SURGICAL TREATMENT OF SPONDYLOLISTHESIS
IN CHILDREN AND ADOLESCENTS

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A retrospective study is reported of 36 children and adolescents who had undergone spinal exploration and fusion for Type I or Type II spondylolisthesis of more than 10 per cent. The patients were examined and their radiographs studied. No progression of slip after operation was found even in the presence of a pseudarthrosis. Where altered mobility was present at the level above the fusion, this tended to be associated with pain. Posterolateral fusion relieved symptoms in 75 per cent, produced a sound fusion in 83 per cent and prevented further slip in all patients.

Spinal fusion for spondylolisthesis in children is recognised as being a satisfactory treatment in alleviating symptoms and preventing further slip. There have been few recent reports of late results in these patients (Adkins 1955a,b; Watkins 1959; Kelly 1963; Hoover 1968; Turner and Bianco 1971; Boxall et al. 1979). This paper reports the results after 3 to 19 years (average 10 years) in 36 patients under the age of 20 at the time of operation who had undergone spinal fusion with or without decompression.

MATERIAL AND METHODS

The records of 142 patients under the age of 20 with spondylolysis or spondylolisthesis of more than 10 per cent (Fig. 1), with Type I (dysplastic) and Type II (isthmic) lesions at the lumbosacral junction (Wiltse, Newman and Macnab 1976), were collected from the Royal National Orthopaedic Hospital, the Hospital for Sick Children, Great Ormond Street, the Middlesex Hospital and Edgware General Hospital. Thirty-two boys and 35 girls of this 142 patients had been treated by operation. Eighteen of these could not be traced for follow-up, because they had moved or had returned overseas on completion of treatment. Ten boys and three girls completed questionnaires but were not available for examination. These 13 patients would have been in the successful groups, but are not included in the review as they have not been examined. Twelve boys and 24 girls completed questionnaires and were examined clinically and radiologically, with flexion and extension views of the lumbar spine. These 36 patients form the basis of this report.

The patients were asked about aches and pains in the back, at rest or on exertion, and whether these interfered with their daily lives or physical activities. An assessment was made of spinal mobility and of the presence of a neurological deficit in the legs. The radiographs were used to assess the extent and levels of fusion and these were compared with the stated aims of the operation. Abnormalities at other levels in the lumbar spine present before or after operation were noted. The percentage slip was measured in order to assess any increase in displacement after operation. An assessment of mobility as reduced, normal or excessive, at the level immediately above the fusion was made by measurement of the relative heights of the anterior and posterior edges of the disc space on the flexion and the extension films.

RESULTS

The series contains no patients under the age of 10 (Fig. 2). The commonest age at fusion was 14 for both sexes.
and the average slip was 60 per cent (Fig. 3).

**Indications.** The main indication for fusion was low backache, with or without radiation to the legs, which had not been relieved by at least six months' conservative treatment. This applied to all but one of the patients. Other indications were present in 18 of the patients, and included abnormal posture such as scoliosis or increased lordosis, severe restriction of lumbar movement, sensory disturbances or reflex abnormalities in the legs and reduced straight leg raising. Severe or progressive displacement was present in 12 patients, four of whom had a slip of 100 per cent or more.

Fifteen of the 36 patients had a midline defect. This is generally associated with a greater percentage slip (Blackburne and Velikas 1977), which may be due to the lack of the stabilising effect of the multifidus muscles (Stott, Cyron, Hutton and Watt, personal communication). Five patients had some backward slip at a level above the spondylolisthesis. Anterior buttressing of the sacrum below the fifth lumbar vertebra was noted in 15 patients (42 per cent). It is possible that both buttressing and retrospondylolisthesis are the result of attempts to stabilise the area (Henderson 1966).

**Operation.** Posterolateral fusion had been performed in 35 patients, 34 bilaterally and one unilaterally. Decompression had been carried out on three of these patients, all of whom had significant root signs. Anterior fusion had been performed in one patient. Thirty-two fusions were at two levels. Four patients had fusion at one level, all of whom had a slip of not more than 20 per cent. From a mechanical point of view it would seem better to perform a fusion from L4 to S1 in cases of lumbosacral spondylolisthesis. The reasons for a single level fusion in four patients could not be determined. No attempt was made to reduce the spondylolisthesis before, during or after operation, since at the time it was considered to be difficult and possibly dangerous (Taillard 1954; Laurent and Österman 1969).

Bone grafts were taken from the iliac crest. Various incisions were used, of which a curved transverse approach seemed to give the best cosmetic result. At the start of the series, patients were confined to bed or to a plaster bed for 6 to 12 weeks after operation, then placed in a plaster of Paris jacket or surgical corset for 6 to 12 weeks. More recently this regime was relaxed and patients are now rested in bed for one to three weeks, and then allowed up, wearing a surgical corset for about 10 weeks.

