THE DEVELOPMENT OF DISCOPATHY IN LUMBAR DISCS ADJACENT TO A LUMBAR ANTERIOR INTERBODY SPONDYLODESIS. A RETROSPECTIVE MATCHED-PAIR STUDY WITH A POSTOPERATIVE FOLLOW-UP OF 16 YEARS

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Of 46 patients who underwent a lumbar or lumbosacral anterior interbody fusion at one or two levels, 16 were available for a follow-up of 16-20 years. The indications for operation were instability, degenerative disc disease, pseudarthrosis of a posterior fusion, and spondylolisthesis. Preoperative roentgenograms were compared with those made at follow-up 16 years (or more) later. In only a minority of patients was discopathy or instability found. The roentgenographic findings of the operated patients at a follow-up of at least 16 years were compared with those of a group of age- and sex-matched controls not previously treated for backache. We found that most degenerative changes of the adjacent discs occurred at a rate nearly similar to that in the corresponding levels of the controls. These results may suggest that lumbar anterior interbody spondylodesis does not accelerate the development of degenerative changes in adjacent discs.

Keywords : lumbar spine ; interbody fusion ; discopathy ; adjacent discs.
Mots-clés : colonne lombaire ; greffe intercorporéale ; discopathie ; disques voisins.

INTRODUCTION

Anterior lumbar interbody fusions are currently performed operations in case of severe discopathy or segmental instability due to spondylolisthesis, discopathy, or previous spine surgery. As in other types of lumbar spondylodesis the immobilization of a segment may result in higher biomechanical demands on the adjacent discs.

In the literature there is only scant information on the development of discopathy in the adjacent discs as a consequence of an isolated lumbar spondylodesis. Cauchoix and David (1985) studied 75 patients who underwent different types of lumbar spondylodesis with a postoperative follow-up of at least 10 years. They detected frequent radiographic evidence of degenerative lesions and some slipping of the vertebrae in adjacent discs. They suggest that a lumbar arthrodesis is responsible for an abnormally rapid degeneration of adjacent discs.

In contrast, in our previous study (11), we did not find a striking rate of disc degeneration or segmental instability in adjacent discs of 24 patients, at more than 10 years after lumbar interbody fusion for spondylolisthesis. In the literature we found no data comparing the occurrence of segmental degenerative signs of the lumbar spine in patients who underwent a lumbar interbody

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fusion and normal persons of comparable age-groups.

In the first part of this study (the longitudinal part) we tried to determine if our 16 patients, with a lumbar or lumbosacral interbody fusion, in the course of time developed degenerative changes in disc levels adjacent to the fusion.

In the second part (the matched-pair study) we determined whether at the last follow-up visit our patients had roentgenographic signs of discopathy more frequently than asymptomatic individuals of the same age and sex.

PATIENTS AND METHODS

In the period from 1962 to the end of 1966, 46 patients underwent a lumbar or lumbosacral interbody fusion in the Sint Radboud Hospital in Nijmegen. Out of this group one category of patients was isolated, i.e. those who had an uninterrupted postoperative follow-up of at least 16 years. For each patient, we selected a matched control of the same age and sex who never had orthopedic treatment for back complaints. This way we could select 16 matched pairs of a patient and a control subject.

The patient group consisted of 7 males and 9 females. The age at the time of operation ranged from 16 to 47 years (mean age 35 years). The mean follow-up period was 17.5 years (with a minimum of 16 years and a maximum of 20 years). The patient group (N = 16) could be classified according to the fused levels: 2 patients L4-L5, 9 patients L5-S1, and 5 patients L4-L5 and L5-S1.

The indications for the interbody fusions were different. Two patients had segmental instability after laminectomy, and 4 had a pseudarthrosis of a previous posterior fusion. Two patients had a spondylolisthesis, 6 suffered from discopathy, and 2 other patients showed discopathy at the same level as their spondylolisthesis. At the time of the operation 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.

Our special interest concerned the behavior and radiological appearance of the adjacent segments above or below the fused level. Therefore, radiological measurements of the function of these segments were made. We used the methods described by Farfan (3) for the disc space height, and Van Akkerveeken *et al.* (1) for the mobility of the segments adjacent to the fused area. These measurements were made on preoperative radiograms or on the earliest postoperative radiograms, again at several occasions during the follow-up period and finally 16 years or more after spondylodesis. They constitute the longitudinal part of this study.

