

ANTERIOR INTERBODY LUMBAR SPINE FUSION FOR INCAPACITATING DISC DEGENERATION AND SPONDYLOLISTHESIS

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Anterior interbody lumbar spine fusion by the extraperitoneal technique was performed on 98 patients with incapacitating low-back pain due to degeneration of the fourth or fifth lumbar disc (56 patients) or spondylolisthesis (42 patients). Of the discs investigated 135 proved to be degenerated, often severely, and 114 were fused. In 75 per cent of the cases no complications occurred; however, 11 patients developed thrombophlebitis, two fatal pulmonary embolism, four mild pulmonary infarcts, and three pulmonary atelectasis.

At follow-up, 3–8 years later, the fusions were solid in 91 per cent and after re-operation in 94 per cent. Among the patients with spondylolisthesis the fusions were not solid in 14 per cent and among those with disc degeneration in 6 per cent. Improvement or cure was reported by 73 per cent of the patients. Thirty-one patients had constant pain. In 21 of them there was a somatic and in a few also a psychological explanation. Sixty-eight per cent were working. Sixty per cent of those patients who underwent the operation after the age of 45 were receiving a disablement pension.

An attitude of reserve should be taken in operating on patients with a history of one or more operations for disc herniation, as there may be nerve root adhesions. Patients with spondylolisthesis should be followed up for at least 3 years, and if there is a suspicion of incipient pseudarthrosis they should be treated by fusion with screws through the arch defects or by classical posterior spondylodesis. The decision regarding indications for the operation and the operation itself should still be in the hands of very experienced orthopaedic surgeons, and it must be emphasized that the postoperative management, especially the prophylaxis against thrombosis, makes great demands on the staff.

Key words: low-back pain; low lumbar disc degeneration; spondylolisthesis; lumbar interbody fusion

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Anterior interbody lumbar fusion is very seldom used in Scandinavia for the treatment of disc degeneration or spondylolisthesis, and no results of this procedure have been published in the Scandinavian medical literature. Reports in the Anglo-American literature too are scarce considering the

enormous number of patients having incapacitating backache. The results reported have varied within wide limits, presumably because the indications have differed. Some surgeons have abandoned the method because of technical difficulties and complications, or the occurrence of pseudarthrosis.

This study has been carried out with the aim of answering the question of whether the method is worthwhile.

PATIENTS AND METHODS

During the period December 1967–May 1973 we performed anterior lumbar interbody spine fusion on 98 patients (pts).

The operative indication was disabling low-back pain due to spondylolisthesis or low lumbar disc degeneration affecting one or at most two discs, the others being normal. For technical reasons, the patients' body weight had to be within the normal range. Ideally, the upper age limit should be 55 years, and the patients should be sufficiently motivated, willing to work, and mentally robust.

Figure 1 gives the sex ratio and age distribution. The age range was 15–58, and most patients were 40–50 years of age. This applies especially to the women who made up 62 per cent of the total.

From Table 1 it is apparent that three-quarters of the patients had suffered from pain for at least 5 years, and one-third had had constant pain for

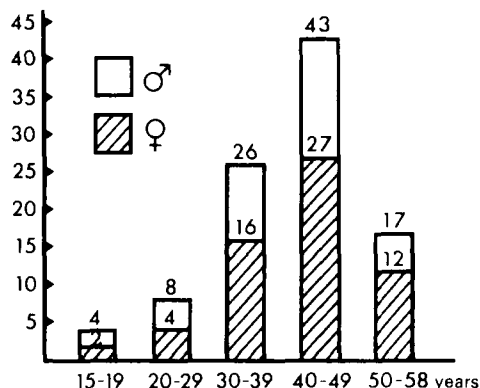


Figure 1. Age distribution and sex ratio.

at least 5 years. In 73 per cent the pain radiated to the lower limbs. Nine had previously undergone operation and 11 had been treated conservatively for lumbar disc herniation. During two of the fusion operations we removed myelographically confirmed herniations from the front, as there had been little suspicion of free herniations.

Forty-four pts were totally and 35 partially incapacitated. In 19 the working capacity was not affected. Most of the latter were younger persons

Table 1. Duration of pain.

Length of history (years)	No. of patients	No. of patients with constant pain
Less than 1	2	25
1–4	23	41
5–9	17	13
10–14	21	12
More than 15	35	7
	73	32

Table 2. Lumbar discs affected and the severity of the disc changes.

