LUMBAR SPINAL STENOSIS

M. A. Nelson, Leeds, England

From the General Infirmary, Leeds

Although narrowing of the cervical canal has been well recognised for many years (Pallis, Jones and Spillane 1954; Wolf, Khilnani and Malis 1956; Payne and Spillane 1957; Hinck, Gordy and Storino 1964; Hinck and Sachdev 1966) a similar and equally important condition of the lumbar canal has until recent years remained relatively neglected in the literature. In 1925 Donath and Vogl first described important morphological changes in the achondroplastic spine, consisting of shortening of the pedicles and reduction of the interpedicular distance, with consequent narrowing of the spinal canal in both diameters. Such patients suffer a high incidence of cord and nerve root compression (Nelson 1972). These bony changes are caused by the basic failure of cartilage growth seen in achondroplasia and were thought to be confined to that disorder. In 1947 Sarpyener described narrowing of the lumbar spinal canal in association with spina bifida. In 1954 Verbiest drew attention to the presence of narrowing of the lumbar canal in an otherwise normal individual. He was the first to associate it with the clinical picture of bilateral radicular pain, disturbance of sensibility and impairment of motor power in the legs, brought on by walking or standing and relieved by rest—a syndrome later to be called “intermittent claudication of the cauda equina” by Blau and Logue (1961).

Several papers have subsequently confirmed this entity (Epstein, Epstein and Lavine 1962; Teng and Papatheodorou 1963; Gravelleau and Guiot 1964; Joffe, Appleby and Arjona 1966; Hancock 1967; Jones and Thomson 1968; Schatzker and Pennal 1968; Ehni 1969a and b). Nevertheless there is still some confusion as to the exact nature of the narrowing.

Verbiest (1954) reported seven patients with spinal stenosis, in all of whom the interpedicular distance was normal: he concluded that the narrowing was confined to the sagittal plane, producing a complete block as revealed by myelography. Epstein et al. (1962) reported twenty-nine patients with symptoms related to narrowing of the lumbar spinal canal, eighteen of whom had a sagittal diameter of 1.5 centimetres or less. The interpedicular distance was in the lower limit of normal in ten of their patients. They stressed the significance of relative flattening of the intervertebral foramina as shown in the lateral radiograph. Teng and Papatheodorou (1963) reported thirty patients with so-called spondylolysis of the lumbar spine, in three of whom they described narrowing of the lumbar canal due to reduced anteroposterior diameter. Hancock (1967) recorded the finding of short pedicles in the narrowed lumbar canal, but in his first patient he also noted a reduction of the interpedicular distance at L.4 and L.5. Schlesinger and Taveras (1953) regarded an abnormal reduction of the interpedicular distance as of great significance in their patients. Schatzker and Pennal (1968) noted that several of their patients, described as having developmental stenosis, had a reduction of the anteroposterior diameter of the lumbar canal. Clark (1969), however, stressed that the total interpedicular distance may be reduced at all levels and that this may account for considerable difficulty at operation.

CLINICAL PRESENTATION

The patient, usually a man in the third or fourth decade, may present either with numbness, paraesthesia, pain in both legs brought on by exercise and relieved by rest (claudicant type), or with low back pain with bizarre unilateral leg pain, again often brought on by activity and relieved by rest (sciatic type).

Claudicant type—The patient says that at rest he has no symptoms, but that as he begins to walk and after a certain distance, a distance which had usually diminished progressively over
the previous one to two years, he begins to notice paraesthesia and eventual numbness in one or both legs. This may be associated with low back pain and if the patient progresses he will record that his legs begin to feel woolly and that his gait and balance become unsteady. If he stops, particularly if he sits down and sometimes if he crouches, there is a very dramatic improvement in symptoms and he is able to continue his journey. He notices that lying on a flat surface relieves his symptoms most rapidly. Examination may or may not reveal any abnormality in the back. There may be slight loss of lumbar lordosis and some pain on extension of the spine, but often movements of the back are full and no pain can be elicited.

Examination of the lower limbs may also be negative and straight-leg raising may be full. All peripheral pulses are present and equal. In a late case, however, there may be evidence of wasting of the thigh and calf and some weakness of dorsiflexion of the ankles, the ankle jerks also may be depressed.

