SPONDYLOLISTHESIS WITH AN INTACT NEURAL
ARCH—THE SO-CALLED PSEUDO-SPONDYLOLISTHESIS

IAN MACNAB, LONDON, ENGLAND

From the Institute of Orthopaedics, Royal National Orthopaedic Hospital

In spondylolisthesis the usual cause of anterior displacement of a vertebra is a bilateral
defect in the pars interarticularis. Sometimes there is no such defect and the whole vertebra
including the spine and neural arch is displaced forwards (Fig. 1). Lamb (1858), Neugebauer
(1889) and Chiari (1892), all of whom are quoted by Friberg (1930), were among the earliest
investigators to study spondylolisthesis and were aware that spontaneous displacement of a
vertebra could occur with an intact neural arch. After the common defect had been adequately
described, however, little attention was paid to the possibility that subluxation of the posterior
joints could allow forward displacement of the whole vertebra. In 1930 Junghanss once
again pointed out that such displacement could occur and named the condition "pseudo-
spondylolisthesis." He described beautifully the pathological changes in eleven cases found
in the course of examining several hundred spines in Schmorl's collection. The term
"pseudo-spondylolisthesis" is not a satisfactory one, however, because vertebral sliding is
correctly called "spondylolisthesis" whether it is associated with a neural arch defect or not.

In clinical descriptions of spondylolisthesis those cases without neural arch defects had not
been distinguished until 1941, when Hallgrímsson described the clinical and operative findings
in a single case. This paper is mainly a report on the clinical findings in twenty-two patients.

Fig. 1
Spondylolisthesis without neural arch defect. The oblique views show the neural arch intact. The
lateral view shows a slight anterior displacement of L4 and marked narrowing of the intervertebral
space between L4 and L5.

* Based upon a paper read to the Orthopaedic Section of the Royal Society of Medicine in November 1949.
ETIOLOGY

There is no recorded instance of a patient with a radiologically normal spine who subsequently developed this condition. Any statement as to etiology must therefore be a matter of conjecture based on the findings and progress of established cases. Examination of the radiographs in this series provides some evidence for the pathogenesis of the slip. The body-weight transmitted through the spinal column tends to displace the lumbar vertebrae forwards, but this force is resisted by the soft tissues and the posterior articulations. These posterior joints may lie in one of three planes—sagittal, coronal or oblique. When the joints are in the sagittal plane the production of an anterior dislocation presents no mechanical problem. In such instances, after disc degeneration, the body-weight could displace the vertebra forwards. Although this undoubtedly occurs, it is unusual, because the posterior joints seldom lie in a true sagittal plane. Though they may be sagittal posteriorly, they hook round anteriorly—like the letter J—and form bony bars resisting forward displacement. In the same way joints lying in an oblique or in the coronal plane act as bony bars preventing dislocation, which can occur only by over-riding or fracture of the facets.

Normally the plane of the inferior articular facet is at right angles to the pedicles and over-riding is virtually impossible. Junghanns, however, pointed out that in his specimens of "pseudo-spondylolisthesis" the angle between the pedicle and the inferior articular facet approached 180 degrees (Fig. 2). This alteration in angle between the pedicle and the inferior facet may be one of the many congenital anomalies found in this region. This is the essential lesion, and when it is present the anterior dislocating force is resisted only by the soft tissues.
and mainly by the intervertebral disc. It may be supposed that the abnormal strain eventually causes disc degeneration, which leads to an alteration in the axis of flexion and extension of the adjacent vertebrae. Calvé and Galland (1930) demonstrated that in the lumbar spine this axis normally passes through the nucleus pulposus, whereas after disc degeneration it passes through the posterior joints so that—except in the rare instances when they are sagittal—flexion and extension movements cause rocking at these joints (Fig. 3). This abnormal movement probably accounts for the gross osteoarthritis of the posterior joints seen in the later stages of the condition. As the osteoarthritis progresses, the body-weight produces

subluxation at these joints and the superior vertebra slips forward, producing a spondylolisthesis. The anterior displacement is increased on flexion, so that flexion and extension movements of the lumbar spine produce not only rocking but also a backward and forward movement of the body of the affected vertebra like the action of a horizontal piston (Fig. 4). This piston movement must cause considerable injury to the posterior joints, which become progressively more disorganised and allow increasing forward dislocation.

Fig. 3

Above—Diagram to show the rocking movement at the posterior intervertebral joints on flexion and extension in the presence of disc degeneration. Below—Radiographs of the lumbar spine in a case of ‘pseudo-spondylolisthesis,’ in extension and in flexion. Note how the posterior facet rocks open in flexion.
At the same time secondary changes occur in the rest of the spine. There may be increased lumbar curvature, lumbo-dorsal osteoarthritis, occasionally pelvic rotation and eventually generalised lumbar arthritis. In the later stages no appreciable movement takes place between the displaced vertebra and the one below it, and it is probably the secondary changes in the spine which now account for the patient’s symptoms.

