

LONG-TERM RESULTS IN LUMBOSACRAL INTERBODY FUSION FOR SPONDYLOLISTHESIS

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Out of a group of 235 patients who underwent a lumbosacral interbody fusion, 24 who were operated on for spondylolisthesis and had a long follow-up period were isolated for careful clinical and radiological evaluation. All patients were examined 1 year after surgery and 10 years or more postoperatively. Bony fusion was achieved within 4 to 6 months in all cases except one. The clinical results, showed that all patients had a good or intermediate result after 1 year. After 10 years or more 20 patients still had a good result, three an intermediate result and one a poor result. Our special interest concerned the radiological behaviour of the discs above the fused segment. This was evaluated on flexion and extension films, preoperatively and 10 years postoperatively. After this period an instability, radiologically visible as a posterior shift of 3 mm or more, was found in three L4-5 segments. No instability was found in the L3-4 segments. The disc space height diminished in three cases in the L4-5 segment and in one case in the L3-4 segment. No definite conclusions could be drawn from the flexion and extension angles measured preoperatively and 10 years or more postoperatively. Analysis of the poor and intermediate results showed that low back pain may persist to some extent after previous posterior surgery. In two cases a correlation was found between narrowing and tilt of an L4-5 segment and pain. In these two cases there was also an inadequate correction of the preoperative olisthetic kyphosis. There was one case of persistent back pain without any clinical or radiological findings. Finally, of the 106 males out of the group of 235 patients, none had problems of postoperative sterility or persistent retrograde ejaculation.

Key words: spondylolisthesis; interbody fusion; long-term clinical results; radiological behaviour; adjacent discs

Accepted 13.ix.81

There has been some disagreement regarding the success rate of anterior spine fusion. Freebody and associates (1971) rate a success percentage of 92, Harmon (1960) of 95 per cent, Stauffer & Coventry (1972) of 56 per cent and, in contrast, Batchelor (1963) of 26 per cent. No real long-term results have been described except in a recent article by Flynn & Hogue (1979). They describe the results of anterior interbody fusion in 50 patients with a follow-up of between 5 and 15 years. Their clinical success rate was 52 per cent,

although no uniform technique of bone-grafting was done and various indications had led to the surgical intervention.

Most of the authors mentioned above also described a lack of correlation between the clinical success and the roentgenographic result. There is also some difference of opinion about how often sterility and impotence occur in men following the procedure of interbody spondylodesis (Freebody 1971, Humphries et al. 1961, Sachs 1965, Taylor 1970).

The present report deals with a carefully selected group of patients with one diagnostic indication for surgery, viz. spondylolisthesis, with clinical symptoms of instability or progressive slip and a uniform fusion technique. The shortest follow-up period was 10 years. The maximum period between operation and follow-up was 17 years.

In this report we present our observations with the purpose of resolving some of the conflicts of opinion mentioned above. Moreover, a long-term radiological study of the behaviour of the segments adjacent to the fused area was also carried out.

PATIENTS AND METHODS

From 1962 to 1979, 235 patients underwent a lumbosacral interbody fusion. Out of this group one category of patients was isolated, viz. those operated for spondylolisthesis of the lumbosacral segment and with a postoperative follow-up of at least 10 years.

This group consisted of 24 patients, 14 male and 10 female. The age at the time of operation varied from 12 to 48 years. All patients were examined 1 year after surgery and again 10 years or more postoperatively. Our special interest concerned not only the ultimate result after such a long period, but also the behaviour and the radiological appearance of the lumbar segments above the fused level. Therefore, a radiological system of measurements of the function of these segments was carried out. We used the methods described previously by Farfan (1973) and Van Akkerveeken et al. (1979).

These measurements were made on preoperative radiograms and again 10 years or more after spondylosis. Apart from these measurements a study of the results of the operation based on criteria such as pain relief, ability to work and to participate in sport was performed.

All patients had the bone-grafting procedure done at one level, L5-S1. At that time we did not use discography as a method for determining the number of levels to be fused. Only radiographs in flexion and extension were made.

