OPERATIVE AND CONSERVATIVE TREATMENT OF MODERATE SPONDYLOLISTHESIS IN YOUNG PATIENTS

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We made a retrospective study of 149 children and adolescents with moderate spondylolisthesis (slip ≤ 30%), 77 treated by fusion and 72 conservatively at an average follow-up of 13.3 years. Both groups were fully comparable with regard to age at diagnosis, sex distribution (46% girls), and mean slip.

The patients who were treated operatively had more pain before treatment and showed more initial progression of the slip. They had better clinical results and less pain at latest review, but the total progression of the slip over the whole follow-up showed no statistical differences between the two groups. Patients with a pseudarthrosis after attempted fusion had had a longer period of postoperative pain, but at the latest review had no more pain than those with sound fusion. None of those operated conservatively came to fusion later and the long-term results in 18 patients who had refused the advised operation were no worse than those for other conservatively treated patients.

Our results suggest that a moderate grade of spondylolisthesis in adolescents usually has a benign course. It seems that spontaneous segmental stabilisation occurs as a result of degeneration of the disc at the level of the slip.

The indications for the operative treatment of children and adolescents with spondylolisthesis have usually been persistent back pain resistant to conservative treatment, radiating pain, tightness of the hamstrings in connection with a spondylolisthetic crisis, and, in symptomless patients, a predicted or real increase in slipping (Wiltse and Hutchinson 1964; Dandy and Shannon 1971; Turner and Bianco 1971; Laurent and Österman 1976; Boyall et al 1979). A slip of 30% or more has been considered to indicate likely progression in adolescent patients (Wiltse and Hutchinson 1964; Laurent and Österman 1976), but the natural history of the condition has been rarely reported.

Several studies report the outcome of operative treatment by fusion with or without reduction, but few have presented the results of conservative treatment (Pfeil 1975; Gramse, Sinaki and Ilstrup 1980; Edelmann 1984; Steiner and Micheli 1985; Willner 1985) except briefly in connection with operative results (Laurent and Einola 1961; Turner and Bianco 1971; Savastano and Navach 1972; Blackburne and Velikas 1977). Taillard (1954) is of the opinion that conservative treatment gives better results than, for example, anterior fusion, but Zippel (1980) warns against simplified conclusions, because of differences in the severity of symptoms and the degree of slipping.

The present study compares results in young patients with established, moderate spondylolisthesis, one group having been treated by fusion and the other by conservative or no treatment. An established indication for operative treatment in children and adolescents has been a 30% slip, even in symptomless patients, because of the assumed high risk of further progression. It was therefore considered essential to compare patients with less than 30% slip, focusing on the factors which led to different treatments and the clinical and radiological results at long-term follow-up.

PATIENTS AND METHODS

In all, 220 consecutive patients with spondylolisthesis under the age of 20 years were operated upon at the Orthopaedic Hospital of the Invalid Foundation from 1948 to 1980. Of these, 190 (86%) had a clinical and radiological review at an average of 14.5 years after their first visit. A total of 100 consecutive patients treated conservatively during the same period were also invited to attend for follow-up examination, and 82 of them complied.

The patients selected for surgery had a significantly higher percentage slip at the time of diagnosis (mean 45.2 ± 29.2%) than the patients treated conservatively.
Table I. Clinical and radiological findings at the first visit in the conservatively and the operatively treated groups of patients with spondylolisthesis

<table>
<thead>
<tr>
<th></th>
<th>Conservative (n = 72)</th>
<th>Operative (n = 77)</th>
<th>Significance of difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr, mean ± s.d.)</td>
<td>13.8 ± 3.6</td>
<td>14.6 ± 3.0</td>
<td>NS</td>
</tr>
<tr>
<td>Sex-ratio of (girls %)</td>
<td>46</td>
<td>46</td>
<td>NS</td>
</tr>
<tr>
<td>Slip (% mean ± s.d.)</td>
<td>16.2 ± 7.4</td>
<td>16.6 ± 7.6</td>
<td>NS</td>
</tr>
<tr>
<td>Low back pain (%)</td>
<td>86</td>
<td>92</td>
<td>NS</td>
</tr>
<tr>
<td>Radiating pain (%)</td>
<td>8</td>
<td>43</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>Low back and radiating pain (%)</td>
<td>8</td>
<td>40</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>Tightness of hamstrings* (%)</td>
<td>3</td>
<td>14</td>
<td>p &lt; 0.05</td>
</tr>
</tbody>
</table>