![Diagrams and radiographs of the lumbar spine in a case of "pseudo-spondyloolisthesis" in extension and in flexion. Note how the vertebral body shifts forwards on flexion.](image)

**Fig. 4**

With regard to the secondary lumbo-dorsal arthritis, it is probable that the mechanical insufficiency gives rise to localised muscle spasm of a protective nature, and that flexion and extension movements of the spinal column then take place largely at the lumbo-dorsal junction, causing excessive strain and, later, disc degeneration and osteoarthritis. This association of a lesion in the lower lumbar area with osteoarthritis of the lumbo-dorsal junction is seen in other forms of mechanical insufficiency such as disc degeneration and spondylolysis, and is an important factor in determining treatment.

Stewart (1935) has stated that the alteration in the angle between the inferior articular facet and the pedicle is secondary to the osteoarthritis of the zygo-apophysial joints. Usually, the osteoarthritis of the posterior joints is obvious by the time the symptoms are severe enough to compel patients to seek advice, but in one case in this series a slip was
present before there was any radiographic evidence of such osteoarthritis. This case, though a single one, lends support to the view that the change in the angle between the pedicle and inferior articular facets is the primary condition.

It has also been suggested that the anterior displacement is merely the result of disc degeneration. However, because of the forward inclination of the superior articular facets, disc degeneration by itself produces not an anterior displacement but a downward and backward movement of the vertebral body (Fig. 5).

THE CLINICAL PICTURE

The symptoms and signs of any one cause of backache are so various and variable that it is impossible to establish the clinical picture of this type of spondylolisthesis from such a small series (see Table I).

In general it may be said that there are three groups of symptom-complex: 1) backache, with or without sciatica, but with no signs of nerve root compression; 2) sciatica, with or without backache, and with evidence of nerve root compression; and 3) symptoms of cauda equina compression.

Symptoms—In five patients the onset of symptoms was sudden, four having had acute sciatica after heavy lifting. More commonly, however, the patients gave a history of a gradual onset of central low back pain radiating transversely, nagging in character, intermittent at first but later becoming more persistent. The backache was aggravated by exercise and commonly was worse on getting up after rest. Many patients stated that the backache was aggravated by lying flat on the back. In twelve patients the backache was followed after some years by sciatica, which was bilateral in six of the twelve, and it was this new symptom that caused them to seek advice.

Signs—Examination showed that flexion of the lumbar spine was restricted, with tenderness on deep pressure over the fourth spinous process and over the supra-spinous ligament between L.4 and L.5. In many cases there was another area of tenderness over the lumbo-dorsal junction, which, as noted earlier, is a common site for secondary osteoarthritic changes.

There were signs of nerve root compression in eleven patients. The ankle jerk was absent in all of these, and in two the knee jerk was absent also. One patient had anaesthesia in the distribution of the fourth lumbar dermatome and in two there was marked weakness of the quadriceps, tibialis anterior and tibialis posterior. In one patient who had never suffered from backache or sciatica the presenting symptom was a dragging of the left foot.

Cauda equina compression is rare and there was no example of it in this series. It has been included in the group of symptom complexes because cauda equina lesions associated
with spondylolisthesis have been recorded in the literature, and it seems likely that many of
the spinal lesions have been examples of so-called pseudo-spondylolisthesis. Sir Arbuthnot
Lane (1893) was the first to record such a case. The patient suffered from backache and a
progressive paraplegia which made her unable to walk. Lane made the clinical diagnosis of
spondylolisthesis and performed a laminectomy. The spinous process and the lamina of the
fifth lumbar vertebra were found to be displaced forwards and severely compressing the
cauda equina. This forward displacement of the spinous process and the lamina excludes
spondylolisthesis due to a neural arch defect, and Lane further remarked that no solution of
continuity of the neural arch could be seen at any point on either side. Similar cases were
later reported by Goldthwait (1911) and Ryerson (1915).