In the matched-pair study, the same measurements were made on radiograms of the patient group at the time of the last follow-up, and these were compared with those of the controls.

Surgical technique

The technique of anterior interbody fusion is the same as has been described previously (9, 10, 11).

RESULTS

The roentgenographic results in the 16 patients were measured on standard AP, lateral, and lateral flexion and extension views, at several occasions preoperatively and up to 16 years or more postoperatively. If preoperative pictures were absent, we measured the first postoperative pictures.

Figure 1 demonstrates the pre- and postoperative range of flexion-extension movements in the lower lumbar discs. Because of the small number of measurable L1-2 levels in the preoperative radiograms we did not consider the development of degenerative signs at this level. According to the criteria for segmental instability on flexion and extension radiograms described by Nachemson (7), no progression in abnormal flexion or extension angles as a possible sign of segmental instability in adjacent discs after 16 years or more postoperatively could be found, as shown in fig. 2. Figure 3 shows the parallel displacement during flexion and extension preoperatively and postoperatively. Accepting 3-mm anterior-posterior shifts or more for the segments L1 to L5 and 4 mm for L5-S1 as a sign of instability (7), we were able to distinguish four modes of development (table I): Eighteen of 30 adjacent segments did not change at all (group B plus group D). The other 12 segments showed changes in stability: Four stable segments eventually became unstable (group A), while 8 unstable segments became stable (group C).

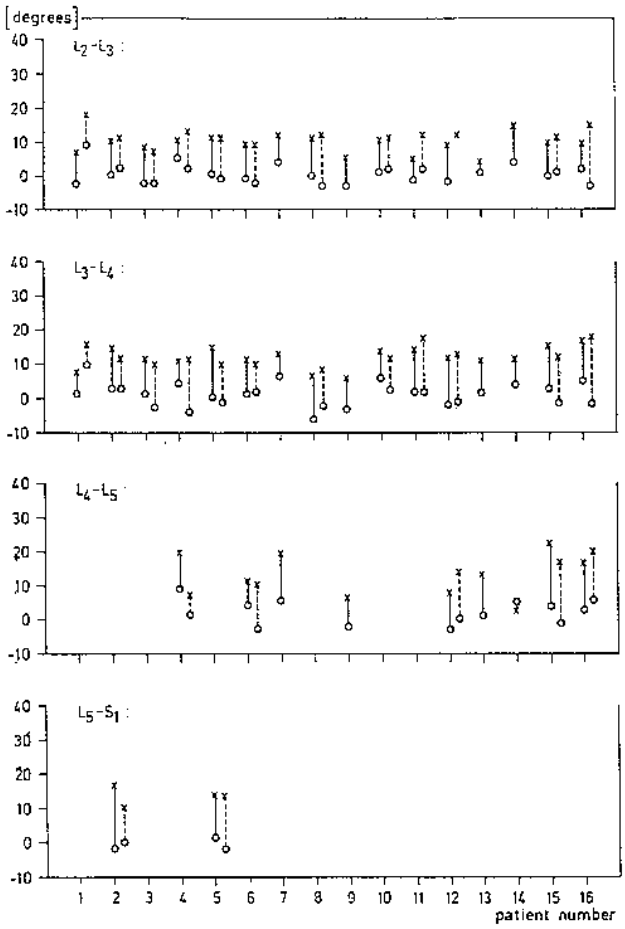

Fig. 1. — Comparison of flexion (o) and extension (x) range of pre- or immediate postoperative radiographs (solid lines) and those at follow-up (dotted lines).
Mean follow-up time 17 years, 6 months.