* straight leg raising < 60°

Table II. Clinical and radiological findings at the latest review of 149 patients in the conservative and operative groups

<table>
<thead>
<tr>
<th></th>
<th>Conservative (n = 72)</th>
<th>Operative (n = 77)</th>
<th>Significance of difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr, mean ± s.d.)</td>
<td>29.1 ± 7.4</td>
<td>28.1 ± 8.2</td>
<td>NS</td>
</tr>
<tr>
<td>Slip (% mean ± s.d.)</td>
<td>16.7 ± 10.6</td>
<td>19.4 ± 14.8</td>
<td>NS</td>
</tr>
<tr>
<td>Progression of slip Early follow-up (% mean ± s.d.)</td>
<td>0.5 ± 4.1</td>
<td>3.8 ± 8.4</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Progression of slip Latest review (% mean ± s.d.)</td>
<td>0.5 ± 6.6</td>
<td>2.8 ± 11.2</td>
<td>NS</td>
</tr>
<tr>
<td>No pain (%)</td>
<td>75</td>
<td>87</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Low back pain (%)</td>
<td>25</td>
<td>13</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Radiating pain (%)</td>
<td>4</td>
<td>3</td>
<td>NS</td>
</tr>
<tr>
<td>Low back and radiating pain (%)</td>
<td>4</td>
<td>3</td>
<td>NS</td>
</tr>
<tr>
<td>Tightness of hamstrings (%)</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Table III. Clinical results and long-term review of 72 conservatively and 77 operatively treated patients

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Conservative</th>
<th>Operative*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>54</td>
<td>67</td>
</tr>
<tr>
<td>Good</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Fair</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Poor</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

* * significance of difference, p < 0.05

(20.4 ± 15.0\%). To make valid comparisons, the patients with a slip of more than 30\% on admission (the standard indication for surgery) were excluded from the review series.

This left 149 patients for assessment, 77 in the operative and 72 in the conservative groups. Both groups included the same proportion of males (54\%) and females (46\%). The average percentage slip and the mean age on presentation were also very similar in both groups. The average slip was 16.6 ± 7.6\% in the operative group and 16.2 ± 7.4\% in the conservative group with average ages 14.6 ± 3.0 years and 13.8 ± 3.6 years respectively. The slip was at L4-5 in two operated and one non-operated patients, all the others were at L5-S1. Significantly more of the operated group had radiating pain (Table I).

Follow-up averaged 13.5 years (range 5 to 30) in the operated group and 15.3 years (range 5 to 25) in the non-operated group. Of the 77 operated patients, 64 had been examined 17.4 months on average before the decision to operate, while 13 had been scheduled for surgery at the initial examination. The operation was carried out at an average of 15.7 years (± 2.8). Eight of the non-operated patients had visited the out-patient department only once, but the period of primary out-patient supervision for the other conservatively treated patients averaged 34.5 months. The symptoms and findings at the first out-patient visit are given in Table I.

Operative treatment. Fusion was in situ in all cases, but seven patients also had a dorsal decompression. Fusion was posterior in 49 and posterolateral in 28 patients. The average hospital stay was 4.5 weeks (1 to 10) and a corset was used for an average of four months. There were five cases of superficial wound infection and a transient unilateral ankle drop in one. Re-operation because of symptomatic nonunion was performed for nine patients (12\%) at a mean of 25.7 months after primary surgery.

Conservative treatment. Conservative treatment was by rest while pain persisted, restriction of activities and stabilising exercises for the spinal and abdominal muscles. A brace was used by only five patients. For 18 patients in this conservatively treated group, operation was suggested at one stage during the out-patient follow-up, but was not performed, either because of spontaneous relief of symptoms or because of fear of surgery. These patients were analysed separately.

