VERTEBRAL SLIP IN LUMBAR SPONDYLOLYSIS AND SPONDYLOLISTHESIS

LONG-TERM FOLLOW-UP OF 22 ADULT PATIENTS

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We studied the aetiology of vertebral slip in a long-term follow-up of 22 adult patients with isthmic spondylolysis or spondylolisthesis of L5. Of the 18 with spondylolysis without slip, 13 showed no slip after ten years, but five developed displacement of over 5%. All four patients with spondylolisthesis showed progression of the slip.

We found that the vertical thickness of the transverse processes of L5 was significantly greater ($p < 0.01$) in the 13 patients with no slip than in the other two groups. The relationship of vertebral slip to the shape of the transverse processes of L5 may be explained by differences in the bulk or physiological strength of the posterior bands of the iliolumbar ligament.

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The incidence of lumbar spondylolysis or spondylolisthesis has been reported to increase until the age of 20 years and not to change thereafter (Roche and Rowe 1951; Raynal, Collard and Elbanna 1977). Increase in vertebral slip is also said to be rare after 16 to 20 years of age (Raynal et al 1977; Fredrickson et al 1984), but in some adult cases new vertebral slip or an increase in slip has been reported (Pfeiffer, Griss and Schuler 1992). The risk factors for an increase in slip in spondylolisthesis have been difficult to define and there are no known prognostic factors other than two cases described by Farfan, Osteria and Lamy (1976); one had grade-II isthmic spondylolisthesis of L5 and very small transverse processes on L5, and another had a very small slip of L5 with long well-developed transverse pro-

cesses on a deep-seated L5.

We considered that the progression of isthmic spondylolisthesis after the age of 20 years may be related to the state of the iliolumbar ligament, and especially its posterior band. This serves to stabilise the lumbosacral junction by controlling forward flexion of L5 (Luk, Ho and Leong 1986). The iliolumbar ligament can be seen on MRI, but its three-dimensional bulk or physiological strength cannot be exactly defined. We postulated that the size and shape of this ligament may be reflected in the anatomical variation of the transverse process or costal process of L5 (Agur 1991) and that the shape of the process could indicate the functional strength of the ligament.

Our study is an attempt to clarify the relationship between vertebral slip and the configuration of the transverse process of L5.

PATIENTS AND METHODS

We studied 22 adult patients. There were 9 women and 13 men, with a mean age at the first visit of 43.6 years (17 to 72). None had a history of trauma or of strenuous sport during prolonged follow-up. Eighteen patients had the diagnosis of isthmic spondylolysis of L5, and four had isthmic spondylolisthesis at the same level. We defined vertebral slip by the method of Boxall et al (1979). All were followed for at least ten years (120 to 214 months, mean 145.1); details are given in Table I.

The following radiological measurements were made on anteroposterior views of L5 vertebra (Fig. 1): A, the interpedicular distance (Hinck, Clark and Hopkins 1966); B, the length of the transverse process from the medial margin of the pedicle to the tip; and C, the thickness of the process, being the craniocaudal width at the junction of the middle and lateral thirds of measurement B.

The posterior band of the iliolumbar ligament has its main attachment posterocaudally around an accessory process of the L5 transverse process in its midportion. The base of this accessory process is not usually well defined on an anteroposterior radiograph, but is near the junction of the middle and lateral thirds, which we measured as C above.

To avoid errors due to patient size and variable radiographic magnification we recorded B and C, the length and thickness of the transverse processes, as percentages of the

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Fig. 1

Radiological measurements on L5 vertebra. The interpedicular distance was recorded as (A), the length of the transverse process (B), and the vertical thickness of the process (C) at the junction of the middle and lateral thirds, expressed as percentages of A.

interpedicular distance A. We also recorded the level of L5 on a lateral radiograph, as deep- or shallow-seated, in relation to the points at which the iliac-crest lines cross the posterior margin of the vertebral body (Fig. 2).

RESULTS

Of the 18 patients with spondylolysis of L5 without slip at their first visit, 13 were unchanged over a ten-year follow-up (unchanged; group U). The other five patients developed a new slip of over 5% (slip appeared; group A). All four patients with isthmic spondylolisthesis with slip at the first visit showed progression during long-term follow-up (progressive; group P).

In group A, the newly-developed vertebral slip was $16.6 \pm 5.1\%$. In group P, the increase in slip was from $15.5 \pm 3.6\%$ at the first visit to $21.5 \pm 5.0\%$ at the latest follow-up (Table I). No patient showed more than 30% slip.

