Degenerative spondylolisthesis is four times more common in women than in men. Although this gender difference has long been recognised there has been no explanation for it. We have examined the radiographs and CT scans of 118 patients over the age of 55 years and of a control group under the age of 46 years.

Our findings confirmed the presence of more sagittally-orientated facet joints in patients with degenerative spondylolisthesis but did not show that the gender difference can be explained by the morphology of the facet joint.

Furthermore, we conclude that the increased angle of the facet joint is the result of arthritic remodelling and not the primary cause of degenerative spondylolisthesis. It is more likely to be due to loss of soft-tissue resilience with subsequent failure of the facet joints which are acting as the last restraints to subluxation.

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Recently, several articles have addressed possible causative factors in the development of degenerative spondylolisthesis (DS), which is between four and five times more common in women than in men. The reason for this has not been explained although hormonal influences and pregnancy have been implicated.

It has been suggested that DS is part of generalised primary osteoarthritis which, since this occurs more commonly in women, could explain the gender difference, but the epidemiological data for this association are lacking.

Other suggested aetiological factors include race, soft-tissue abnormalities, the influence of the lumbosacral angle, lower intercristal line, lumbosacral bony anomalies, facet tropism and alignment and diabetes.

Several authors have studied the orientation of the lumbar facet joints. In particular, the finding of an increased sagittal angle in patients with degenerative spondylolisthesis has suggested the possibility that a developmental predisposition to this alignment may be present, but data supporting this conclusion are circumstantial.

We have examined an age- and gender-matched population of patients to determine the angle of the facet joint, the depth ratios at L4/L5 and their relationships to DS. We then ascertained whether or not there is a group of younger adults who may be predisposed to the development of DS on the basis that the sagittal angles of the facet joint are greater than normal. Finally, we investigated the possibility that the observed differences in the incidence of DS between men and women result from disparity in the morphology of their facet joints.

Patients and Methods

From our records we identified 220 patients over the age of 55 years who had had a lumbar decompressive laminectomy between 1991 and 1996. We studied 140 patients from this group; 14 did not reply to a written request to send radiographs and CT scans. Of the 126 patients who complied, eight did not have preoperative CT scans available for measurement, leaving 118 patients for review. They were divided into four groups: group 1, 32 women with DS with a mean age of 70.9 years (53 to 88); group 2, 37 women without DS with a mean age of 68.5 years (52 to 87); group 3, 14 men with DS with a mean age of 70.3 years (54 to 78); and group 4, 35 men without DS with a mean age of 69.6 years (52 to 88).

The angles of the L4/L5 facet joints were measured on CT scans by the senior author (TWL) (Fig. 1). The measurement was taken at the superior endplate of L5, as described by Grobler and Wiltse, who found this level to be consistent and easy to measure. They called the measured angle the ‘theta angle’. The degree of slip in the patients with DS was recorded and the depth ratio (expressed as a percentage) was calculated for each L4/L5 joint (Fig. 1).
The intersection of the intercristal line with the vertebral column was identified for each patient as well as the lumbosacral angle as described by Rosenberg. Radio-graphs of a small subset of five randomly chosen women and five randomly chosen men were measured by an independent observer (ABF) and remeasured by the senior author to enable intraobserver and interobserver error to be calculated.

In the second part of the study, we measured the CT scans of 40 women and 40 men, all under the age of 45 years, who had sustained injuries to the vertebral column other than at L4/L5, or had been investigated for either prolapse of a disc or discogenic back pain. Patients with pathology at L4/L5 were excluded.

The two-tailed Student’s t-test was used for statistical analysis of the data. A p value of less than 0.05 was considered significant.