Disc	37 men	61 women	Total: 98 pts	135 discs
LD 3	2	1	3	3
LD 4	5	4	9	9
LD 5	17	36	53	53
LD 4 + 5	15	20	35	70
Not narrowed	3	3	6	
Slightly narrowed	14	12	26	
Moderately narrowed	20	19	39	
Severely narrowed	17	47	64	

with symptoms of spondylolisthesis, and the operation was done in an endeavour to comply with their occupational wishes. Prior to the operation nine were receiving disablement pension and eight had changed to another job. Twenty-nine were doing heavy physical work, 67 light work, and seven non-physical work.

Radiography showed that in the 98 patients 135 discs were affected (Table 2), usually the fourth or fifth, in 35 cases both. The third lumbar disc was affected in only three pts. Severe narrowing of the disc was present in half the men and two-thirds of the women. Sclerosing of the end plates and marginal exostoses were common findings. Among the females severe lumbo-sacral spondylosis and disc narrowing were the most common operative findings (Figure 2). Spondylolisthesis was present in 42 pts (Table 3), 67 per cent were males and 28 per cent were females. The displacement was less than 25 per cent in 26, 25–50 per cent in 13, and 50–75 per cent in three (Meyerding 1956). Furthermore, the vertebral body was displaced forward in relation to the overlying body in 12 of the 25 males and in 5 of the 17 females. This displacement averaged 6 mm (3–11), but fusion of the overlying disc was done in only two of the 16 pts. In all, fusion was performed on 114 discs.

Surgical technique. The patient is placed supine, with the site of fusion on a level with the peak of the kidney kink of the operating table. A paramedian longitudinal incision is made over the middle

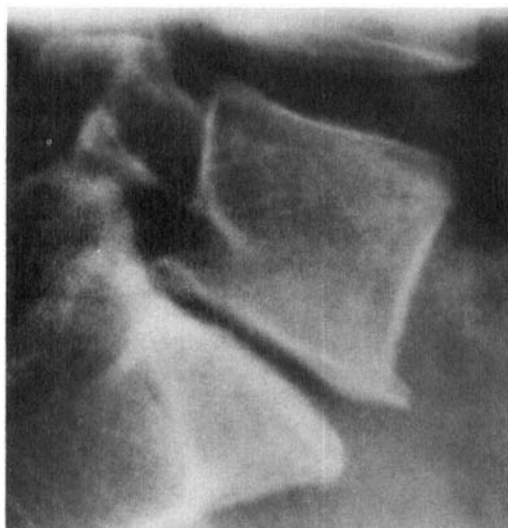


Figure 2. X-ray showing severe narrowing of the 5th lumbar disc with exostoses and sclerosing of the end plates in a woman of 50.

Table 3. Spondylolisthesis: site, sex ratio, and grade.

Grade of spondylolisthesis	I	II	III
25 men	18	6	1
17 women	8	7	2
Total 42	26	13	3
LD 3	—	1	—
LD 4	6	—	—
LD 5	20	12	3

dian longitudinal incision is made over the middle of the left rectus sheath which is opened. The rectus is loosened and pulled laterally to spare vessels and nerves. The peritoneal sac with extraperitoneal fat, containing the ureter, is gently mobilized from the inferior aspect and pushed upwards to the right, and the iliac vessels are exposed. The sacral promontory is exposed and the fifth disc located distally to the bifurcation of the aorta and vena cava. Gentle dissection is needed to avoid tearing the small vessels from the large ones. The soft tissues, with the autonomic nerves, are pushed aside, and the median sacral artery may have to be ligated. The disc is kept exposed by four Steinmann pins covered with rubber drains, two above and two below the disc, as laterally as possible, but without compressing the common iliac vein. The disc is opened in the middle, and stay sutures are applied to the two flaps of the annulus, also protecting the vessels. In operations on the fourth lumbar disc, the posterior rectus sheath has to be divided. It is tightly adherent to the peritoneum which is very apt to be opened. The fourth disc is exposed above and laterally to the common iliac vessels, possibly after ligation and division of the ileo-lumbar vein. The affected disc is emptied by a pituitary forceps, and the end plates are chiselled off as far as the posterior limbus, as a rule to a depth of 3 cm, and until the cancellous bone is normal. Suction is applied. The latter part of the chiselling is done with the patient in a position of marked lordosis, with the aid of the kidney kink, so that the disc gapes anteriorly, and the thickness of the bone grafts can be calculated. A few pts develop hypotension during the lordosis positioning, and the anaesthetist should be warned that the intratracheal tube may slide down towards the carina, obstructing the main bronchus and causing atelectasis. Through a separate incision along the left iliac crest two, or in some cases three grafts are chiselled out at right angles to the crest, so