In the unchanged group U, the mean thickness of the transverse processes at L5 was $59.3 \pm 8.1\%$ on the right and

Fig. 2

The level of the iliac crest was recorded in relation to the bodies of L4 and L5, using the midpoint of the projection of the two crests.

$61.2 \pm 9.3\%$ on the left. In group A these figures were $49.1 \pm 7.6\%$ and $49.2 \pm 5.1\%$ and in group P $47.7 \pm 7.6\%$ and $51.2 \pm 10.7\%$ respectively. The relative thickness in group U was significantly greater ($p < 0.01$) than in groups A and P (Table II). We found no significant differences between groups U, A and P with regard to the relative length of the transverse process or the height of the iliac-crest line.

One patient, diagnosed as showing isthmic spondylolysis of L5 at the age of 54 years, developed a new vertebral slip of L4 without isthmic defect during a 13-year follow-up, but no slip at L5. In this patient the transverse processes were broad, with relative thicknesses of 59.4% on the right and 60.4% on the left. The zygapophyseal joint at L4/5 was noted to be orientated sagittally. The angle between the pedicle and inferior articular facet (Macnab 1950) appeared

Table I. Details of the 22 patients in the three groups (see text)

	Group		
	Unchanged (U)	New slip (A)	Increased slip (P)
Number	13	5	4
Male:female	6:7	2:3	1:3
Age at first visit in years (mean $\pm$ sd)	34.9 ± 10.4	44.4 ± 18.8	62.8 ± 9.0
Follow-up in months (mean $\pm$ sd; range)	158.5 ± 37.8 (120.0 to 214.0)	143.0 ± 15.0 (122.0 to 158.0)	152.8 ± 41.3 (125.0 to 213.0)
Degree of slip (%) [*] (mean $\pm$ sd)			
First visit	0	0	15.5 ± 3.6
Follow-up	0	16.6 ± 5.1	21.5 ± 5.0

^{*} evaluated by the method of Boxall et al (1979)

Fig. 3a

Fig. 3b

Fig. 3c

A woman with spondylolysis of L5 was diagnosed at the age of 54 years (a,b). Thirteen years later, there was no slip at the affected vertebra, but she had developed spondylolisthesis of 14.8% at L4 with no isthmic defect (c). The transverse processes were broad with relative thicknesses of 59.4% on the right and 60.4% on the left. The angle between the pedicle and the inferior articular facet of L4 had increased by about 13° in 13 years.

Table II. Relative thickness (%; mean $\pm$ SD) of the transverse process in the three groups (see text)

Group	Number	Relative thickness*	
		Right	Left
Unchanged (U)	13	59.3 $\pm$ 8.1	61.2 $\pm$ 9.3
New slip (A)	5	49.1 $\pm$ 7.6	49.2 $\pm$ 5.1
Increased slip (P)	4	47.7 $\pm$ 7.6	51.2 $\pm$ 10.7

* difference between group U and A and P together is highly significant ($p < 0.01$)

to alter during follow-up from 104° at the first visit to 117° at 13 years' follow-up (Fig. 3).

DISCUSSION

It is known that most isthmic defects occur in young children, with an increasing incidence until the age of 20 years but not after this, and that progression of vertebral slip is also relatively rare after adolescence. We aimed to study the incidence of new anterior displacement after adolescence, and of progression of slip in relation to the structure of the transverse process of L5. We found newly-developing anterior slip or progress of slip in nine of 22 patients with isthmic spondylolysis or spondylolisthesis at a mean 12-year follow-up.

In the 13 patients without slip the transverse processes of L5 were relatively broad, but significantly more slender in five patients with newly-developed vertebral slip and in four with progression of slip in spondylolisthesis of L5.

In one patient with spondylolysis without slip of L5 and broad transverse processes, a new slip developed at L4/5 without an isthmic defect, but there was no change at L5/S1 after 13 years. It seems possible that the L5 vertebra was well stabilised on the sacrum by a thick iliolumbar liga-

ment, thus transferring stress to the L4/5 segment.

Our study has shown a significant relationship between adult vertebral slip at L5/S1 and the vertical thickness of the transverse process of L5, and allows the following conclusions:

- 1) New vertebral slip or progression of slip may occur in adult isthmic spondylolysis and spondylolisthesis of L5 with no evidence of trauma.
- 2) The relative thickness of the transverse processes of L5 may be related to the functional strength of the iliolumbar ligament.
- 3) Inadequate function of the ligament may reduce stability at the lumbosacral junction.

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