Results

The mean angles for the right and left facet joints for group 1 (women with DS) were 58.53° and 59.19°, respectively. Both these mean angles were significantly greater than those in group 2 (women without DS) which were 44.51° for right facet joints and 43.65° for left facet joints (p < 0.001). Likewise, in group 3 (men with DS) the mean angle on the right was 60.71° and on the left, 61.93°, which were significantly higher (p < 0.001) when compared with group 4 (men without DS) in which the mean angle on the right was 46.11° and on the left 45.91°. There was no significant difference between group 1 and group 3 (p = 0.47) or between group 2 and group 4 (p = 0.46).

Overall, there was no significant difference between women and men when the mean of the theta angles for all women (right 50.97°; left 50.87°) was compared with that for all men (right 50.29°; left 50.49), (right, p = 0.79; left, p = 0.89).

Although it did not reach statistical significance, there was a trend towards a greater (i.e., flatter or less lordotic) lumbosacral angle in both men and women with DS (p = 0.08). There was no significant difference between the height of the intersection of the intercristal line with the vertebral column and the existence of DS (p > 0.05 for women and men). The depth ratios showed no significant difference among the various groups. For right and left, respectively, they were 0.20 and 0.17 for group 1, 0.19 and 0.17 for group 2, 0.16 and 0.19 for group 3, and 0.16 and 0.16 for group 4.

The correlation coefficient for the interobserver measurements was r = 0.96 for the angle of the facet joint and r = 0.96 for the depth ratio. Similarly, the correlation coefficient for the intraobserver measurements was r = 0.98 for the angle of the facet joint and r = 0.98 for the depth ratio (Fig. 2).

The mean age of the younger patients was 36.66 years. There was no significant difference (p = 0.82) between the mean age for women (36.8 years, 24 to 45) and that for men (36.53 years, 26 to 45). We analysed the angles of the facet joint and the depth ratios at the L4/L5 level for this younger population. There was no significant difference between the men and women for the mean of the theta angles for either the right (37.48° for men, 37.28° for women) or left (36.48° for men; 37.15° for women) facet joints or for the depth ratio for the right (0.15 for men; 0.16 for women) facet joints. The difference between the depth ratio of the left facet joint of women (0.16) and men (0.14) just reached significance (p = 0.04). The greatest theta angle recorded in women was 49°, and in men 48°.

The range of theta angles and the range of depth ratios, for all groups, are shown in Table I. The distribution of the theta angles in groups 1 to 4 are shown in Figure 3.

Discussion

The exact prevalence of DS is unknown although Farfan found an incidence of 4.1% at postmortem. In a review of the influence of childbearing on DS, we found an incidence of 27% in women over the age of 50 years who presented with symptoms in the low back. Degenerative spondylolisthesis is the only disorder of the adult spine in which a distinct difference between the genders has been observed. It is approximately four times more common in women than in men. Although this gender difference has long been known, until recently there has been no study of possible explanations for it. Rosenberg considered osteoporosis and hormonal factors but found no evidence for either. On the basis that the White population has a greater incidence of osteoporosis and a
lower incidence of DS compared with the Black, he concluded that osteoporosis is unlikely to be a contributing factor.

DS may well be part of generalised primary osteoarthritis, which may explain the increased incidence in women. This would also support the view that DS is the result of arthritic remodelling rather than a developmentally greater facet angle.

Imada et al investigated the influence of oophorectomy on the development of DS and concluded that patients had a threefold greater incidence of DS after this procedure.

A recent study from our institution has shown a twofold incidence of DS in parous compared with nulliparous women. There is no clear explanation for this finding, although it is speculated that the effect of childbearing on the abdominal musculature and hormonal changes in pregnancy, particularly the production of relaxin, could be contributing factors. Most commonly, DS occurs at the L4/L5 level where the lack of soft-tissue restraints may be responsible. Matsunaga et al found that patients with DS had greater anterior flexion of the lumbar spine than ‘normal’ individuals of comparable age. They noted that 65% of the DS patients had increased joint laxity compared with 8% of the normal group.