**Radiography.** The flexed and extended spine was studied to determine the levels of fusion obtained. It was found that in six patients fusion had involved one level higher than was intended, producing a three-level fusion. In four patients the upper of two levels had failed to unite, and in one patient there had been failure at both levels. Thus in 11 of 36 patients (31 per cent) fusion had failed at an intended level or had included an additional level. No fatigue fractures were seen above the fused segments, but the lowest unfused joint did show variable mobility (Figs 4 and 5). This was classified as reduced, normal or excessive according to the ratio of the anterior to posterior height of the space on the flexion and extension views. Seven patients had reduced movement at the level above the fusion, 23 had normal movement and six had excessive movement.

In no patient was it found that the percentage of slip had progressed after fusion. This differs from the findings of Boxall et al. (1979), although in their series all the patients had a slip of 50 per cent or more.

**Clinical results.** The patients were classified as follows: Group A—symptom-free, active; Group B—mild occasional pain, no sciatica and no interference with activity; Group C—moderate, intermittent pain, with or without sciatica, brought on by activity and relieved by rest and analgesics; and Group D—severe pain, which was difficult to control.

These results are recorded in Table I and related to the operation performed. Of the 36 patients, 27 were in Group A and B and nine patients were in Group C. In all patients pain was much less than before operation and no patient was made worse.

**Mobility.** An attempt was made to correlate symptoms with radiographic findings at the level above the fusion. It was found that two of the six patients who had increased movement had pain, and that two of the seven patients with reduced mobility also had pain; that is, four
of 13 patients with abnormal mobility had pain (31 per cent), whereas of the 23 patients with normal mobility, 18 (78 per cent) had no pain. We consider that this may be significant but acknowledge that small numbers are involved. It seems possible that altered mobility above the fusion may be related to pain.

No correlation could be made between radiographic and clinical assessments of movement of the lumbar spine.

DISCUSSION

Intertransverse fusion appears to stabilise the defective segment. It is accepted that accurate determination of fusion levels from radiographs has limitations, and that re-operation is the only certain method of confirming fusion. Pseudarthrosis was found in one patient who had a further operation 14 months after the first because of persisting backache and sciatica. The end-result in this patient was radiological union but moderate pain persisted. The four patients with failure at the upper of a two-level fusion were all practically free of symptoms and it appears that a pseudarthrosis need not preclude a good result. This is in accord with previous experience (Newman 1965; Henderson 1966; Lettin 1967; Turner and Bianco 1971). The overall fusion rate in this series was 83 per cent. The four single-level operations all fused, but the fusion rate for a two-level fusion was 87.5 per cent. The fusion rate in this series compares with that of other series (Table II). Fusion may predispose to instability from the level above. It has been found that hypermobility in the level above the fusion is likely to be related to pain.

Excessive mobility has been suggested to be an early radiographic sign of degeneration (Knutsson 1944; Harris and Macnab 1954; Lettin 1967; Farfan 1973). The upper vertebra may be displaced forward on the lower in flexion and backward in hyperextension (Knutsson 1944), or the space may show a rocking or rotational movement (Farfan 1973). Instability may be due to annular degeneration (Friberg 1948; Harris and Macnab 1954), and indicates that posterior ligaments and joints may be subjected to strain. It has also been suggested by Harris and Macnab (1954) that marked separation of the spinous processes in flexion may be caused by damage to the supraspinous ligament. The level above the fused segment is exposed to stress and strain as the result of attempts to regain a normal range of movement.

In this series posterolateral fusion relieved the symptoms in 75 per cent of children and adolescents with spondylolisthesis, was technically successful in 83

Table II. Previously reported series

<table>
<thead>
<tr>
<th>Author</th>
<th>Number of cases</th>
<th>L4–S1</th>
<th>L5/S1</th>
</tr>
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<tbody>
<tr>
<td>Adkins</td>
<td>1955b</td>
<td>29</td>
<td>83</td>
</tr>
<tr>
<td>Watkins</td>
<td>1959</td>
<td>28</td>
<td>66</td>
</tr>
<tr>
<td>Kelly</td>
<td>1963</td>
<td>32</td>
<td>44</td>
</tr>
<tr>
<td>Hoover</td>
<td>1968</td>
<td>10</td>
<td></td>
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<tr>
<td>Boxall et al.</td>
<td>1979</td>
<td>36</td>
<td>75*</td>
</tr>
<tr>
<td>This series</td>
<td>1980</td>
<td>36</td>
<td>87.5</td>
</tr>
</tbody>
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* These patients all had a slip of 50 per cent or more.
per cent and prevented further slip in all. It is a relatively easy operation to perform and has a short convalescence with return to full activity at an average of eight and a half months. It is considered that fusion at one level of the spine may cause alteration in mobility at the level above, which may often be associated with pain.

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REFERENCES