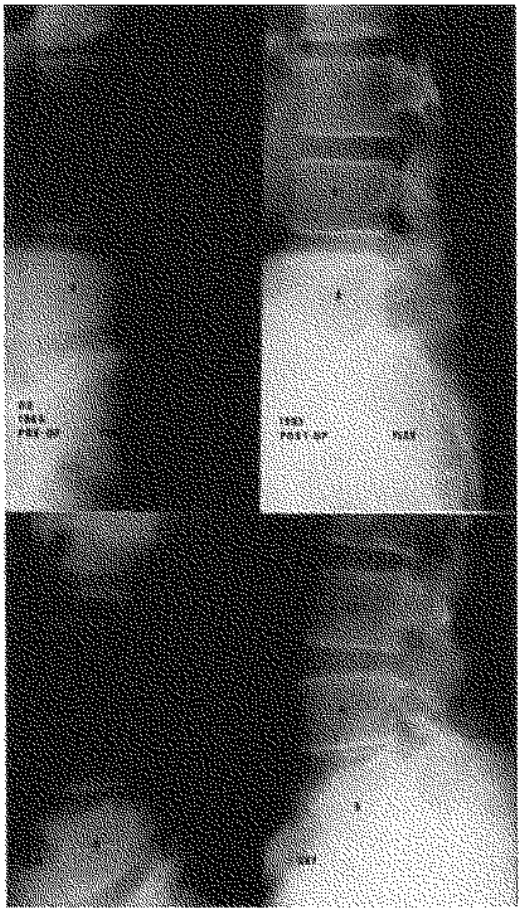

Fig. 2. — Lateral radiograms of the lumbar region in flexion and extension preoperatively (left) and postoperatively (right) of a patient who underwent an L5-S1 spondylodesis.

Table I. — Analysis of figure 2 : (A-D shift) During the follow-up, four modes of development can be distinguished : of the 43 free segments (without a fixed fusion) we could compare 31 segments during follow-up time. Because of insufficient roentgenographic representation we could not compare the remaining 12 segments (viz. 5 segments at level L2-L3, 4 segments at L3-L4 and 4 segments at L4-L5)

	A) a stable segment becomes unstable	B) an unstable segment remains unstable	C) an unstable segment becomes stable	D) a stable segment remains stable	Number of free segments that can be compared	Total of free (unfixed) segments
L2-3	1	1	3	6	11	16
L3-4	0	3	3	6	12	16
L4-5	3	0	2	0	5	9
L5-S1	0	0	0	2	2	2
Total	4	4	8	14	30	43

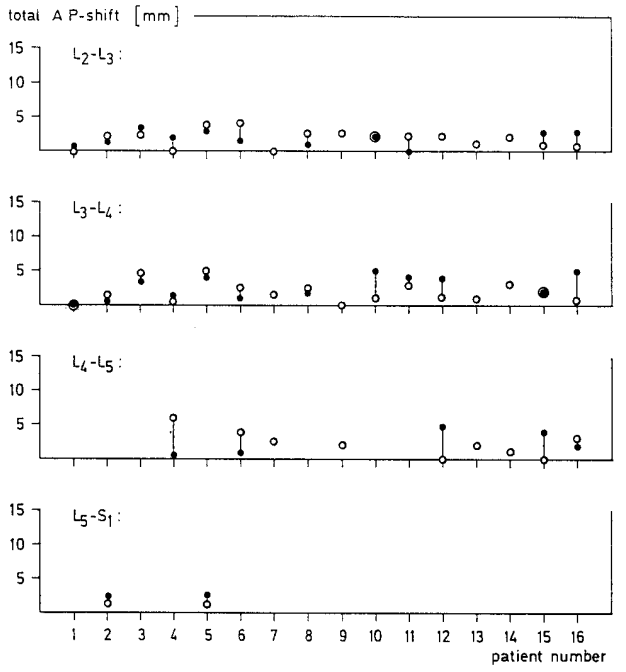

Fig. 3. — Comparison of A-P parallel vertebral shifts in the segments adjacent to the fused level, between the preoperative or first postoperative radiographs (●) and those at follow-up 16 years or more after fusion (○).

The number of unstable segments that eventually became stable (group C : 8 segments) obviously surpasses the number of stable segments that became unstable (group A : 4 segments). These results suggest that there is no progression of segmental instability in our patients during a long follow-up.

Figure 4 shows the disc space height in the adjacent discs, according to the method described by Farfan (3). An example is shown in fig. 5. Because of inherent inaccuracy of measuring on roentgenograms, as previously described by Pope *et al.* (8), we accepted a decrease of 25% or more as a significantly diminished disc space height. Table II shows that we found a diminished disc space height in 4 adjacent discs out of a group of 31 segments.