Surgical technique

This technique was previously described by us in 1967 and 1969 and has not been changed since. It consists of a paramedian laparotomy and a retroperitoneal approach to the vertebral column. The layers of the peritoneum and the posterior abdominal fascia can be separated easily with blunt dissection (Figure 1). This gives excellent access to the retroperitoneal space and the lower lumbar vertebrae. By this approach the presacral nervous plexus, which has a complex and no circumscribed anatomy, and whose fibres are located directly underneath the peritoneum, can be kept out of the operation site. The presacral artery and veins are ligated and dissected. Then the annulus of the disc L5-S1 is excised and disc material removed with a grasping forceps. The end plates of the L5-S1 segment are chiselled away until fresh bleeding cancellous bone is visible (Figure 2). The height of the trough between these end plates is variable, but this is enlarged in all cases by means of a bone spreader. Before this manoeuvre the preoperative kyphosis of the slipped vertebral body is levered into a lordotic position (Figure 3). In young persons the degree of slip can also be corrected with this manoeuvre. In our opinion correction of the olisthetic kyphosis is essential and of more

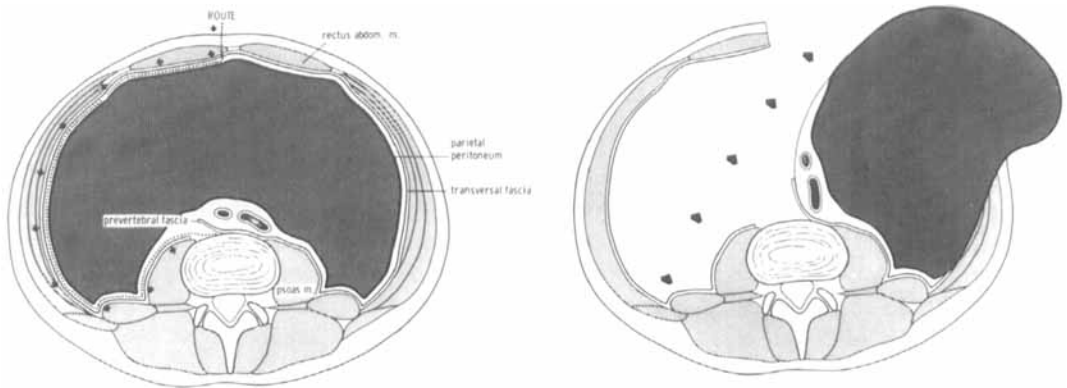


Figure 1. Pararectal incision and route of retroperitoneal approach to the vertebral column. Peritoneum and abdominal fascia can be separated easily and without any bleeding manually or with swabs. For the L4-5 or L3-4 segments the left lumbar arteries and veins have to be ligated and separated in order to mobilize the aorta and vena cava.

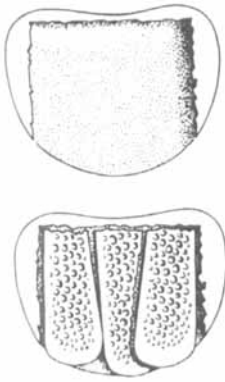


Figure 2. Schematic representation showing the bone-grafts.

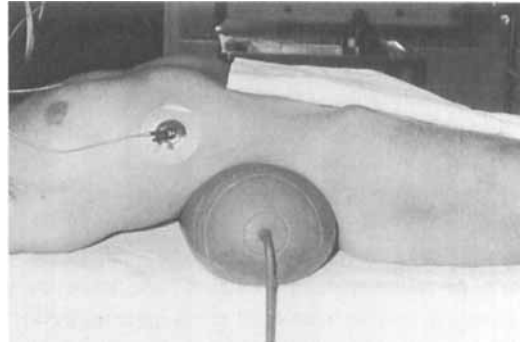
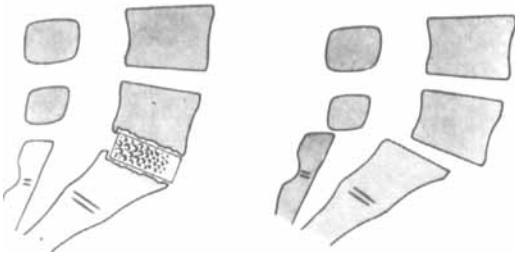


Figure 4. Inflatable pillow used during the operation to produce hyperlordosis.



importance than correction of the degree of anterior slip.

