SPONDYLOLISTHESIS IN CHILDREN AND ADOLESCENTS

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A study of spondylolysis and spondylolisthesis in 142 children and adolescents is reported. In twelve of the seventy-nine patients followed for over a year the affected vertebra slipped further by 10 per cent or more. Increasing slip occurred mainly during the adolescent growth spurt, and was greater when spina bifida or other vertebral anomalies were present. If at presentation the slip is less than 30 per cent then further slip beyond 30 per cent is unlikely. Decompression posteriorly is advised when signs of nerve pressure are present. Indications for spinal fusion are suggested; the intertransverse method of fusion was used in sixty-nine patients.

Spondylolysis occurs in about 5 per cent of the population at the age of seven years (Baker and McHollick 1956), but the incidence of symptoms at this age is low. Spondylolisthesis can occur with or without a defect in the pars interarticularis. In the group under study only Type I, or dysplastic, and Type II, or isthmic, lesions are considered (Wiltse, Newman and Macnab 1976).

FIG. 1

Histogram showing percentage slip at presentation.

Three important questions are posed by this surprisingly high incidence of spondylolysis in children. First, what proportion of these cases will progress to spondylolisthesis, or, having developed a slip, will progress? Second, can one predict whether this will take place? Third, what are the indications for fusion in this age group and at what age should operation be undertaken?

The records of 142 patients under the age of twenty were collected from the Royal National Orthopaedic

Hospital, the Hospital for Sick Children, Great Ormond Street, the Middlesex Hospital and Edgware General Hospital. In sixteen patients (11 per cent) there was spondylolysis only. The remaining 126 patients (89 per cent) presented with a slip of from 5 to 100 per cent (Fig. 1). In three patients the level of the lesion was between the fourth and fifth lumbar vertebrae, and in 139 patients it was at the lumbo-sacral level. The age at presentation is shown graphically in Figure 2. Of these 142 patients it was possible to follow seventy-nine for one year or more before operation had been carried out, if it had been necessary. Eighteen females and twenty males were followed through to skeletal maturity (Fig. 3).

The method used to measure the percentage slip is shown in Figure 4. Because of the inaccuracy of this and

FIG. 2

Graph of ages at presentation.

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other methods of measurement, it was decided that changes of less than 10 per cent would not be regarded as significant.

Many structural features of the lumbo-sacral spine have been suggested as leading to increased or decreased stability, and some of these were assessed and when possible measured.

FIG. 3

Histogram showing length of follow-up.

Lumbar index—This is the posterior vertebral height divided by the anterior vertebral height. Sim (1973) measured this in twenty-four patients with spondylolisthesis and noted that whereas the normal average index was 0.91, in spondylolisthesis it was 0.70. Taillard (1954) suggested that this increased wedging predisposed to further slip. In this study it was found that the scatter of results was too great to support this view, but it was felt that in many patients, where progression of the slip had occurred, increased wedging had followed rather than precipitated the slip.

$$\frac{a}{b} \times 100 = \text{Percentage slip}$$

FIG. 4

Diagram showing the method used to measure percentage slip.

Rounding of sacral promontory—A similar conclusion was reached with respect to sacral rounding, and in some patients the alteration of the anterior corner of the sacrum could be followed through serial radiographs, as the vertebral body above slipped over it.

Size of the transverse processes—Farfan (1973) believed that a large transverse process of the fifth lumbar vertebra stabilised the lumbo-sacral joint. However, in this study of young and adolescent spines, difficulty was

experienced in determining in either relative or absolute terms what was an enlarged process.

Lumbo-sacral angle—In the resting or neutral position, when lying, the lumbar 3–4 disc space is at right angles to the long axis of the body (Farfan 1973; Stott, Cyron, Hutton and Wall 1977), and by using this as a reference line it is possible to measure the angle of inclination of the lumbo-sacral disc (Fig. 5). The normal is 32 degrees. It seems logical to suppose that when this angle is increased (that is, when the lumbo-sacral disc is more vertical) stability at this level would be decreased. Although it was not possible to show that a larger lumbo-sacral angle predisposed to further slipping, it was found that when this occurred the lumbo-sacral angle increased.

Midline lumbar or sacral defect—The incidence of a midline lumbar or sacral defect in the population as a whole is 5 to 10 per cent (Rothman and Simeone 1975). Of the 142 patients under study here, eighty-three (58 per cent) had such a defect. This is higher than in other series: Friberg (1939) noted 28 per cent, Taillard (1954) 42 per cent and Laurent and Österman (1969) 25 per cent. A reason for the high incidence may have been partly because some of the children had been referred from the spina bifida clinic of the Hospital for Sick Children.

The multifidus muscles are important in stabilising the lumbar spine (Cyron, Hutton and Troup 1976). The slips of this muscle are attached to the spinous processes, and when these spinous processes are absent or deficient the stabilising effect of the muscle would be correspondingly reduced. Not only was the incidence of a midline

FIG. 5

Diagram showing the method used to measure the lumbo-sacral angle.