that the grafts comprise the entire thickness of the ala. Length and height have been measured beforehand. Again the patient is placed into a position of maximum lordosis, and the grafts are rammed in from the front by special rammers. During this procedure the assistant presses the overlying body backwards in cases of spondylolisthesis. When the lordosis position is straightened out, the two adjacent vertebral bodies grip around the grafts which thus become solidly fixed, their anterior edges behind the anterior edges of the vertebral bodies. The wound is closed. A vitallium plate with two screws recreates the level of the iliac crest, and above this the periosteal edges and muscular aponeuroses are firmly sutured.

Postoperatively paralytic ileus is counteracted by injections of neostigmine during the first days. The patient is mobilized with a supporting corset in a few days. Pts with spondylolisthesis or fusion at two levels are treated with strict bed rest for 3 months and wear a supporting corset for at least 1 year. Vertebral and abdominal muscles are trained before ambulation. The final follow-up examination is carried out 3 years after the operation.

Most often the fifth disc was the object of surgery (Table 4). In 16 patients the operation involved the fourth as well as fifth disc, in one patient (spondylolisthesis) only the third lumbar disc.

Complications. The postoperative course was uneventful in 76 per cent. Eleven pts developed thrombophlebitis (Table 5), one has permanent oedema with a 4–5 cm increase in the circumference of the left leg, and two patients have mild oedema (a 1 cm increase in circumference). Two cases of fatal pulmonary embolism occurred, one of them about 48 hours after the operation in a patient who was otherwise in good health. The other patient had been disabled for years, bed-ridden for 6 months, and had been slimming. She lacked initiative, was impossible to mobilize, and died 5 weeks after the

Table 5. *Complications.*

	No. of pts	Sequelae	
		No	Yes
Thrombophlebitis	11	7	4
Pulmonary embolism	2	—	2 (died)
Infarct (but no phlebitis)	4	4	—
Pulmonary atelectasis	3	3	—
Pneumonia	1	1	—
Renal calculus (t.l.)	1	1	—
Neuritis of ulnar nerve due to pressure	2	2	—
Total	24	18	6
No complications	74 = 76 %		

operation. This patient was among our first operated cases, and with our present experience we would now consider her too great a surgical risk. Experience has taught us to expend great energy on exercises to avoid thrombosis. Four pts developed mild pulmonary infarcts, but no clinical signs of phlebitis. Three developed severe atelectasis, but with no sequelae.

RESULTS

All the pts were seen at a clinical and radiological follow-up 3–8 years after the operation. If there was any doubt about whether or not solid fusion had been achieved, tomography was performed. Solid fusion was obtained in 86 out of 95 patients, viz., 90.5 per cent (three have died, one of them 17 months after the operation) (Figures 3 and 4). Solid union was obtained in 16 of the 17 disc spaces in which the grafts were inserted in the sagittal plane and in 85 of the 93 disc spaces in which the grafts were inserted in the frontal plane, i.e., in 101 out of 110 disc spaces or 91.8 per cent, with no difference between the two techniques of insertion. Six of the 42 pts with spondylolisthesis (14.3 per cent) and three of the 53 with disc degeneration (5.7 per cent) did not show primary union. In spondylolisthesis the only stabilization is afforded by the inserted grafts. In disc

Table 4. *Site of spine fusion.*

	37 men	61 women	Total: 98	
LD 3	—	1	1	
LD 4	6	6	12	
LD 5	24	45	69	
LD 4 + 5	7	9	16	32 (discs)
Total	44	70	114	

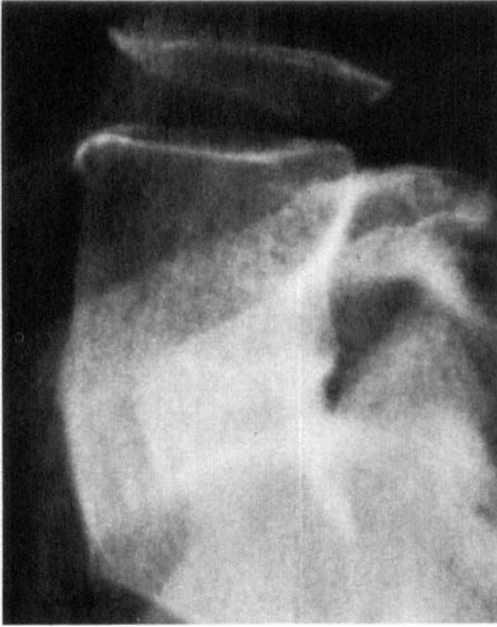


Figure 3. X-ray showing solid fusion 7 years after the operation on the 5th lumbar disc in a woman of 46.