Sciatic type—The patient who gives a long history of low back pain, then describes a more recent onset of leg pain, which may be associated with paraesthesia and numbness, usually confined to one side only and brought on by walking, running, and relieved by standing, crouching and lying. Occasionally the pain is constant. Clinical examination may again be quite normal, with a full range of spinal movements, normal straight-leg raising and no neurological abnormality. Usually, however, there is some wasting of the thigh and calf and some weakness of dorsiflexion of the ankles, with a depressed ankle jerk on that side.

**DIAGNOSIS**

The condition of spinal stenosis is strongly suggested by the above history, in the presence of normal peripheral pulses. Routine antero-posterior and lateral radiographs of the lumbar spine usually show some generalised spondylosis, with possible narrowing at the lumbar 4/5
or the lumbo-sacral disc space; but with careful inspection shortening of the pedicles is revealed, as shown by the size of the intervertebral foraminae. These often become progressively smaller from L.1 to L.5. At the L.4/5 and L.5/S.1 levels it may be impossible to identify the intervertebral foraminae at all (Figs. 1 and 2); particularly at these levels the antero-posterior radiograph may also give some suggestion of narrowing or reduction of the interpedicular distance.

Myelography should be done preferably with the needle at the lumbar 3/4 level. Occasionally the myelograph strongly suggests that an epidural injection has been done, but this appearance may be simply caused by the marked narrowing of the antero-posterior diameter of the canal. If spinal myelography fails, it should be done through a cisternal puncture. The myelographic findings may vary from multiple disc prolapses in the lumbar region (Figs. 3 to 5) to a complete block (Fig. 6); the latter may often be relieved by flexing the lumbar spine, or by rescreening the patient after he has been recumbent for one or two days.

CLINICAL MATERIAL

Nine men with spinal stenosis, proven at operation, have been reviewed (Table 1). Four patients (Cases 1 to 4) gave a "claudicant" history and three of these had a partial or complete block on myelography. The remaining five patients gave a "sciatic" history and in these myelography revealed multiple disc lesions.

The patient in Case 1, although of normal height, had an appearance suggestive of achondroplasia, with forehead bossing, bridging of the nose and short limbs. The routine radiographs showed wedging of the first lumbar vertebra, with reduction in both sagittal and coronal diameters of the spinal canal (Figs. 7 and 8). Myelography showed a partial block.
at the L.1–2 disc space (Fig. 9). Treatment by local decompression at the thoraco-lumbar level was done because the patient refused blood transfusion on religious grounds. Only slight relief followed operation.

The patient in Case 3 had long-standing thoracic kyphoscoliosis with a compensatory lumbar lordosis. Backache had been present for many years, although paraesthesia on walking had only started four years before. Myelography showed a complete block (Fig. 6).

**MANAGEMENT**

Although conservative measures such as rest and a lumbar support may help patients in the early days, symptoms eventually become increasingly disabling and surgery is indicated. Before operation the myelograph gives essential information needed to plan the operation, so that decompression is adequate: it is both lateral and longitudinal and must be sufficient to release the compressed dura and the lateral recesses containing the nerve roots. At the end of the operation the dura should be lying loosely and with no kinks. Pulsation should be present. It has been suggested that decompression of the dura should also be included if the pulsation fails to return. This seems logical, but the author has had no experience of this. Despite the removal of the posterior elements, stabilisation of the spine seems not to be indicated, but protection of the spine after operation by a lumbar support should be routine. Because of the thickness of the laminae and the encroachment of the posterior joints to the midline, the operation may be very difficult. Such difficulty, when met during a routine lumbar disc

---

**Fig. 6**
Case 3—Cisternal myelograph showing complete block at upper lumbar region.

**Fig. 7**
Case 1. Figures 7 and 8—Antero-posterior and lateral radiographs of the lumbar spine showing both the short pedicles and the reduced interpedicular distance.

