was unchanged but only about 50 per cent of the disc patients could return to normal work. Intercorporal fusion for disc degeneration should be considered a salvage procedure; all the patients in this group had had prior surgery from behind.

The two materials of spondylolisthesis and disc degeneration comprised a number of patients with other dysfunctions of the lumbar spine possibly causing low back and radicular pain. According to the literature, this fact seems to have been disregarded earlier when assessing the results of spinal fusion. Therefore it seemed reasonable to exclude this group of patients prior to assessment in order to establish the real effect of the operation. In the so-called "cleaned material" (Table 9), the total

fusion rate was unchanged in both groups but an unequivocal improvement of the clinical result was noted in both patient groups.

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