Often a complete or subtotal correction can be

achieved in young patients. In older patients, normally over the age of 30, where secondary changes due to the spondylolisthesis are present, only partial correction or no correction at all can be achieved. In these cases we perform a spondylodesis *in situ*.

During the operation the patient is placed on a cylindrical inflatable pillow (Figure 4), so as to produce hyperlordosis at the lumbosacral junction. This enables a thorough inspection of the intervertebral discs. The pillow is deflated when the bone grafts have been inserted into the trough of the olisthetic segment. This creates a good compression of the bone plugs to be inserted afterwards.

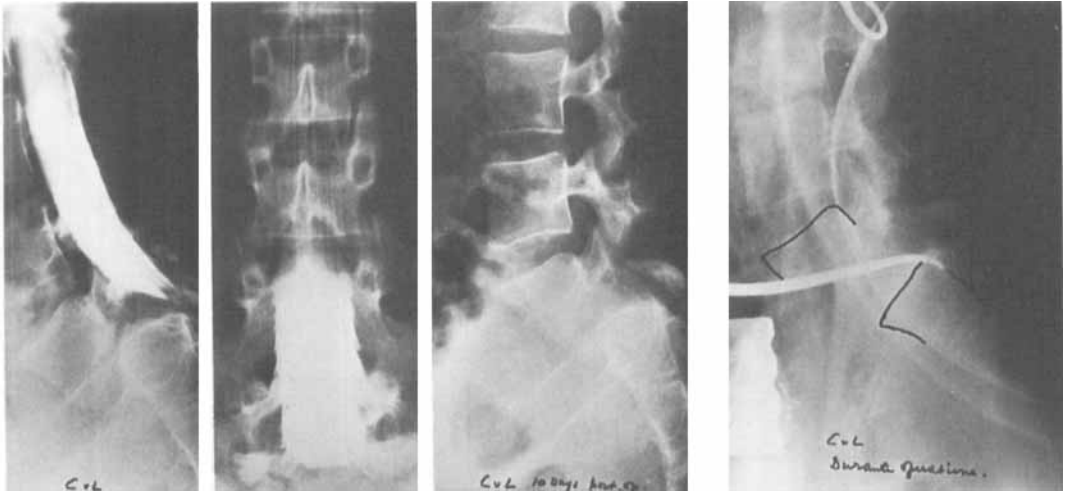


Figure 3. Peroperative X-ray of correction of the spondylolisthesis (right). The disc and the complete anterior part of the annulus have been excised. The patient lies on an inflated pillow, which can be seen as a balloon in this picture. Left: Preoperative and postoperative situation.

RESULTS

First of all the subjective results given by the patients themselves were studied. They could classify their result as *good* (= no pain, ability to perform any desired job, participate in any sport or perform other comparable social activities), *intermediate* (occasional, not disabling pain, able to work and participate in less demanding sports) or *poor* (chronic or intermittent pain, sometimes disabling, unable to work or participate in sport). Table 1 gives the results in the various age groups after 1 year, and

Table 2 gives the results 10 years or more after surgery.

Table 3 gives the correlation of these results with the degree of slip.

Table 4 gives the number of healed fusions related to the degree of spondylolisthesis.

The ability to work has been classified as follows:

- (3) – all kinds of work without complaints;
- (2) – no complaints whilst at work;
- (1) – some complaints whilst doing light work;
- (0) – inability to work.

The distribution of these classifications preoperatively and postoperatively is illustrated in Table 5. The fact that not all patients could be classified preoperatively is due to the fact that in the age group below 20 years some of the patients were of school-going age. The ability to work after 10 years or more showed a diverse distribution among the categories mentioned above,

Table 1. Subjective clinical results 1 year postoperatively

Age at operation (years)	No. of cases	No complaints	Intermediate (occasional pain, not disabling)	Poor (chronic or intermittent pain)
10–20	14	13	1	
20–30	4	4		
30–40				
40–50	6	4	2	

Table 2. Subjective clinical results >10 years postoperatively

Age at operation (years)	No. of cases	No complaints	Intermediate (occasional pain, not disabling)	Poor (chronic or intermittent pain)
10–20	14	13		1
20–30	4	3	1	
30–40				
40–50	6	4	2	