**Fig. 8**

**Fig. 9**
Figure 9—Myelograph showing partial block at L.1 to L.2 disc space.
## TABLE 1

**Details of Nine Patients, All Male, with Spinal Stenosis**

<table>
<thead>
<tr>
<th>Case number</th>
<th>Age (years)</th>
<th>Occupation</th>
<th>Duration and type of symptoms</th>
<th>Radiographs</th>
<th>Myelograph</th>
<th>Operation</th>
<th>Follow-up</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>28</td>
<td>Storeman</td>
<td>5 years. Bilateral calf parasthesia on walking, 1 year. Pain left loin after fall</td>
<td>Wedging of T.12/L.1 with short pedicle L.1/5 and reduced interpedicular distance L.1/5</td>
<td>Partial block at T.12/L.1</td>
<td>Local decompression T.12/L.1</td>
<td>6 months</td>
<td>Slight improvement only</td>
</tr>
<tr>
<td>2</td>
<td>54</td>
<td>Post office engineer</td>
<td>14 years. Low back pain with bilateral leg parasthesia on walking</td>
<td>Short pedicles from L.1 to L.5</td>
<td>Anterior and posterior narrowing of column at L.4/5</td>
<td>Decompression L.1/5</td>
<td>1 year</td>
<td>Excellent</td>
</tr>
<tr>
<td>3</td>
<td>61</td>
<td>Plumber</td>
<td>Aged 36, posterior fusion for scoliosis; since then persistent pain with more recent parasthesia and weakness both legs on walking</td>
<td>Marked lower thoracic kyphoscoliosis with increased lumbar lordosis</td>
<td>Complete block at L.2</td>
<td>Decompression L.1/5, dura compressed markedly at L.2/3 and L.5/S.1</td>
<td>2 years</td>
<td>Excellent, Slight burning in buttocks only on sitting</td>
</tr>
<tr>
<td>4</td>
<td>62</td>
<td>Bus driver</td>
<td>15 years. Laminectomy with complete relief of pain in back of left leg. 3 years. Progressive parasthesia and weakness of both legs on walking</td>
<td>Progressive shortness of pedicles from L.1/5, with reduction in interpedicular distance</td>
<td>Lumbar puncture not successful. Cisternal puncture, complete block at L.3/4</td>
<td>Decompression of lumbar spine from L.2 to sacrum</td>
<td>6 months</td>
<td>Excellent. Urinary incontinence not improved</td>
</tr>
</tbody>
</table>

### Claudicant type

### Sciatic type

<table>
<thead>
<tr>
<th>Case number</th>
<th>Age (years)</th>
<th>Occupation</th>
<th>Duration and type of symptoms</th>
<th>Radiographs</th>
<th>Myelograph</th>
<th>Operation</th>
<th>Follow-up</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>60</td>
<td>Transport driver</td>
<td>11 years. Recurrent low back pain with pain in right calf on walking</td>
<td>Progressive shortness of pedicles L.1/5</td>
<td>Narrowing of column opposite L.2/3, L.3/4 and L.4/5</td>
<td>Decompression of L.2 to sacrum. Theca compressed and pulseless. Bulging disc at L.3, L.4 and L.5</td>
<td>18 months</td>
<td>Excellent, Increase in walking</td>
</tr>
<tr>
<td>6</td>
<td>47</td>
<td>Crane driver</td>
<td>1 year. Back pain and left leg pain</td>
<td>Progressive shortness of pedicles from L.1/5</td>
<td>Marked constriction of column opposite L.3/4, L.4/5 and disc bulge at L.5/S.1 on the left</td>
<td>Decompression of L.2 to sacrum, with removal of sequestrated disc at L.5/S.1</td>
<td>1 year</td>
<td>Excellent</td>
</tr>
<tr>
<td>7</td>
<td>65</td>
<td>Storekeeper</td>
<td>9 months. Low back pain and right leg pain</td>
<td>Shortening of pedicles from L.1 to L.5 with narrowing of disc space L.4/5</td>
<td>Not done</td>
<td>Decompression of L.2 to sacrum</td>
<td>6 months</td>
<td>Excellent</td>
</tr>
<tr>
<td>8</td>
<td>44</td>
<td>Motor mechanic</td>
<td>1 year. Low back pain and left leg pain</td>
<td>Shortening of pedicles L.1/5, Slight narrowing L.4/5 and L.5/S.1</td>
<td>Narrowing of column at L.3/4, L.4/5 and L.5/S.1</td>
<td>Decompression of L.2 to sacrum, large medial joint facets</td>
<td>6 months</td>
<td>Excellent</td>
</tr>
<tr>
<td>9</td>
<td>32</td>
<td>Labourer</td>
<td>4 months. Low back pain and left leg pain</td>
<td>Narrowing L.4/5, L.5/S.1, Short pedicles L.3, 4 and 5</td>
<td>Hour glass construction L.4/5 and L.5/S.1</td>
<td>Decompression L.4 to S.1</td>
<td>6 months</td>
<td>Excellent</td>
</tr>
</tbody>
</table>
removal should make the surgeon suspicious of a narrow canal and central laminectomy rather than hemilaminectomy should be done.