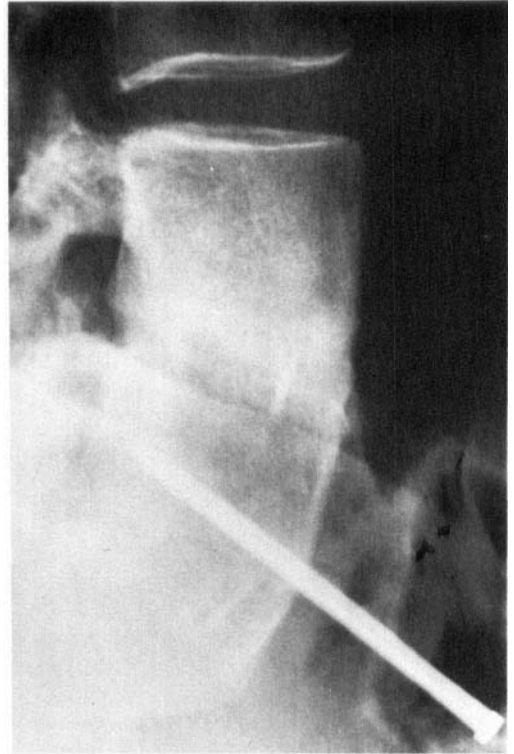


Figure 4. Solid fusion of the 4th and 5th lumbar disc spaces 5 years after the operation in a woman of 45.

degeneration additional stabilization is obtained by the pressure of the small joint surfaces against each other posteriorly. Fifty-two pts wore a corset for at least 1 year, 19 for less than 6 months.

In nine pts solid union was not obtained. In three of them it was achieved by re-operation from the front (right-sided approach) and in three by posterior spondylodesis (Figure 5). In one, laminectomy was done (nerve root irritation), and in one an extra disc segment was operated on from the front.

At follow-up one-third of the pts were free of pain, one-third had constant and one-third periodical pain of varying duration (Table 6). Nearly all the pts having constant low-back pain wore a corset and were taking analgesics regularly. More than half of the total material suffered from back fatigue and had to rest up to several times daily. Only 27 had sciatica, including 25 who also had had radiating pain prior to the operation. One underwent a

successful Gill operation (Gill & White 1955). Eleven had minor complaints from the donor site at the iliac crest; in six of them the metal had been removed.

At follow-up 68 per cent were working (Table 7), but a few were receiving supplementary disablement pension. A total of 29 had been referred to rehabilitation centres, half of this number having been awarded disablement pension. A total of 37 were receiving disablement pension at the time of follow-up as compared with nine prior to surgery.

Seventy-three per cent considered themselves as cured or improved (Table 8). In 35 pts a possible somatic cause could be demonstrated as an explanation for a not completely satisfactory result, and in 24 cases psychological factors had influenced the

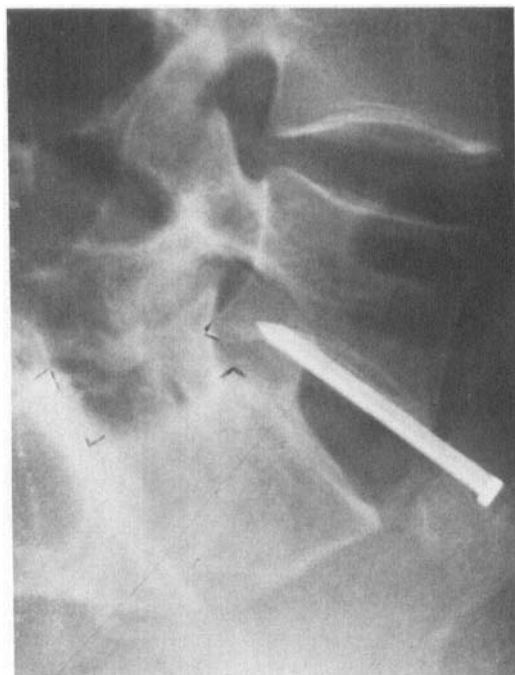


Figure 5. Solid fusion of the 5th disc space in a 28-year-old man with spondylolisthesis. Solid union with L5 displaced 18 mm forward over the sacral bone and 10 mm under L4.