Review assessment. The clinical and functional status of the back was evaluated, and anteroposterior, lateral, oblique and flexion-extension radiographs were taken using a standardised and reproducible method.

Clinical results were scored by severity of complaints at follow-up and recorded as excellent if there was no pain; good if there was occasional pain, which did not disturb working or sports activities; fair if there was periodic low back pain or radiating pain interfering with working capacity or sports activities; and poor if the patient had received a disability pension because of back pain, or the symptoms were worse than at admission. In addition, back and lower extremity pain were scored on a 0 to 2 scale after half-an-hour of continuous sitting, walking or running or after repeated lifting, where 0 indicated no pain, 1 moderate pain and 2 severe pain. The sum of the scores after these different exertions yielded the total pain score for each case.

Patients also evaluated their working capacity and
their sport activities, while for females, difficulties experienced during pregnancy and childbirth were also recorded.

Percentage slipping was recorded (Laurent and Einola 1961) as the proportion of the width of the slipping vertebral body, from the radiographs at the initial and review examinations. Segmental motion was measured from the flexion-extension radiographs. Intervertebral disc degeneration was assessed by measuring the height of the disc (Saraste 1984) and graded from 0 to 3, where 0 indicated a normal height, 1 a height decrease of less than 50%, 2 a height decrease of 50% or more and 3 intervertebral ankylosis.

The different groups were compared and the statistical calculations were made using the chi-squared and Student's t-tests.

RESULTS
At review it was found that none of the original conservatively treated patients had had an operation at a later date. Symptoms and findings are presented in Table II. Occasional pain was reported by 25% (18/72) of the conservatively treated patients and 13% (10/77) in the operated group. Pain was mild in both groups, with a pain index of 0.4 ± 0.8 in the operated and 0.7 ± 0.9 in the non-operated patients (p = 0.04). The clinical results are given in Table III. The conservatively treated patients

Figure 1a – Radiograph of a 13-year-old boy with a 25% slip, a lumbosacral kyphosis of 18°, back pain and radiating pain. Figure 1b – Thirteen years after posterior fusion from L4 to S1 and removal of the loose posterior element of L5, the slip has increased to 60% and the lumbosacral kyphosis to 42°. He has occasional back pain which does not interfere with working capacity.

Figure 2a – Radiograph of a 14-year-old girl with a slip of 30%, a lumbosacral kyphosis of 8°. Figure 2b – Nine years later the slip has increased to 68% and the lumbosacral kyphosis to 30°. Flexion-extension radiographs showed no movement at either L4-5 or L5-S1. She had no pain.
were employed in heavier labour than the operatively
treated. None of the patients were on disability pensions
and none considered themselves totally disabled. Four of
the surgical and six of the conservative group reported
partial loss of working capacity.

Regular sport activities were enjoyed by 57% of the
operated patients and 43% of the conservative group;
30% of the operated and 21% of the conservative groups
being occasionally active in this way. Only 13% of the
operated and 36% of the conservative groups were not
interested in sports activities.

Of the 25 women who had been pregnant, nine had
had operations and 16 were conservatively treated. One
of the former and three of the latter reported considerable
back pain during pregnancy or labour.

Radiological results. The percentage of slip at review was
19.0% ± 14.8 in the operative and 16.7% ± 10.6 in the
conservative group, a non-significant difference (Table
II). The progression of slip during initial follow-up was,
however, significantly greater in the operative group
(p = 0.003). Marked progression of the slip, with an
increase of over 10% during early follow-up, was
measurable in 19% (15/77) of the operated and in 4% (3/
72) of the conservative group (p = 0.004), but for the
whole period of follow-up the difference was non-
significant (Figs 1 and 2). After cessation of growth no
progression of slip was detected.

Over 10% spontaneous correction of slip during the
review follow-up was found in two of the operated (Fig.
3) and in three of the non-operated (Fig. 4) patients.

Figure 3a - This 14-year-old boy had a slip
of 15% and persistent back pain. Figure 3b
- Ten years after posterolateral fusion at L5-
S1, the fusion is solid and the slip is corrected.
He has no pain.