Table 3. Subjective clinical results related to degree of spondylolisthesis 10 years or more postoperatively

Degree of spondylolisthesis	No. of cases	Good	Intermediate	Poor
I	8	6	1	1
II	2	2		
III	6	5	1	
IV	8	7	1	

Table 4. Number of healed fusions related to the degree of slip after 1 year

Degree of spondylolisthesis	No. of segments	Fused	Failed
I	8	8	1
II	2	1	
III	6	6	
IV	8	8	

Table 5. Ability to work

Category	3	2	1	0
Preoperative	1	4	7	4
Postoperative (1 year)	17	2	3	2

Table 6. Ability to participate in sport

Category	3	2	1	0
Preoperative		1	8	15
Postoperative (1 year)	17	3	2	1

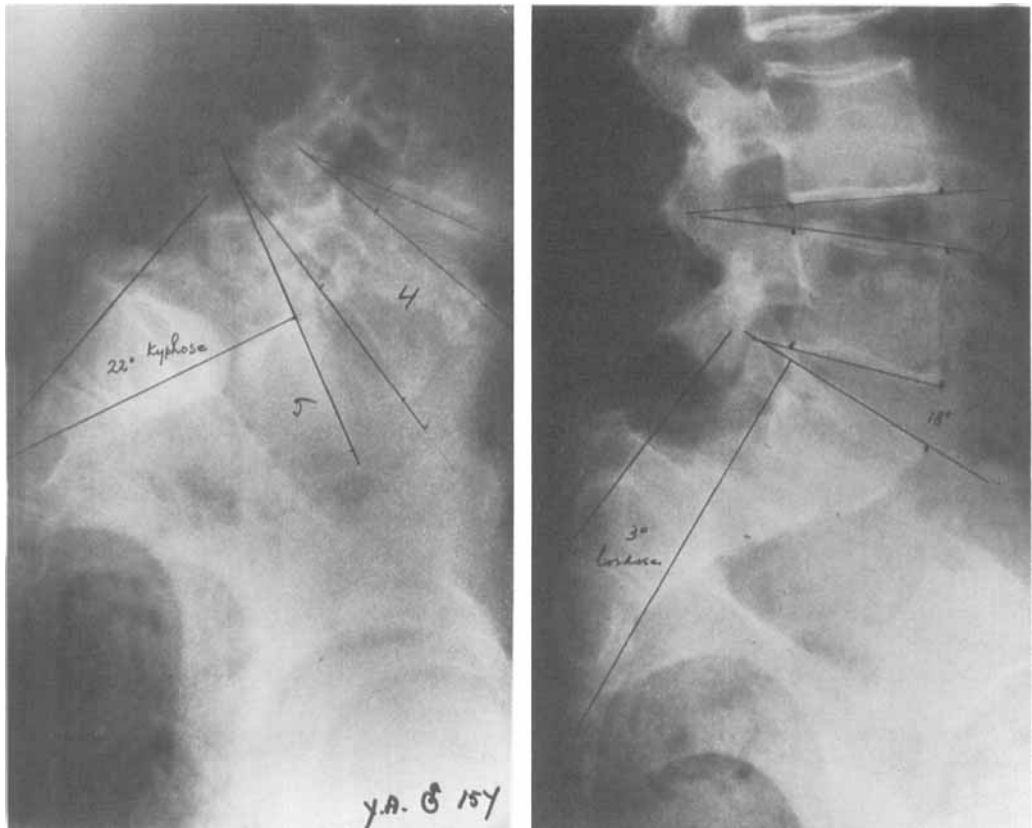


Figure 5. Measurement of flexion-extension angles, lumbosacral kyphosis and parallel vertebral shift in a case of third degree spondylolisthesis. The lumbosacral kyphosis has been changed into a lordosis of 3 degrees.

mainly due to the altered social conditions of an affluent society such as Holland and to unemployment. No general conclusions could be drawn at that point of time postsurgically.

Two patients were not working: one due to inability to do his work as a railway engineer and the other because of early retirement as a military man. Four had changed work because of reasons unrelated to their previous surgery. Two were unemployed. All women were able to carry out their household duties.

The ability to participate in sport was classified as:

- (3) – unlimited;
- (2) – unlimited for less demanding kinds of sport;

- (1) – limited for less demanding kinds of sport;
- (0) – unable to participate in sport.