Figure 6. Fusion of the 4th as well as 5th disc space in a 28-year-old man. X-ray (tomogram) 4 years after the operation shows non-union of the grafts and the inferior aspect of L4. After posterior fusion, union obtained also in the 4th disc space.

result: Eight had been admitted to psychiatric departments, and another six had been examined by a psychiatrist. In 10 pts evident psychiatric diseases were detected by us. Seven have later been found to suffer from cardiovascular disorders.

Table 6. Pain 3–8 years after the operation.

	36 men	59 women	Total: 95
No pain	15	17	32 = 34 %
Periodical pain	9	23	32
Constant pain	12	19	31
Analgesics periodically	6	11	17
Analgesics constantly	8	19	24
Corset constantly	11	18	29
Back fatigue, has to rest daily	15	37	52

Table 7. Employment situation 3-8 years after the operation.

	36 men	59 women	Total: 95
Previous work resumed	19	36	55
Lighter work	8	9	17
Work later given up	4	3	7
Still working	23	42	65 (68 %)
Referred for rehabilitation	17	12	29 (14 disablement pensioners)
Disablement pension awarded	16	21	37 (before op.: 9 pts)

Table 8. Patients' own evaluation of the result

	36 men	59 women	Total: 95	
Cured	11	12	23	73 %
Better	15	31	46	
Unchanged	9	15	24	
Worse	1	1	2	

Table 9. Possible somatic explanation of an unsatisfactory result in 31 patients having constant pain at follow-up

	No. of pts
Fusion of the body 9-21 mm ventrally (spondylolisthesis)	7
Not solid fusion	5
Narrowing of other lumbar discs	4
2-4 previous operations for slipped disc (positive myelogram)	3
Subsequent slipping of overlying disc	1
Subsequent obesity (99 kg, 173 cm)	1
No somatic explanation for the pain	10
Constant pain	31
Preoperative history exceeding 10 years	16
Constant pain for more than 1 year preoperatively	31
Radiation to lower limbs	30
Totally incapacitated for more than 6 months before operation	14
Has not been working after the operation	13
Referred for rehabilitation after operation	13
Disablement pension, 8 men + 11 women (before operation 0 + 5)	19

Among 31 pts having constant pain we could find a possible somatic explanation in 70 per cent (Table 9). If in spondylolisthesis the fusion is performed with the vertebral body displaced too far anteriorly, a mechanical disproportion will persist, and if the body has been displaced forward under the overlying body, there is a predisposition to disc degeneration (Figure 6). Three had already undergone at least two operations for slipped disc and two myelographies using the locally irritant contrast medium Conray®. In 10 cases we found no somatic explanation for the pain, but in several cases hysterical neurosis has been diagnosed by psychiatrists.

Pts with constant pain had a particularly long history of preoperative pain, and practically all of them had sciatica. Inability to work was more common in this group, and even before the operation five had been receiving disablement pension, as compared with 19 or 61 per cent at follow-up.

Sixty per cent of the pts who had the operation when over the age of 45 were receiving disablement pension. The spine fusion had united in all but 7 per cent.

Some but not all pts were questioned about sexual potency, and none complained of impotence.

DISCUSSION

Technique. Like Harmon (1963), Hodgson & Wong (1968), and Stauffer & Coventry

(1972), we used the extraperitoneal approach and did not have any difficulties or cases of paralytic ileus. The latter condition also does not seem to be a major problem in the transperitoneal technique (Sachs 1965, Debeyre & Dorat 1969, Freebody et al. 1971).

Cortical grafts appear to give poorer union (Hodgson & Wong). Harmon has reported good results using sandwich grafts (cortical + cancellous bone); however, most authors use iliac grafts, as in the present series.

Harmon mobilized the pts from the day after the operation, Sachs and Stauffer & Coventry from the 3rd–4th day, Hodgson after a maximum of 14 days. Freebody et al. immobilized their pts in bed for 4 weeks after fusion at one level, and cases with spondylolisthesis or multiple level fusion had 6 weeks in plaster followed by a moulded polyethylene jacket for another 3 months and thereafter an ordinary corset. Debeyre & Dorat immobilized the pts in bed for 3 months. Judging by the healing results, long immobilization does not appear to have led to any notable gain.