The reliability and usefulness of CT in measuring the angle of the facet joint have been verified by Grobler et al and by earlier work from our institution. One of our aims was to determine whether there were anatomical differences between women and men in the orientation of the facet joint which could explain the increased incidence of DS in women. It has been postulated by Grobler et al that a segment of the population is predisposed to DS by the sagittal orientation of their facet joints. If this is the case, this group would have approximately four times more

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women than men, but they described no such gender-related difference in the angle of the facet joint for the non-pathological group (15 men, 10 women; mean age 41.3 years).

Similarly, our study of 80 patients aged less than 46 years showed no significant differences in the angle of the facet joint of men and women. Only one man and one woman had both angles greater than 45°, which is thought to be associated with an increased risk of developing DS by Boden et al.1 Furthermore, there was no significant difference in the sagittal or coronal alignment of the facet joints between women and men with DS or between age-matched women and men without the condition.

Grobler et al4 and Boden et al1 found a significant increase in the sagittal orientation of the facet joints in patients with DS compared with other groups. The results of our study confirm this. Comparing the DS patients with an asymptomatic control group, Boden et al also found higher angles of the facet joint at L3/L4 and L5/S1, and concluded that DS was the result of a predisposing morphological development of the joint in certain subjects. On the basis of their findings, they stated that individuals with angles of the facet joint greater than 45° have a 25 times greater risk of developing DS. This opinion, however, was derived from a comparison of a control group with a mean age of 42 years with DS patients with a mean age of 72 years. Our results challenge this view by demonstrating that younger patients have more coronally orientated joints than older patients irrespective of whether they have DS. The respective proportion of women and men in Boden’s study groups is not stated and gender bias could explain part of the differences observed.

Our results indicate that the greater angles seen in DS are not developmental but are acquired as a result of remodelling associated with the arthritic process. The higher angles are the effect of anterior wear of the facet joint in patients with DS rather than being a cause of the forward subluxation. This concept is supported by Farfan’s postmortem review1 and by Taylor and Twomey,9 who suggested that the greatest resistance to flexion is from the anteromedial (coronal) portion of the facet joint. In our study, older adults who did not have DS still had a significantly (p < 0.001) greater mean angle than those in the younger group. We consider this to be also the result of arthritic remodelling although, since the soft tissues are more resilient, the stress borne by the facet joints is less and the changes are not so marked. The capacity for wear to change the characteristics of a joint is commonly seen elsewhere in the body, and it seems unlikely that the facet joint would react differently.

A flatter facet joint would be expected to be less inherently stable than a curved one. The mean depth ratios for the patients with DS were, however, equivalent or slightly greater than those without, including the younger age group, although this observation did not reach significance. This agrees with the findings of Grobler et al.4 As the inferior facet of L4 slides and wears its way forwards it deforms the anterior portion of the superior facet of L5 and the joint is deepened by the trailing posterior edges, which are wider apart than the anterior.

A major possible flaw in our and in all previous studies is that the measurements of the facet joint have addressed only one plane of angulation, ignoring the inclination of the frontal plane. The combination of sagittal and horizontal inclination of the facet joint may be significant in the development of DS. As can be seen in Figure 3, some patients with DS have coronally disposed facet joints whereas they tend to be sagittally orientated in patients without DS. If the degree of inclination is taken into consideration, these exceptions may be explained.

Farfan3 from his cadaver studies suggested that the listhesis is a rotatory deformity rather than a simple for-
ward displacement. This may be due to a three-dimensional difference in the facet joints rendering one side more susceptible to subluxation than the other. It may be possible to explore this possibility further with modern imaging techniques.

We believe that it is unlikely that there is a group of people who have facet joints which develop in a more sagittal plane thereby placing them at a greater risk of developing DS. Other factors such as the lumbosacral angle, ligamentous laxity, previous pregnancy and hormonal factors, impose an increased stress on the L4/L5 facet joints which are effectively acting as the last restraints to anterior subluxation. Despite the marked difference in the prevalence of DS we were unable to show any significant difference between the genders in the measured anatomical parameters in any of the groups which we studied.

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References


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