Table 6 shows the pre- and postoperative ability to participate in sport of the entire group of 24 patients after 1 year. Due to age-related factors with respect to the ability to participate in sport, this classification cannot be made after 10 years or more.

The roentgenographic results in the 24 patients were measured on standard AP, lateral and lateral flexion and extension pictures preoperatively and 10 years or more postoperatively.

We measured the disc space height according to the method described by Farfan (1973). In an evaluation of Pope et al. (1977) this method was described as the most reliable way of obtaining an

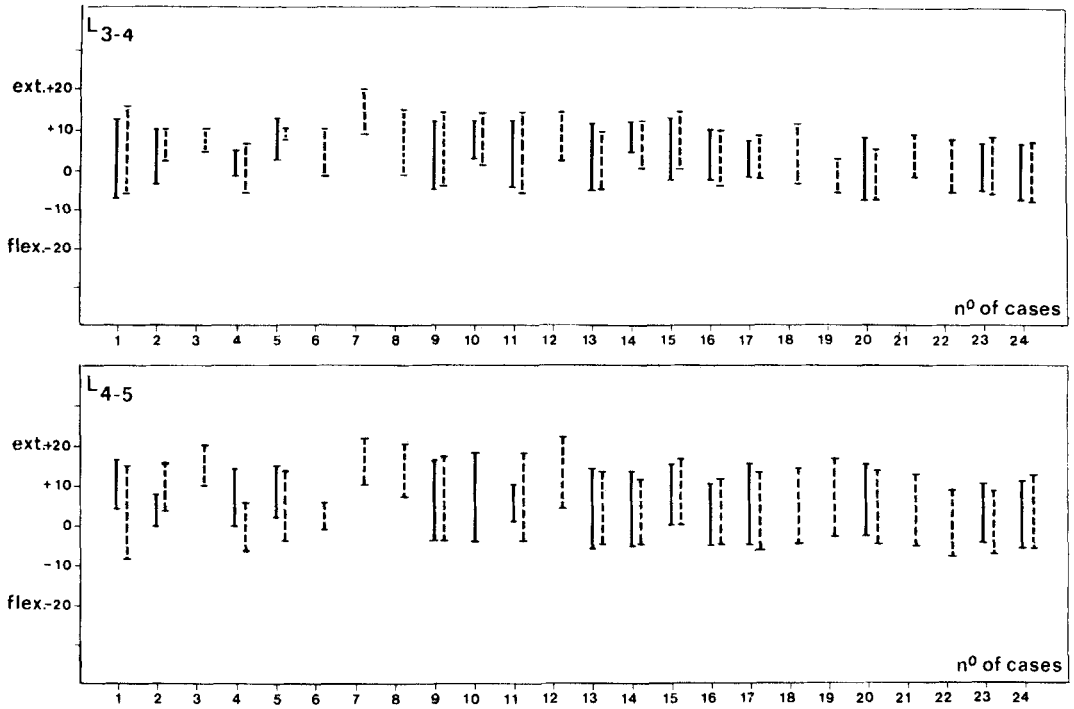


Figure 6. Flexion-extension angles in the L3-4 and L4-5 segments preoperatively and at examination 10 years or more after fusion of the L5-S1 level. Preoperative — Postoperative - - - -.