Results. Harmon reported complete or partial relief of pain (clinically excellent or good results) in about 90 per cent of his 244 patients, 3–5 years after the operation. The results were related to the severity and extent of the radiological changes. Hodgson & Wong, Sachs, and Freebody et al. have reported similar results, whereas Debeyre & Dorat obtained good results in 73 per cent. Stauffer & Coventry obtained clinically satisfactory results in only 36 per cent, but their material comprised many patients who were having the operation for symptoms of pseudarthrosis following posterior fusion or instability following one or more laminectomies. Hodgson & Wong reported a greater relief from pain than would have been expected judging by the radiological healing result, although they achieved radiologically solid fusion in a very high percentage of cases, especially when using iliac grafts. Harmon obtained solid fusion in 95 per cent, Freebody et al. in 84 per cent, and Debeyre &

Dorat in 76 per cent, whereas Stauffer & Coventry had solid healing in only 56 per cent of their unfavourably biased material. We obtained solid healing in 90.5 per cent, or in 91.8 per cent of the fused discs, which we consider satisfactory.

Complications. Deep vein thrombosis and other postoperative complications occurred in less than 1 per cent of Harmon's patients. This must be ascribed to the energetic and early mobilization, as the patients were discharged within 9 days. Hodgson & Wong encountered deep vein thrombosis in two out of 74 operated patients, Sachs in two out of 50 plus two cases of non-fatal pulmonary embolism. Freebody et al. recorded 11 per cent with deep vein thrombosis and three cases of pulmonary embolism among 252 operated patients (one fatal pulmonary embolus). Among 83 operated patients Stauffer & Coventry found three with deep vein thrombosis and one with pulmonary embolism, and Debeyre & Dorat recorded two cases of deep vein thrombosis among 184 patients plus two cases of pulmonary embolism. In our material we had two cases of fatal pulmonary embolism. This may have been a chance coincidence, as the frequency of embolism in our Department is otherwise very low (one in more than 1200 operations for osteoarthritis of the hip), but in one of the cases it was due also to the indications for operation. We would not have done this operation today on this patient. We have not subsequently encountered this complication.

Cardiac arrest during the operation has been reported by Stauffer & Coventry and by Freebody et al., but without sequelae.

Only Stauffer & Coventry have reported the occurrence of anterior displacement of the inserted grafts (one case) requiring re-operation. Infection in the disc space arose in two of Stauffer & Coventry's patients and in one of Hodgson & Wong's.

The *indications* have varied, and this has influenced the results. Stauffer & Coventry's series in particular differed from those of

others because of the particularly biased material.

The reason why this operation has not gained as much ground as it deserves is, apart from anxiety due to technical problems, the difficulty and uncertainty of the task of selecting pts who can be expected to achieve a satisfactory result. Harmon (1963) has demonstrated the importance of the organic changes being of sufficient severity judging by myelograms, X-ray motion films, and mature clinical consideration, as well as testing, during the operation, of the grade of disc degeneration by injecting saline solution into the disc space. Candidates for this operation usually have a long history of constant pain, and this is bound to affect them psychologically, so that many of them have neurotic symptoms, possibly inveterate neurosis, which can decisively affect the result. Therefore, Wilfling et al. (1973) have suggested including psychological tests in the assessment. Our material confirms that mental disorders may aggravate the result, even when a definite cause of pain cannot be demonstrated clinically or radiologically. Patients who have not been relieved of pain go on consulting the orthopaedic surgeon unlike those who are free of pain, and this distorts the evaluation of the results, thus influencing his future attitude to the indications. Therefore, follow-up is necessary. Thereby, the result proves to be considerably better than assumed *a priori*, viz., three-quarters cured or definitely better and 68 per cent working, in a country with a highly developed social welfare service. In our opinion, this method of treatment is still justified, but its indications have now been further elucidated. In the future we shall be very restrictive in the case of patients over 45 years of age, as 60 per cent of them are awarded disablement pension after the operation. We shall try to evaluate the patients' psyche more closely before deciding upon an operation and shall exclude patients having

fixed neurotic symptoms. Reserve should also be displayed in operating on patients who have previously undergone one or more operations for disc herniation, as there may be nerve root adhesions. Patients with spondylolisthesis should be followed for at least three years, and if there is the slightest suspicion of incipient pseudarthrosis posterior spondylodesis by screws through the arch defects or some other form of fixation should be performed.

The decision regarding the indications for operation and the operation itself should still be in the hands of very experienced orthopaedic surgeons, and it must be emphasized that the postoperative management, especially the prevention of thrombosis, makes great demands upon the staff.

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