**TABLE I**

**Summary of Twenty-two Cases**

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<thead>
<tr>
<th>Sex</th>
<th>7 male</th>
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<tbody>
<tr>
<td></td>
<td>15 female</td>
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<tr>
<th>Duration of symptoms</th>
<th>3 months (shortest)</th>
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<tr>
<td></td>
<td>15 years (longest)</td>
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<td><em>(Average, 7 years)</em></td>
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<table>
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<tr>
<th>Classification of symptoms</th>
<th>Backache only—7 cases</th>
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<tr>
<td></td>
<td>Backache and unilateral sciatica—6 cases</td>
</tr>
<tr>
<td></td>
<td>Backache and bilateral sciatica—6 cases</td>
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<tr>
<td></td>
<td>Sciatica only—2 cases</td>
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<td></td>
<td>&quot; Drop-foot &quot;—1 case</td>
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**Radiographic findings**—The fourth lumbar vertebra is most commonly affected, whereas neural
arch defects are most commonly found in the fifth vertebra. In a series of 142 cases of
spondylolisthesis reviewed for this study, thirty-eight were found to involve the fourth lumbar
vertebra and **twenty-two of these had no neural arch lesion.** These findings suggest that anterior
displacement of the **fourth** lumbar vertebra is as commonly due to subluxation of the posterior
joints as to a defect in the neural arch. It is difficult to assess the incidence of spondylolisthesis
of the fifth lumbar vertebra without neural arch defect, because satisfactory radiography of
the pars interarticularis is difficult. Many cases of anterior dislocation of the fifth lumbar
vertebra are diagnosed as spondylolisthesis in the ordinary sense of the term without a defect
being seen, and it is quite possible that in some of these the neural arch is intact.

The anterior displacement was in no case great. In one instance the vertebral body had
moved forward 140 centimetre, but the average displacement was only 06 centimetre. There
was usually marked osteoarthritis of the posterior joints between the fourth and fifth lumbar
vertebrae. The osteoarthritis may be confined to these joints, but often by the time the
patient seeks advice degenerative changes can be seen in all the lumbar posterior joints.

As the average age of patients with this condition was sixty years, the usual radiographic
appearance was one of an osteoporotic, osteoarthritic spine with slight anterior displacement
of the fourth lumbar vertebra but with no defect of the arch revealed by the oblique views.

**TREATMENT**

Treatment is most easily discussed under the headings of the three groups of
symptom-complex previously mentioned.

**Group I.** Backache with or without sciatica, but with no signs of nerve root compression—The
presence of "pseudo-spondylolisthesis" indicates a mechanically unstable spine which, if
left untreated, will lead to progressive lumbar osteoarthritis, and possibly to nerve root
compression or even to compression of the cauda equina. Seen early, therefore, it calls for
spinal fusion. Since there is no neural arch defect there is no need to fuse three vertebrae as for the common type of spondylolisthesis. Adequate stability can be obtained by fusion of the displaced vertebra to the one below it (Fig. 6). In the later stages, however, when there are marked secondary changes, localised spinal fusion will relieve the symptoms from one source only and may indeed aggravate the others, so that conservative treatment is best.

**Fig. 6**  
Spinal fusion of L4 and L5 for spondylolisthesis without arch defect.

**Group II. Sciatica with or without backache, and with signs of nerve root compression**  
Nerve root compression can arise in three ways: (a) *Compression in the intervertebral foramen*—Forward displacement of a vertebra is associated with narrowing of the two inferior intervertebral foramina. The osteoarthritis which occurs in the posterior joints may be associated with marked capsular thickening and occasionally there is spur formation on the posterior edge of the displaced vertebral body. Any one or all three of these factors may play a part in root compression (Fig. 7).  
(b) *Compression by the lamina of the displaced vertebra*—This type of compression occurs only in the presence of an intact neural arch; otherwise only the vertebral body slips forward, and the lamina remains in situ (Fig. 8).  
(c) *Compression of a nerve root by an associated prolapsed intervertebral disc*.

Whatever the cause of nerve root compression, if the symptoms are severe enough laminectomy with subsequent spinal fusion is indicated.

**Group III. Signs of compression of the cauda equina**—Laminectomy would of course be imperative and should be followed by spinal fusion.

**SUMMARY**

Spondylolisthesis without a defect in the neural arch, the "pseudo-spondylolisthesis" of Junghanns, usually affects the fourth lumbar vertebra. The essential lesion is an increase in the angle between the inferior facets and the pedicles which allows subluxation at the inferior joints. The forward displacement averages less than one centimetre.

It commonly produces a clinical picture of backache and sciatica, but may present with a "drop foot," and in unusual instances compression of the cauda equina may occur.
A diagram to show the mechanism of nerve root compression in spondylolisthesis without arch defect.

In spondylolisthesis with an arch defect (left), because the lamina remains in situ, the spinal canal is widened at the site of the slip and cauda equina compression does not readily occur. In spondylolisthesis without arch defect (right) the lamina is displaced with the vertebral body.
Patients seen in the early stages without signs of nerve root compression are best treated by localised spinal fusion. Late fusion may afford no relief because of secondary changes in the spine, but these patients obtain some benefit from a corset. Laminectomy is indicated for severe symptoms in patients who show signs of nerve root compression; it should be followed by spinal fusion.

I would like to thank the surgeons of the Royal National Orthopaedic Hospital for access to their clinical material and, in particular, Mr P. H. Newman for his help and encouragement.

REFERENCES

Friberg, S. (1939): quoting Chiari (1882), Lambl (1858) and Neugebauer (1889) in Acta Chirurgica Scandinavica, 82, Supplement 52.