In the second part of this study (the matched-pair study) we compared the measurements as described above in the patients with those in the matched controls at corresponding levels. In accordance with Knuttson (6) we studied segmental instability as a characteristic of disc degeneration, by using the same measurements and criteria we used in the first part of this study. As in the matched pair study we counted all segments with discopathy present at the last follow-up. The total number will be higher than in the first part of the study, where we only studied the evolution of normal to discopathic segments, and did not count discopathic segments already present at the time of operation.

It can be seen from table III that both groups showed evidence of discopathy in part of the studied segments. The controls showed discopathy even more often (21 segments) than the patients (17 segments). There was no striking difference in

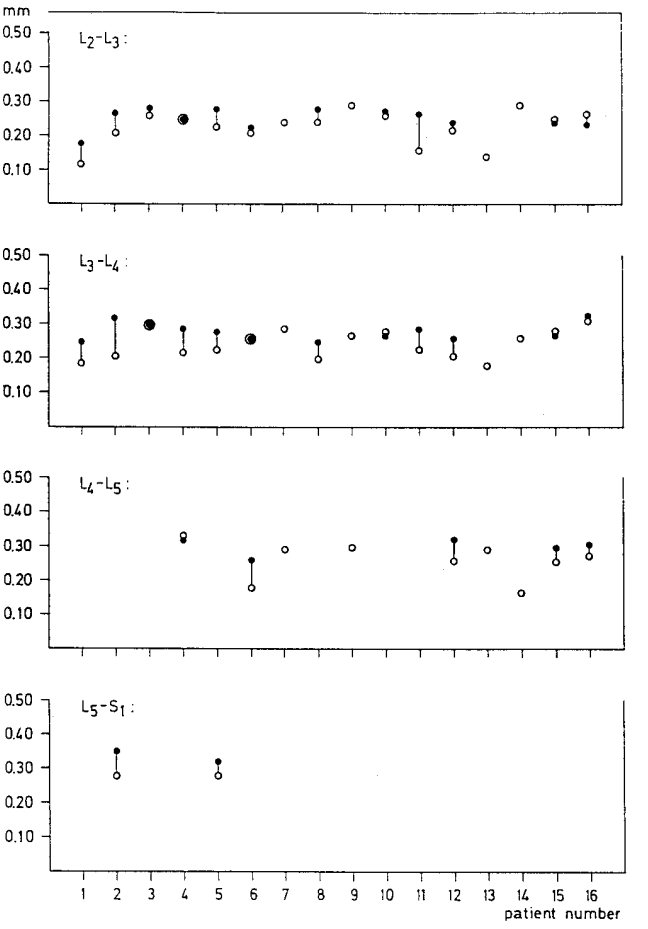

Fig. 4. — Ratio of anterior and posterior disc space height measured according to Farfan (3)

$$\frac{(A1 + A2)}{2D}$$

A comparison of values between the preoperative or first postoperative pictures (●) and those at follow-up (○).

Table II. - Analysis of figure 3 : During the follow-up only 4 segments out of a group of 31 discs showed a diminished disc space height. Because of insuffiscient roentgenographic representation we could not compare the other 8 segments

Segment	Total number of segments with diminished disc height space	Total number of free segments that can be compared	Total number of free segments (without fixed fusion)
L2-3	2	12	16
L3-4	1	12	16
L4-5	1	5	9
L5-S1	0	2	2
Total	4	31	43

Table III. — The different types of discopathy in the patient group and the controls

Type of discopathy	P	C
A) Segmental instability	7	11
B) Diminished disc space height without segmental instability	8	6
C) Diminished disc space height plus segmental instability	2	4
(N = 43)	17	21