TABLE I
DETAILS OF THE TWELVE PATIENTS WHO SUFFERED FURTHER SLIP OF 10 PER CENT OR MORE

Case number	Sex	Age at onset	Initial slip	Final slip	Fusion	Remarks
1	M	2	0	10	No	Multiple congenital defects
2	F	9	0	10	No	No symptoms
3	M	13	10	20	No	No symptoms
4	M	15	10	20	Yes	Fusion at age 18
5	F	4	10	25	No	No symptoms
6	M	4	35	100+	Yes	Fusion at age 7: multiple congenital defects
7	F	9	70	85	Yes	Fusion at age 14: vertebral abnormalities present
8	F	10	40	75	No	No symptoms
9	M	12	10	25	Yes	Fusion at age 14: six lumbar vertebrae
10	F	14	100	100+	Yes	Fusion at age 15
11	M	14	100	100+	No	No symptoms
12	M	16	60	75	Yes	Fusion at age 18

defect high, but it was found that the average slip for those with a defect was 33 per cent, whereas when there was no defect present this was 21 per cent.

The presence of scoliosis, pars interarticularis defects and vertebral anomalies were also studied.

RESULTS

Of the seventy-nine patients followed for more than one year there were twelve in whom a further slip of 10 per cent or more occurred (Table I). In four the increased slip had been only 10 per cent. Two of the twelve patients had presented with a slip of 100 per cent, which had progressed further, but only one of them continued to have symptoms and required operative stabilisation.

From a review of the whole series and of these twelve cases in particular it is suggested that several features are associated with increasing slip.

Male predominance—Although the ratio of males to females in the whole series was sixty-nine to seventy-three, seven of the twelve patients with progression were male.

Age at presentation—From the graph (Fig. 6) it can be seen that the percentage slip at presentation increases with age and that this increase occurs at about the age of eight for females and twelve for males.

The amount of slip at presentation—In no case did the slip, if less than 30 per cent initially, progress beyond 30 per cent. However, one case presented with 35 per cent and progressed to 100 per cent.

Presence of midline lumbo-sacral defect—Not only was the midline defect associated with a higher average percentage slip, but of the twelve patients in whom the slip had increased, all the seven males and three of the five females had such a defect.

Other vertebral anomalies—In four of the twelve patients there were associated vertebral anomalies.

Presence of defect of pars interarticularis—A defect of the pars interarticularis was found in seven of the twelve patients.

Spinal exploration and fusion

Operation was performed upon thirty-three males and thirty-six females. This consisted of spinal fusion by the intertransverse method, with decompression if signs of nerve compression were present. The indications for operation were (1) back pain of at least one year's

FIG. 6

Graph to show the percentage slip at presentation at different ages.

FIGS. 7 to 9

A patient aged fourteen with scoliosis, restricted flexion and reduced straight-leg raising caused by spondylolisthesis.

FIG. 10

Lateral radiograph of a patient with a 75 per cent slip.

FIG. 11

Graph to show the presence of signs at different percentages of spondylolisthesis.

duration, which had not been relieved by conservative measures; (2) progression of slip; (3) certain physical signs, namely altered posture or scoliosis, decreased spinal flexion, diminished straight-leg raising and diminished or absent leg reflexes (Figs. 7 to 10).

From the graph (Fig. 11) it can be seen that the greater the slip the more likely are physical signs to be present, and as a rough guide it was found that if the slip was less than 30 per cent then only 21 per cent presented with physical signs; whereas if the slip was more than 30 per cent, 60 per cent did so. It was also found that of those presenting with physical signs, only five of the eighteen males and two of the twenty-seven females responded to conservative measures.

The age at which spinal fusion was performed is shown in Figure 12. None of the girls required fusion before the age of ten, and only one boy needed fusion before the age of thirteen. This was a boy who presented with multiple abnormalities at the age of two, in whom

FIG. 12

Histogram of age at spinal fusion.

spinal fusion was carried out at the age of seven for severe and progressive scoliosis. In only one patient was reduction by traction attempted before fusion. Traction not only failed to reduce the deformity but it aggravated the physical signs. Taillard (1954) and Laurent and Österman (1969) were also unable to hold reduction when it had been attempted. Monticelli and Ascani (1975), however, believed that reduction of the slip was important; they gave no details of the method employed or of the proportion of patients in whom the reduction has been maintained.

DISCUSSION

In the large series of children and adolescents (173) reviewed by Turner and Bianco (1971) and in that of Laurent and Österman (1969) (also 173) there was a preponderance of males over females of 74 per cent and 59 per cent respectively. In contrast there were only 49 per cent males in our series. However, the age distribution at presentation is similar in all the series, with a maximum in the ten to eighteen years range, with in our series a peak at the age of fourteen. Details on the peak are not given in the other papers mentioned.

The methods used to measure slip vary slightly from series to series, but all authors agree that increasing slip tends to occur during the time of the adolescent growth

spurt. Like Laurent and Österman (1969) we found that when the slip at presentation was less than 30 per cent progression beyond 30 per cent was unlikely. The incidence of midline defect was much higher in our series than in previous reports, for reasons already given, and the importance of this defect as a cause of weakening of the stabilising action of the multifidus muscles has been shown by Stott *et al.* (1977).

In managing children and adolescents with spondylolisthesis or spondylolysis, it seems reasonable to treat these children conservatively and to examine them and take radiographs at six-monthly intervals when the only complaint is one of pain or discomfort. Stabilisation by operation should be offered when pain has persisted for a year or more despite conservative measures—a corset, restricted games, etc. When physical signs are present earlier operation may be necessary, with or without posterior decompression at the level of the slip. When the slip is greater than 30 per cent careful supervision is required, and also in children just reaching or within the age of the adolescent growth spurt. Friberg (1939) and Brocher (1958) have shown that progression of the slip after the age of twenty is rare. Attempts to reduce the slip are hazardous and of dubious value if decompression is to be carried out. Fusion by the intertransverse method is simple and associated with a high rate of success.

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