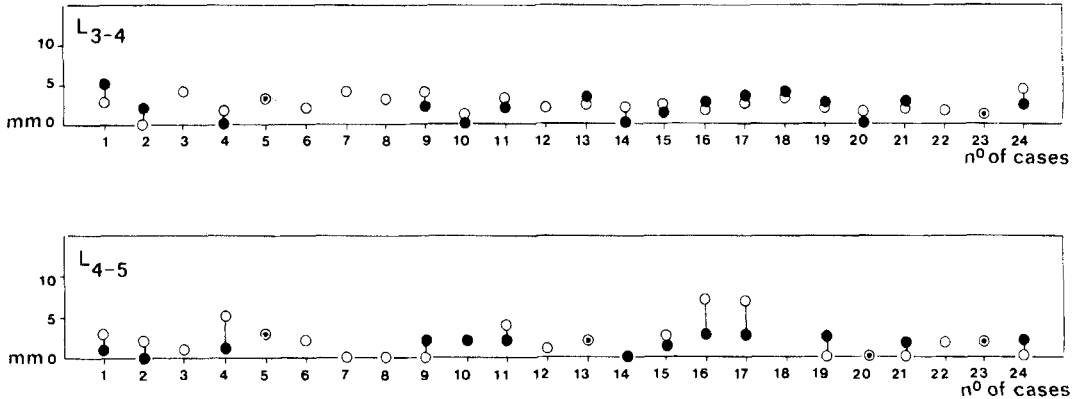


Figure 7. Pre- and postoperative parallel vertebral shift in the two segments adjacent to the fused area. In three L4-5 segments this parallel shift was more than 3 mm, 10 years or more postoperatively. Signs of instability were found in the L3-4 segments. Preoperative ● Postoperative ○

accurate estimate of the disc space height. The mobility of the segments adjacent to the fused area was measured according to the method described by Van Akkerveken et al. (1979) (Figure 5). Based on these measurements we calcu-

lated the degree of tilt and the length of the parallel displacement in flexion and extension. Figure 6 demonstrates the pre- and postoperative degrees of flexion and extension in the L3-4 and the L4-5 segments. Accepting 3 mm posterior

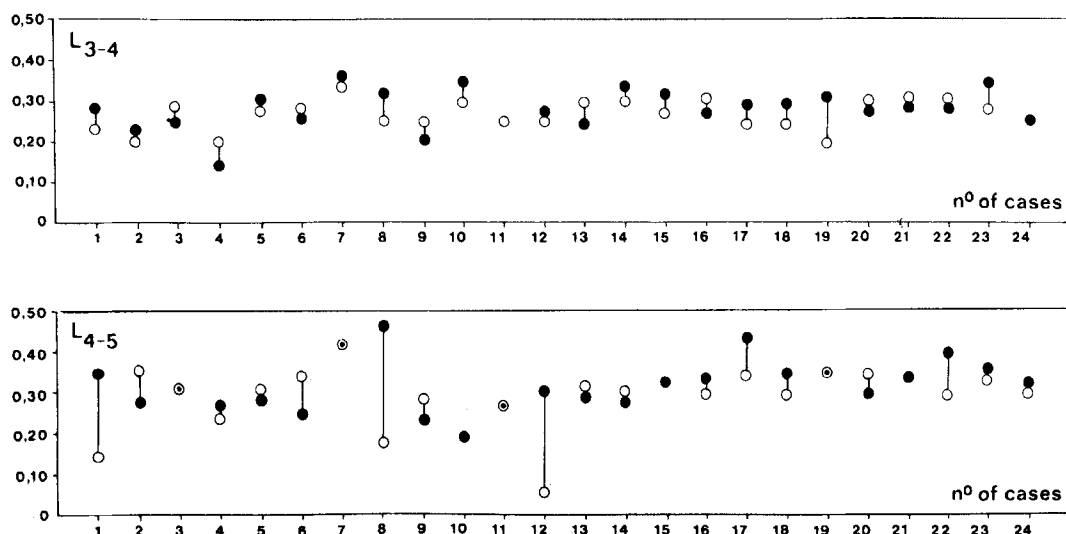
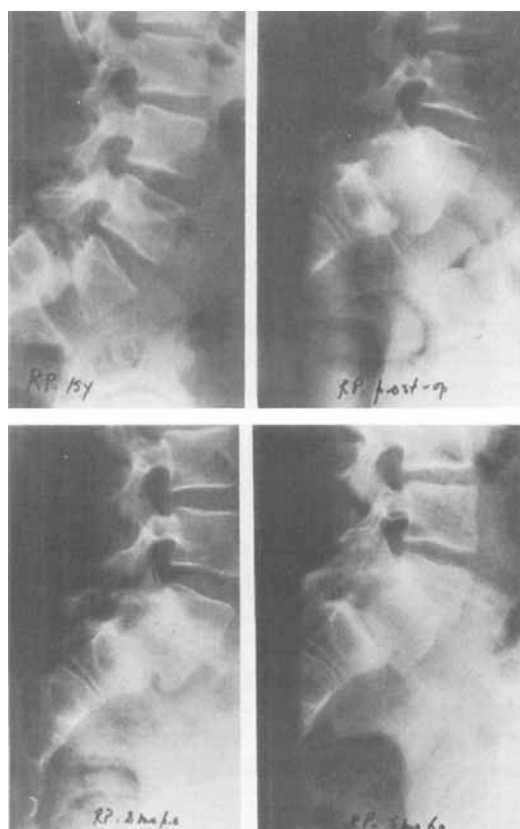


