Orientation of lumbar pars defects
IMPLICATIONS FOR RADIOLOGICAL DETECTION AND SURGICAL MANAGEMENT
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Lateral oblique radiographs are considered important for the identification of spondylolytic lesions, but these projections will give a clear view only when the radiological beam is in the plane of the defect. We studied the variation in orientation of spondylolytic lesions on CT scans of 34 patients with 69 defects.

There was a wide variation of angle: only 32% of defects were orientated within 15° of the 45° lateral oblique plane. Lateral oblique radiographs should not be considered as the definitive investigation for spondylolysis.

We suggest that CT scans with reverse gantry angle are now more appropriate than oblique radiography for the assessment of spondylolysis. Variation in the angle of the defect may also need consideration when direct repair is being planned.

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Spondylolysis is seen in between 3% and 10% of the adult population. Since the pars articularis is not parallel to any of the three orthogonal planes there is difficulty in radiological imaging. Various methods have been devised to obtain true frontal and lateral radiographs of the pars. These include the 45° lateral oblique view, the anteroposterior (AP) projection with 30° cranial angulation and the 40° lateral oblique with 30° cranial angulation. Choplin, Gilula and Murphy have also suggested spot views of the pars at various degrees of obliquity. The 45° lateral oblique radiograph is considered an important projection for the assessment of spondylolysis, but plain radiographs are optimal only when the radiological beam is parallel to the plane of the fracture. The 45° lateral oblique view is of routine value only when the plane of the spondylolysis is at or near 45° to the coronal plane and approximately perpendicular to the pars interarticularis. Most spondylolyses are reported to lie closer to the coronal plane.

We used axial CT to study the angle relative to the coronal plane of pars defects, and discuss our findings with respect to the radiological detection of spondylolysis and its surgical management.

Patients and Methods

We assessed 34 consecutive axial CT scans in patients with spondylolysis. A defect in the pars was diagnosed if there was a break in the neural arch at the junction of the pedicle with the lamina, seen typically on sections through the lower half of the pedicle. This allowed clear differentiation from the facet joint above or below since these were best identified on sections through the disc space or the upper half of the pedicle. There were 19 men and 15 women with a mean age of 38.6 years (14 to 71). The presence or absence of spondylolisthesis was not recorded since it was not considered relevant to the angle of the defect. A total of 69 pars defects was demonstrated (Table I). The angle of the defect in relation to the coronal plane was determined as illustrated in Figures 1 to 3. A line parallel to the posterior cortex of the vertebral body at the level of the lysis defined the coronal plane, and a second line was drawn tangential to the defect. The angle between them was measured. When defects were curved as a result of the formation of new bone, particularly from the lateral aspect, the angle measured was that of the fracture through the pars

Table I. Distribution of defects in the pars in 34 patients with spondylolysis

<table>
<thead>
<tr>
<th>Level</th>
<th>Right</th>
<th>Left</th>
<th>Total</th>
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<tbody>
<tr>
<td>L1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>L2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>L3</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>L4</td>
<td>5</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>L5</td>
<td>30</td>
<td>27</td>
<td>57</td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
<td>33</td>
<td>69</td>
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rather than the apparent defect produced by the adjacent osteophyte. Coned lateral radiographs were available for 29 cases and 45° lateral oblique radiographs or lateral oblique films of myelograms for 13.

Results

There was a wide variation in the angles between defects in the pars and the coronal plane (Fig. 4). The mean angle was 23.7° with respect to the coronal plane with a standard deviation of 21.4°. Twenty-two lyses (32%) lay within 15° either side of the 45° oblique plane; only seven (10%) lay approximately perpendicular to the pars, within 5° of the 45° oblique plane. In three patients the defect was not visible on the lateral coned view. In the 13 in which both the lateral coned view of the lumbosacral junction and the oblique views were available, only two lesions (both in the same patient) were identified on oblique views and not seen on the lateral films; each was at 45° to the coronal plane.

Three defects were not seen on oblique views but were shown by CT and in two other patients the radiological diagnosis on the oblique view alone was equivocal. In these five cases, however, the diagnosis could be made on the lateral radiograph. In two other patients stress reactions in the pars were demonstrated by CT at three sites but these had not progressed to complete defects and were not identified by plain radiography.