Figure 4a - At the age of 12 years this boy
had a slip of 30%, but only minor symptoms
not justifying an operation. Figure 4b -
Nineteen years later he was symptomless
with a slip of 18%.
Spontaneous bony healing of the isthmic defect had occurred in two conservatively treated cases.

Segmental mobility, indicating nonunion at the site of fusion, was found in 32% (25/77) of the operated patients, but there was no significant difference in pain levels at review between the group with pseudarthrosis and the patients with solid fusion. However, the postoperative duration of back pain was longer in patients with pseudarthrosis (14.5 ± 10.2 months) than in patients with solid fusion (4.1 ± 14.1 months, p < 0.001). There was no correlation between occurrence of the pseudarthrosis and progression of slipping. Pseudarthrosis occurred more frequently after posterior (23/49 = 47%) than after posterolateral fusion (2/27, 7%; p < 0.001).

Those 18 patients who had been offered surgery, but were managed conservatively, differed from the other non-operative patients in having more initial back pain (p < 0.05) and more progression of slip during the whole follow-up (p < 0.05). Pain index and clinical results, however, showed no significant difference.

Review radiographs of the non-operative group showed decrease in the height of the disc at the slipped level in 33 patients (46%). This decrease correlated positively with the length of follow-up (p < 0.05) and with the degree of slipping (p = 0.006). In 31 of the 72 conservative patients there was no movement at the involved level on flexion-extension radiographs. These had a longer average follow-up (17.1 ± 6.8 years) than patients in whom the slipped segment was still mobile (13.0 ± 5.0 years, p = 0.005). There was a strong correlation between degenerative changes and non-mobility, with 27 degenerate and non-mobile L5-S1 levels. Of the 77 operatively treated patients, 13 (17%) had a decrease of the height of the disc space above the fusion. As regards pain, there was no statistical difference between patients with and without disc degeneration.

DISCUSSION

Only limited conclusions can be drawn from a retrospective study, as has been emphasised by Zippel (1980). He also found that more severe primary symptoms usually led to a decision for surgery, especially when radiating pain was involved. However, in our study we obtained groups which were homogenous as regards sex distribution, follow-up time and degree of vertebral slip. We feel justified in making comparisons. Of course, the decision for surgery was also influenced by the experience of the surgeon, the attitudes of the patient and the parents and the state of the patient at the time of the physical examination.

During early follow-up a slightly greater progression of the slip was seen in the operative group. By final review, however, there was no significant difference in the progression of the slip between the two groups, though the clinical results were slightly better in those treated by operation.

None of the patients for whom conservative treatment was initially decided had surgical treatment later. This strongly suggests that the natural course of spondylolisthesis in adolescents is quite benign; this is supported by the statistically comparable clinical and radiographic end results in both groups, and by the assessment of those patients who were managed conservatively after being advised to have operative treatment.

The number with pseudarthrosis after an attempted fusion was relatively high, possibly related to the older practice of using posterior methods. It should be pointed out that although the patients with pseudarthrosis had clinical end results comparable with those with solid fusions, they had experienced much longer duration of pain after operation.

The natural course of spondylolisthesis seems to be towards spontaneous stabilisation. This was seen radiographically in 38% of the non-operated cases, shown by the loss of segmental mobility combined with a decrease of intervertebral height at the level of the slip. Our study also showed progressive degeneration in the adjacent intervertebral space after stabilisation at the spondylolisthesis. However, the degree of this degeneration did not correlate with back pain symptoms at the latest review. This natural history is analogous with the generally accepted hypothesis of Kirkaldy-Willis (1983) for the degeneration of lumbar spine through stages of dysfunction, instability and stabilisation. In spondylolisthesis, progress through these stages appears to happen faster and at a much younger age.

The timing of this process of stabilisation of the unstable segment varies and is influenced by many factors. In our series, spontaneous stabilisation seemed to develop between 13 and 17 years after the diagnosis of spondylolisthesis had been established. Both this spontaneous stabilisation at the spondylolisthetic level and the possible later progression of the degenerative changes at the adjacent disc space must be taken into account when symptoms are evaluated and surgical treatment is considered. After adolescence, pre-operative planning should include discography or magnetic resonance imaging to evaluate the state of the discs.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

REFERENCES


