

AP-translation in the proximal disc adjacent to lumbar spine fusion

A retrospective comparison of mono- and polysegmental fusion in 120 patients

Cornelius Wimmer¹, Herbert Gluch², Martin Krismer¹, Michael Ogon¹ and Rupert Jesenko¹

120 consecutive patients with painful spondylolisthesis underwent combined anterior and posterior fusion. Patients were divided retrospectively into two groups. In group I, 46 patients were treated with monosegmental fusion. In group II, 74 had polysegmental fusion. The mean follow-up time was 3 (2–7) years.

Anterior posterior (AP)-translation in the first disc superior to fusion was measured according to Wiltse and Winter (1983). In group I, 3 and in group II, 10 patients developed an AP-translation of more than 3 mm in the disc adjacent to the fusion. AP-translation correlated with the number of fused segments and the follow-up time.

Departments of ¹Orthopedic Surgery, University of Innsbruck, Anichstrasse 35, A-6020 Innsbruck, Austria
Tel +43 512 504-2690. Fax -2701, ²Spinal Surgery, Vogtareuth, Germany
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Various studies have demonstrated disc degeneration adjacent to spinal fusion (Anderson 1956, Harris and Wiley 1963, Rombold 1965, Froning and Frohman 1968, Brodsky 1976, Frymoyer et al. 1979, Frymoyer 1981, Lee 1988, Axelsson et al. 1994, Pihlajamäki et al. 1996). We evaluated the AP-translation in the proximal disc adjacent to lumbar spine fusion and compared the incidence of AP-translation between monosegmental and polysegmental fusion.

Patients and methods

From 1986 to 1993, 120 consecutive patients (63 women), mean age 40 (9–65) years with painful spondylolisthesis underwent combined anterior and posterior lumbar fusion. The cause of spondylolisthesis was isthmic in 95, dysplastic in 4 and degenerative in 21 cases. The commonest symptom was persistent back pain, which did not respond to conservative treatment with nonsteroidal anti-inflammatory medication, restriction of activities and physiotherapy for at least 6 months. All 72 patients who had preoperatively clinical evidence of a deranged disc adjacent to the level of spondylolisthesis were also examined by discography. When discography revealed a disrupted disc (53 patients), fusion was extended. Therefore, in both groups, there were no degenerative signs in the proximal disc adjacent to the fusion. All patients had

posterior fusion using pedicle screws or laminar hooks and underwent additional anterior fusion with autologous or homologous bone grafts. Autologous bone grafts were taken from the iliac crest or from the fibula. Homologous bone grafts were taken from deep-frozen femoral heads. The mean follow-up was 36 (26–84) months.

The level of the slip ranged between L3 and L5 (Table 1). The slip was classified according to Meyerding (1932). The first and second authors did a double examination of the radiographs with no significant difference. The patients were divided retrospectively into two groups. Group I had been treated with monosegmental fusion (46 patients, 21 women), group II with bi- or polysegmental fusion (74 patients, 42 women) (Table 2).

Postoperatively, all patients had bed rest for 3 days, and were mobilized on the fourth day wearing an orthosis. The patients were evaluated clinically and radiographically after 3 and 6 months and thereafter annually. All patients were interviewed at the final follow-up. Pain level, use of analgesics, work status and the influence on activities of daily living were recorded. History included detailed questions for symptoms of spinal stenosis. A standing AP and a lateral radiograph of the lumbar spine were taken. AP translation of the proximal motion segment adjacent to lumbar fusion was measured according to Wiltse and Winter (1983). A tangent was drawn to the posterior

Table 1. Location and classification of spondylolisthesis

		Cases
Level	L3/L4	1
	L4/L5	25
	L5/S1	98
Meyerdung	I	42
	II	66
	III	10
	IV	2

Table 2. Data of fused segments

Group	Cases	Fused level
I	35	L5 to S1
	11	L4 to L5
II	45	L4 to S1
	6	L3 to L5
	18	L3 to S1
	2	L2 to L5
	3	L2 to S1

cortex of the cranial and caudal vertebral body adjacent to fusion. The distance between both tangents was measured (Figure). We considered sagittal translation of more than 3 mm as translatory instability (Shaffer et al. 1990).

Paired Wilcoxon test, two-sample Wilcoxon test, and chi-square test were used for statistical analysis.

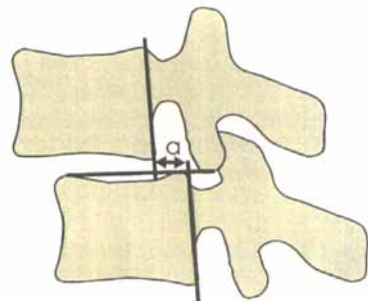
Results

At final follow-up, 42 (35%) patients were pain-free, 57 (47%) had marked improvement and 21 (18%) no improvement of pain. 97 (81%) patients resumed their work or other previous activities within 2 years after the operation, 16 retired, 4 were out of work and 3 had part-time employment.

In 60 cases, no correction of the slip was achieved. In 15 cases the reduction of the slip was between 3 and 4 mm, in 25 cases between 5 and 8 mm, in 7 cases between 9 and 12 mm, and in 5 cases between 13 and 15 mm. There was no statistically significant correlation between AP-translation, age at operation, correction of spondylolisthesis, and type of spondylolisthesis.