Discussion

The 45° lateral oblique radiograph produces the ‘Scottie-dog’ appearance of the neural arch with the pars representing the neck of the dog. On this view the pars is approximately transverse to the X-ray beam and theoretically any abnormality should be better demonstrated than on a coned lateral film. It has been shown, however, that a coned lateral radiograph of the lumbosacral junction is the most sensitive single projection for the diagnosis of
spondylolysis without spondylolisthesis.\textsuperscript{9} 84% of defects were identified by this view alone. This suggests that most defects lie close to the coronal plane and parallel to the lateral X-ray beam.

Libson et al\textsuperscript{2} observed that approximately 20% of defects were visible only on the 45° lateral oblique radiograph and stressed the importance of this view in young adults, but they had no confirmation from CT or surgery to confirm that these ‘defects’ were present. There is a possibility that they could represent false-positive findings.

In a study by Markwalder, Saager and Reulen\textsuperscript{10} all defects were demonstrated on the lateral oblique view, but since the patients all had a spondylolisthesis it was not surprising that the defects were easily identified. The difficulty of demonstrating a defect is in patients who have spondylolysis without spondylolisthesis.

We have shown that only 32% of defects lie within 15% of either side of the 45° lateral oblique plane, and only seven (10%) were actually perpendicular to the pars interarticularis. This suggests that a 45° oblique lateral radiograph will fail to show most defects unless there is spondylolisthesis, since the X-ray beam will not be in the plane of the defect. Despite this, many defects are seen, on both lateral and lateral oblique views.\textsuperscript{9} There are two possible reasons. Some defects are curved, with one section tangential to a lateral beam and another to a lateral oblique beam. Secondly, a defect which is relatively wide or has atrophic margins will be visible on both lateral and oblique views. We did not measure the width of the defects. The plane of the CT scan was not always perpendicular to the defect because the reverse gantry angle was not always used, which made accurate measurement impossible. Thin and linear defects with sclerotic margins are the most difficult to identify on plain radiography.

Amato et al\textsuperscript{9} suggested that poor positioning of patients was the cause of false-negative oblique radiography in patients with spondylolysis. Hession and Butt\textsuperscript{11} felt that defects which were not seen on oblique radiographs lay at ‘abnormal’ angles, implying that there is a ‘normal’ angle at which lesions occur, presumably perpendicular to the pars. Our study indicates that the angle of the defect varies greatly and is an important factor in radiological demonstration. An oblique lateral radiograph should not be considered as a reliable projection for this purpose. Some defects were unlikely to be identified on either coned lateral or lateral oblique radiographs, and stress reactions which have not progressed to defects will not be seen on plain films. A normal series of plain radiographs, including the right and left 45° lateral oblique views, does not therefore exclude the possibility of a spondylolysis.

We have shown the importance of CT in the accurate diagnosis of spondylolysis. We suggest the use of a limited thin-section scan using the reverse gantry angle technique,\textsuperscript{11} rather than oblique radiography, when coned lateral radiographs fail to show a suspected abnormality. Congeni, McCulloch and Swanson\textsuperscript{12} identified 18 chronic unhealed fractures of the pars by CT in 40 patients who were considered to have normal plain radiographs. If the lateral radiograph shows a defect but its side cannot be determined, an AP view with 30° cranial angulation will show the side of the defect.\textsuperscript{7}

The variation in the angles of defects in the pars may also affect surgical management. Various techniques for direct repair include the passage of a screw across the
defect, first described by Buck.\textsuperscript{13} This has been reported to be successful in 83\% to 88\% of patients,\textsuperscript{14,15} and Pedersen and Hagen\textsuperscript{14} identified improper placement of the screw as the major cause of failure in their series. The angle of the defect was not considered in planning the site of the screw. Recently, Lu et al\textsuperscript{16} have shown, in an anatomical study, that the optimal angle for placement of a screw across the pars of L5 is at 30° to the sagittal plane. If an interfragmentary lag screw is to achieve maximal compressive force across a fracture it must be inserted perpendicular to it.\textsuperscript{17} A screw placed at more than 20° to this plane may result in slippage of the fracture, but it is not known whether this principle applies to the neural arch. Screw placement at the angle suggested by Lu et al\textsuperscript{16} would be perpendicular only to defects lying at 30° to the coronal plane. In our study, 40 of 69 defects lay within 20° of the 30° plane; this indicates that a screw placed at this angle would be almost perpendicular to approximately 60\% of lesions. Defects which lie well away from the 30° plane may be poorly fixed by such a screw; this may result in failure. In future it may be possible to manage such cases by computer-assisted placement of a screw or else to use an alternative method such as posterolateral fusion.

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