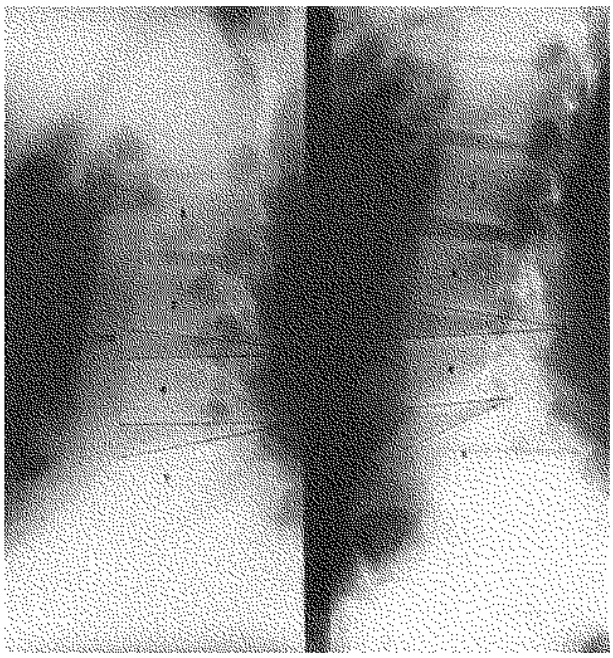

Fig. 5. Lateral radiograms of the lumbar region preoperatively (1963) and postoperatively (1983) of a patient treated with L5-S1 spondylodesis.

the distribution of the type of discopathy (A, B, C) between the two groups (table III). It was interesting to remark that 11 out of the 16 detected segments with discopathy in the patient group were localized directly adjacent to the segment with a fixed spondylodesis. Of the other 5 levels showing discopathy, 3 were found at a distance of one interjacent disc and 2 at a distance of two interjacent discs.

Whereas all patients with discopathy in adjacent discs had complaints from time to time, we could not find a correlation between the characteristics of their complaints and the number or type of discopathy per patient. In addition, only 2 out of 4 patients with no evidence of discopathy at all were free of complaints.

DISCUSSION

As in our previous study (11), dealing with a 10-year follow-up in 24 patients who underwent an anterior interbody fusion, we did not find a striking rate of disc space narrowing on roentgenograms in adjacent discs. Radiological symptoms of instability 16 to 20 years after the operation were present in 8 out of 30 studied segments. Four of these 8 segments already were unstable at the time of the operation ; therefore only a minority of adjacent discs showed newly developed instability. This finding is in accordance with the results in our previous study (11).

Another interesting observation is that the number of unstable segments that finally became

stable clearly surpasses the number of stable segments that became unstable (see table I). This appears as a decrease in the total number of unstable lumbar segments during a long post-operative period. We think that this development can be attributed to the normal process of aging of the human spine (see also ref. (12)). We found that most degenerative changes of adjacent discs occurred at a frequency nearly similar to that in asymptomatic individuals of the same age and sex. This comparison with a matched control group confirms the results of our previous study (11).

Our present study does not enable us to explain these findings definitely. They may be related to the capacities for compensation of the adjacent segments, or by changes in behavior of the patients postoperatively as has been stated by Goymann *et al.* (5).

Farfan (3) does not support the first explanation, as he indicates the limited capacities for compensation in the other lumbar segments.

The subjective clinical results in the present study correlated only to some degree with the presence of disc degeneration in the segments adjacent to the fused area. All our patients with discopathy in adjacent discs had different kinds of complaints that were totally independent of type or extent of discopathy, whereas only half of the patients without discopathy had no complaints at all. Similar results are reported by other investigators (2, 4, 11, 13). It can be concluded from the present study that anterior interbody fusion in one or two intervertebral disc spaces in the lumbar or lumbosacral spine, after a 16-year follow-up period, did not induce early degeneration of adjacent discs, or discopathy in a higher frequency than could be found in a group of normal people matched for age and sex. It is clear that the small number of patients and controls in this study (n = 16) does not allow general conclusions for all patients with interbody fusions.