After an average of 3 years, 13 (10%) patients developed an AP-translation of more than 3 mm in the disc adjacent to the lumbar fusion with an annual increase. The incidence of AP-translation increased significantly with the follow-up time (Table 3). We observed an increase in AP-translation from 1 to 3 years and from 1 to 4 years postoperatively ($p = 0.0001$).

In group I, 3/46 patients developed an AP-translation of more than 3 mm and in group II, 10/74 (Table 3). Compared to group I, we found in group II an increase of AP-translation in the first unfused segment proximal to fusion after 3 years (Wilcoxon two-sample test, $p = 0.03$). The maximum AP-translation was 7 mm after 7 years' follow-up. Only patients who had a fused lumbosacral segment developed instability in the disc adjacent to lumbar fusion. The radiographic signs of AP-translation did not correlate with clinical symptoms.



Measurement of AP-translation according to Wiltse and Winter (1983). A tangent is drawn to the posterior cortex of the cranial and caudal vertebral body. The distance between both tangents "a" is measured.

Table 3. Data of the patients with instability in the proximal disc adjacent to lumbar fusion

A	B	C	D	E	F	G	H	I	J
I	1	f	60	0	4	6	L5-S1	1	p
	2	m	52	2	4	6	L5-S1	1	p
	3	f	60	0	4	4	L5-S1	2	i
II	1	m	46	0	3	4	L4-S1	3	i
	2	m	37	2	4	4	L4-S1	2	i
	3	m	45	0	4	6	L3-S1	2	i
	4	f	39	1	4	5	L4-S1	1	n
	5	m	37	1	4	6	L4-S1	1	n
	6	f	36	2	4	6	L3-S1	2	i
	7	f	35	0	4	4	L4-S1	1	i
	8	m	51	0	4	5	L4-S1	1	p
	9	f	20	0	4	5	L4-S1	2	i
	10	m	40	1	4	4	L3-S1	2	i

- A Group
- B Case
- C Sex
- D Age at operation
- E Occurrence, years
- F AP-translation postoperatively, mm
- G AP-translation after 3 years, mm
- H AP-translation after 4 years, mm
- I Fused segments
- J Pain
 - p pain-free
 - i improvement
 - n no improvement

In 2 patients with AP-translation of 6 mm after 5 years' follow-up and pain, the proximal motion segment was fused.

In 4 cases, we found radiographic signs of disc degeneration adjacent to the unfused segment, 1 monosegmental fusion and 3 polysegmental fusions ($p < 0.005$). Concomitant AP-translation was detected in 3 patients. We found no clinical signs of spinal canal stenosis adjacent to lumbar fusion. The pseudarthrosis rate was 6%.

Discussion

Lee and Langrana (1984) evaluated the change in stiffness of the lumbosacral spinal column after three different types of fusion and changes in kinematics of the adjacent unfused segments. The facet joints of the adjacent unfused segment were found to be the most vulnerable. All fusions changed the mechanical properties of the adjacent unfused segment.

In fresh cadaveric spines, Yang et al. (1986) found an increased stress at the segment adjacent to fusion. Frymoyer et al. (1978) showed that the total range of motion in the lumbar spine was greater in patients without fusion. Patients with lumbar fusion, however, demonstrated a significant compensatory increase in motion above fusion.

Several authors have reported sequelae of increased stress in the functional spinal unit adjacent to fusion. Lee (1988) examined 18 patients, who underwent posterior lumbar fusion, with a mean follow-up of 15 (3–38) years. 16 patients showed symptomatic hypertrophic facet-joint arthrosis, 8 spinal stenosis, 5 severe disc degeneration, 2 degenerative spondylolisthesis, and 1 patient spondylosis acquisita. The fusion was extended in 9 patients. In our study, fusion had to be extended in 2 patients.

Axelsson et al. (1994) reported on 12/61 patients with progressive disc degeneration in the superior segment above fusion, after an average follow-up of 4 years. Pihlajamäki et al. (1996) observed 3 patients with disc degeneration among 63 consecutive cases treated with posterolateral lumbosacral fusion, after 4 years' follow-up.

Unlike these authors, Frymoyer et al. (1978) reported that only 5 of 96 patients developed degenerative spondylolisthesis or hypertrophic facet-joint arthritis at the segment above fusion with a minimum follow-up of 10 years. Frymoyer et al. (1979) suggested that fusion does not generate additional stress on the unfused segments.

Our findings strongly support those of most authors, showing that the extent of fusion correlates

with the incidence of degenerative spondylolisthesis. In our study, patients had no more pain with AP translation of more than 3 mm in the segment adjacent to lumbar fusion than patients without it. This corresponds to the findings of MacNab and Dall (1971), who recognized the entity of segmental instability and stated that it did not necessarily correlate with symptoms.

Lehman et al. (1987) examined 62 patients after an average follow-up of 33 years. 28 patients had instability in the unfused segment and 26 patients had spinal stenosis. Back pain was considered a clinical symptom of instability, and correlated with the radiographic findings.

Danielson et al. (1989) reported, that only a progression of the slip exceeding 20% (8 mm) is related to clinical symptoms. In our study only 2 of 13 patients with a slip of 6 mm developed pain, confirming Danielson's findings.

Various studies have demonstrated that increased stresses in the motion segment above lumbar fusion cause "disc disease" (Frymoyer et al. 1978, Lee and Langrana 1984, Yang et al. 1986). Our retrospective results indicate that polysegmental fusions lead to higher rates of disc disease than monosegmental fusions. At least after short follow-up, disc disease does not correspond to pain.

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