Figure 8. Ratio of anterior and posterior disc space height and disc diameter measured according to Farfan ($A_1 + A/2D$). In three L4-5 segments the disc space height diminished considerably, whereas in the L3-4 discs this occurred in only one segment. Preoperative ● Postoperative ○



shift or more as a sign of instability, three of the L4-5 segments showed a progression of instability after 10 years or more postoperatively (Figure 7). Two of them had a kyphotic L5 vertebra. No long-term postoperative instability was found in the L3-4 segments. The disc space height diminished in three cases in the L4-5 segment and in one case in the L3-4 segment. Figure 8 illustrates these findings. Figure 9 gives a follow-up of an operated spondylolisthesis from preoperatively through 5 months postoperatively. Note that after 5 months also the defect in the posterior part of L5 has fused.

In our material we encountered one case of pseudarthrosis. Retrospectively, the cause of this failure was an inadequate grafting technique. Although two iliac grafts had been inserted, the graft bed had not been properly prepared. The impression was that this was due to insufficient removal of the end plate of S1, which caused necrosis of the inserted bone at that site of the

Figure 9. Follow-up after interbody fusion in a 15-year-old boy with spondylolisthesis. Note the fusion of the posterior defect of L5 after 5 months.

Table 7. Analysis of patients with a subjective intermediate or poor result

Age at operation	Category	Cause of complaint(s)	Olisthetic kyphosis corrected?
21	Intermediate	Degeneration L4-5	No
41	Intermediate	Pseudarthrosis	Yes
16	Poor	Solid fusion. No other signs or symptoms.	Yes
		Discrepancy. Psyche?	
42	Intermediate	Previous Gill procedure and non-healed posterior fusion	No

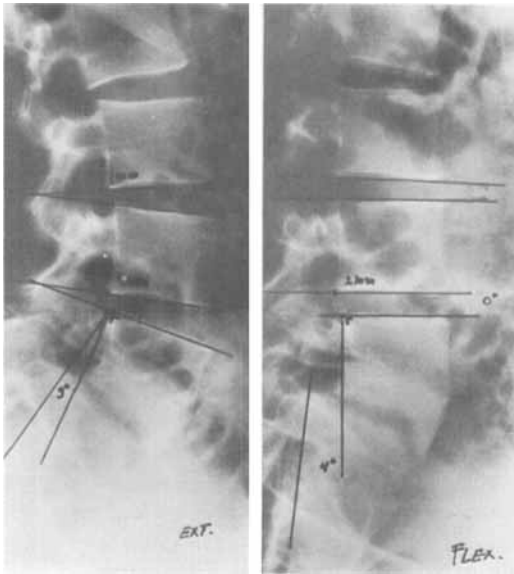


Figure 10. A case of pseudarthrosis after L5-S1 interbody fusion due to inadequate removal of the end-plate of S1.

fusion (Figure 10). In Table 7 there is an analysis of the 'poor' and 'intermediate' results giving the most probable cause of complaints.

DISCUSSION

The clinical criteria and the function of the back demonstrate a marked improvement after 1 year, which is maintained after 10 years or more postoperatively. It appears that low back pain may

persist to some extent after previous posterior surgery and when secondary disc degeneration in the segments adjacent to the fused area(s) develops. In two cases we found a correlation between pain and narrowing and tilt of a segment overlying the fused area. In these two cases there was also inadequate correction of the listhetic kyphosis. However, one patient with L4-5 disc space narrowing did not have any complaints. In this case no listhetic kyphosis persisted after fusion of L5-S1. Finally, in one case back problems persisted without any clinical or radiological findings, psychosomatic reasons or pension neurosis being a possible explanation.