REFERENCES

1. Van Akkerveen P., O'Brien J., Park W. Experimentally induced hypermobility of the lumbar spine. Spine, 1979, 4, 236-241.
2. Cauchoix J., David T. Arthrodèses lombaires : Résultats après plus de 10 ans. Rev. Chir. Orthop., 1985, 71, 263-268.
3. Farfan H. F. Mechanical disorders of the low back. Lea and Febiger, Philadelphia, 1973, 25-28, 37-38, 204-205, 225.
4. Flynn J. C., Hoque M. A. Anterior fusion of the lumbar spine. End result with long-term follow-up. J. Bone Joint Surg., 1979, 61-A, 1143-1150.
5. Goymann V., Thümler P., Konermann H. Das benachbarte Bewegungssegment — Reaktionen nach interkorporeller Spondylodese. Z. Orthop., 1980, 118, 514.
6. Knuttson F. The instability associated with disc degeneration in the lumbar spine. Acta Radiol., 1944, 25, 593-609.
7. Nachemson A. L. The role of spine fusion : question 8 : How do you define instability ? How is this diagnosed, and what surgical treatment policy do you follow ? Spine, 1981, 6, 306-307.
8. Pope M. H., Hanley E. N., Matteri R. E., Wilder D. G., Frymoyer J. W. Measurement of intervertebral disc space height. Spine, 1977, 2, 282-286.
9. Van Rens T. J. G. Erfahrungen mit der vorderen lumbalen Spondylodesis bei der Kreuzschmerzbehandlung. Z. Orthop., 1967, 162, 546-558.
10. Van Rens T. J. G. The value and technique of anterior vertebral interbody fusion. Acta Orthop. Belg., 1969, 35, 752-762.
11. Van Rens T. J. G., Van Horn J. R. Long-term results in lumbosacral interbody fusion for spondylolisthesis. Acta Orthop. Scand., 1982, 53, 383-392.
12. Schmorl G., Junghanns H. Die gesunde und die kranke Wirbelsaüle in Röntgenbild und Klinik. G. Thieme Verlag, Stuttgart, 1968, 209.
13. Stauffer R. N., Coventry M. B. Anterior interbody lumbar spine fusion. Analyses of Mayo Clinic series. J. Bone Joint Surg., 1972, 54-A, 756-768.

SAMENVATTING

J. R. VAN HORN en L. M. L. J. BOHNEN. De ontwikkeling van discopathieën van naburige lumbale segmenten bij een lumbale of lumbosacrale spondylodese. Een retrospectief matched-pair onderzoek met een postoperatieve follow-up van 16 jaar.

Van 46 patiënten, met een lumbale of lumbosacrale anterieure intercorporeale spondylodese op 1 of 2 niveau's, waren er 16 beschikbaar voor na-onderzoek met een follow-up van 16-20 jaar. De indicaties voor de operatie waren segmentale instabiliteit, discusdegeneratie, pseudarthrose van een posterieure fusie, en spondylolisthesis.

Preoperatieve röntgenfoto's werden vergeleken met die van 16 jaar (of meer) na de operatie. Slechts bij een minderheid van patiënten kon discopathie of instabiliteit

gevonden worden. De röntgenografische bevindingen van de geopereerde patiënten met een follow-up van meer dan 16 jaar werden vergeleken met een controlegroep, bestaande uit — naar leeftijd en geslacht gematchte — individuen zonder behandeling voor rugklachten. Wij vonden hierbij dat de meeste degeneratieve afwijkingen van aangrenzende disci ongeveer in dezelfde mate voorkwamen als op de hiermee corresponderende niveau's van de controlepersonen. Een ventrale intercorporeale spondylodese liet in deze groep (N = 16) geen versnelde of toegenomen ontwikkeling tot discopathie zien van aangrenzende segmenten.

RÉSUMÉ

J. R. VAN HORN et L. M. L. J. BOHNEN. Discopathies des disques adjacents à une greffe intercorporéale antérieure lombaire ou lombo-sacrée. Revue rétrospective avec recul de 16 ans.

D'un groupe de 46 patients, traités par greffe intercorporéale antérieure lombaire ou lombo-sacrée à un ou deux niveaux, 16 purent être réexaminés avec un recul de 16 à 20 ans. Ces interventions furent pratiquées sur les indications suivantes : instabilité segmentaire, dégénérescence discale, pseudarthrose d'une greffe postérieure et spondylolisthésis.

Les radiographies préopératoires furent comparées aux clichés de 16 ans (ou plus) après l'intervention. Dans une minorité des cas, on constata une discopathie ou une instabilité. Les radiographies des malades opérés avec un recul de plus de 16 ans, furent comparées avec un groupe témoin, composé d'individus de sexe et d'âge similaire, qui n'avaient suivi aucun traitement pour lombalgie. Cette comparaison montra que la plupart des lésions dégénératives des disques adjacents se présentaient de la même manière, aux mêmes niveaux que chez les témoins. Une greffe intercorporéale antérieure ne semble pas provoquer d'accélération ou d'augmentation des discopathies de voisinage (N = 16).