The patients reported here and in the literature have prompted a suggested classification of spinal stenosis, as shown in Table II.

**DISCUSSION**

Primary narrowing of the lumbar canal is of great significance because individuals with this condition are more liable to develop symptoms as a result of further slight reduction in the capacity of the lumbar canal. Such reduction may occur with age and the progressive

<table>
<thead>
<tr>
<th>Table II</th>
<th>Classification of Spinal Stenosis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary narrowing of the canal</strong></td>
<td>Reduced sagittal diameter, caused by short pedicles</td>
</tr>
<tr>
<td></td>
<td>Reduced coronal diameter, caused by reduction in the interpedicular distance</td>
</tr>
<tr>
<td></td>
<td>Achondroplastic type—reduced sagittal and coronal diameters, caused by short pedicles and reduced interpedicular distance</td>
</tr>
<tr>
<td><strong>Secondary narrowing of the canal</strong></td>
<td>Severe kyphosis with secondary lordosis</td>
</tr>
<tr>
<td></td>
<td>Degenerative spondylosis</td>
</tr>
<tr>
<td></td>
<td>Degenerative spondylolisthesis</td>
</tr>
<tr>
<td></td>
<td>Iatrogenic</td>
</tr>
</tbody>
</table>

loss in height of the discs, the gradual increasing lumbar lordosis and the slight but significant bulging of discs with degenerative changes in the posterior vertebral joints. A normal canal may have secondary narrowing because of kyphosis, severe degenerative spondylosis, degenerative spondylolisthesis and after surgical procedures (Schatzker and Pennal 1968, Ehni 1969a and b). Thus the onset of symptoms coincides with a further reduction in an already narrowed canal. Breig (1960) studied the lumbar spine in the cadaver and showed that when the spine moved from kyphosis (or flexion) to lordosis (or extension) the following changes occurred. 1) The lumbar canal shortened by 2.2 millimetres and the contained nerve tissue also shortened and became broader. 2) The fibres of the ligamentum flavum became slack and their cross-sectional area increased. 3) The intervertebral foramina narrowed. 4) There was a slight posterior protrusion of the disc at all levels into the spinal canal.

Although the history strongly suggests that vascular insufficiency is the cause, there is considerable evidence that the clinical syndrome could be explained on a mechanical basis in the first instance. In the normal lumbar spinal canal there is sufficient space surrounding the dura to allow for normal movement of the dura and nerve sheath. In the narrowed lumbar canal, however, the dura and its contained nerves lie firmly within the canal, so that any further reduction in its capacity may prevent the dura and nerve tissue from contracting and stretching, as needed for the range of movement from kyphosis to lordosis. It is suggested that, with standing and walking, there is a slight but definite increase in the lumbar lordosis. This is sufficient further to embarrass the capacity of the spinal canal and to prevent the contained nerve tissue from moving within the bony canal. Traction on the nerve tissue occurs and interferes with its microscopic blood supply; delayed nerve conduction results. On sitting or crouching, the spine immediately reverts to the slightly kyphotic position, the space within the bony canal increases, the blood supply improves and the symptoms are relieved. This is
further substantiated by the observation that myelographic block can be freed by flexing the lumbar spine, or by permitting the patient to rest in bed, after which the dye can be shown to have passed the block.

**SUMMARY**

1. Nine patients with radiological evidence of narrowing of the lumbar spinal canal, proved at operation, are reviewed.
2. They presented with either a claudicant or a sciatic clinical picture.
3. A classification into primary or secondary spinal stenosis is described. The primary type may be due to a reduction in either the sagittal, coronal or both diameters of the spinal canal.
4. Secondary narrowing of the canal may be superimposed upon a primary anatomical abnormality or may cause narrowing in a previously normal canal.
5. The symptoms are thought to be caused by a further reduction in the size of an already narrow canal, producing traction on the nerve tissue, which is then unable to move freely.

I wish to thank Mr John Fitton for permission to include Cases 2, 5 and 7 in this paper.

**REFERENCES**