Stauffer & Coventry (1972) stated that many patients who achieve good clinical results after lumbosacral interbody fusion gain their maximal symptomatic relief by 1 year postoperatively. Flynn & Hogue (1979) believe that this interval is longer in many cases. Our findings in cases with spondylolisthesis demonstrate a bony consolidation of 23 out of 24 cases within 6 months postoperatively. The clinical results are somewhat better after 1 year than after 10 years or more postoperatively.

We believe that the best conditions for bony fusion are: early mobilization of the patient in a plaster hip spica or a comparable corset which allows axial compression of the spine, but immobilizes the lumbosacral junction, and a surgical technique by which iliac bone grafts are inserted in a widened disc space, with reposition of the slipped vertebrae. Correction of the preoperative kyphosis is of utmost importance. The widening of the operated segment can be achieved by

means of a spreader. A good contact of the cancellous bony surfaces of the grafts and the resected end plates is imperative. This enables an early adaptation of the transplanted iliac bone in the resected interbody segment. Following this procedure, 21 out of 24 patients in our series were completely free of pain after 1 year and so were 20 out of 24 after 10 years or more postoperatively. The best results were gained in the younger age group (<30 years).

When the discs adjacent to the fused segments are studied radiologically for a sufficiently long period, i.e. 10 years or more, no striking rate of disc space narrowing is seen. After this period only three discs in the L4–5 segment and one in the L3–4 segment were narrower than preoperatively.

No data are available regarding disc space narrowing in comparable age groups during the same period in normal persons. Radiological symptoms of instability, such as posterior displacement on lateral extension pictures of 3 mm or more, were seen in 3 out of 24 patients with a fused spondylolisthesis in the L4–5 region. Again no data are available in normal humans.

An anterior interbody fusion for spondylolisthesis seems not to provoke early deterioration of the adjacent discs, provided that the position of the adjacent vertebrae is normal. The fused segment acts as a lumbalization or sacralization without any particular side-effects. The good results in spondylolisthesis with anterior interbody fusion confirm the results of many other authors (Freebody et al. 1971, Jung et al. 1974, Merle d'Aubigné et al. 1950, Sachs 1965, Speed 1938, Hodgson & Wong 1968). The procedure allows early mobilization and enables a thorough radiological evaluation. In case of doubt, tomography can give exact information.

This is contrary to the dorsal and paravertebral fusions, where no exact judgement of the quality of the bone-bridged area can be achieved. Finally, a secondary fusion of the defect in the pars interarticularis of the slipped vertebra is often seen after solid fusion of the resected interbody segment (Figure 10). Olson (1976) demonstrated in a few patients that the operated areas in these types of fusion can still be shown to be mobile, on flexion and extension pictures marked with the

Selvik (1974) technique, in spite of the fact that they were thought before to be fused radiologically.

One observation of importance concerning our patients, which was mentioned earlier, is the problem of postoperative sterility in the male. Our 14 male patients did not have this complication. Nor did we encounter a single case in our series of 235 patients, 106 of which were males. Possibly the retroperitoneal approach is less hazardous in this respect than the transperitoneal, but even then this complication is quite uncommon. Flynn & Hogue (1979) reviewed the literature on postoperative potency and retrograde ejaculation and stated that this seems to be transient and sometimes psychological in origin.

In conclusion it may be stated that retroperitoneal anterior interbody fusion of the spine is a good primary procedure for spondylolisthesis. With the technique described here and early mobilization in a plaster spica, a solid structural bony fusion could be achieved within 4 to 6 months postoperatively in 23 out of 24 patients operated on for spondylolisthesis. A 10-year or more follow-up revealed one pseudarthrosis and no early deterioration of the segments adjacent to the fused area.

These segments show no premature degeneration nor progression of instability, provided that a natural position of the segments has been achieved. In cases of severe spondylolisthesis this means correction of the olithetic kyphosis. Correction of the degree of slip seems to be of less importance.

Clinical success, as measured by pain relief, ability to work and participate in sport, usually is determined 4 to 6 months postoperatively.

Pain relief correlates to some extent with the presence of disc degeneration in the segments adjacent to the fused area and pseudarthrosis, although in one case previous posterior surgery and in another patient psychological problems were the cause of an 'intermediate' and a 'poor' result.

In our series we encountered no case of impotency or retrograde ejaculation.

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