FURTHER EXPERIENCES ON THE PATHOLOGICAL INFLUENCE
OF A DEVELOPMENTAL NARROWNESS OF THE
BONY LUMBAR VERTEBRAL CANAL

H. VERBIEST, Utrecht, Holland

From the Department of Neurosurgery, University Hospital, Utrecht

In an earlier paper (Verbiest 1954) I reported some patients who developed signs of compression of caudal nerve roots on the basis of abnormal developmental narrowness of the bony lumbar vertebral canal. These signs appeared only during walking, standing or heavy bodily exertion. They disappeared immediately at rest. The symptomatology consisted of signs of irritation or of deficit. The most typical symptoms were one or more of the following: tiredness and loss of power in both legs, anaesthesia, a feeling of numbness in some lumbo-sacral dermatomes, or bilateral sciatica. The diagnosis had been made from: 1) myelographic examination; 2) the discovery at operation of a shallow canal and a compressed dural sac which did not contain cerebrospinal fluid and which expanded on decompression; and 3) the absence of other causes of compression.

In this paper further studies on the influence of a narrow lumbar spinal canal in the production of signs of compression of the caudal nerve roots will be described, with special reference, first, to the measurement of the width of the canal, and secondly, to the symptomatology of small disc protrusions when occurring in a narrow lumbar spinal canal.

A MEASURING DEVICE

In my previous paper I discussed the difficulties encountered in obtaining exact measurements of the spinal canal. The cross-section of the lumbar spinal canal has the form of a pentagon. Precise measurement would have to comprise the distance between the medial aspects of the pedicles of the vertebral arch, the length of these pedicles, the breadth of the laminae, the interlaminar angle and the mid-line antero-posterior diameter. From a practical point of view, however, there was no reason to measure more than the transverse interpedicular and the mid-line antero-posterior distances because these are at the moment the only ones that can be compared with values known for normal human skeletons (Huizinga et al. 1952). As they represent the length and breadth of the lumbar vertebral foramen, the measurements give some idea of the capacity of the lumbar vertebral canal.

In all my patients the interpedicular distance has been calculated from radiographs and, as previously reported, normal values were found. I could not obtain measurements of the antero-posterior diameter from the routine radiographs. Even sagittal tomographs were of little help because of scoliosis of the lumbar spine in most of the patients. It appeared, however, that this diameter could be estimated fairly exactly during operation. Since the ordinary calipers could not be applied for this purpose, a special instrument was designed by my assistants Brizzi and Kooyman (Fig. 1). For antero-posterior distance we measured the mid-line perpendicular from the arch to the body. Before measuring, the ligaments are carefully stripped from the vertebral arch. The posterior longitudinal ligament is not removed.
because of the danger of profuse bleeding from the underlying veins. The inferior extremity of the measuring device is firmly pressed down against the posterior longitudinal ligament. The walls of the underlying veins are very thin and the thickness of the ligament opposite the body amounts as a rule to not more than three-quarters of a millimetre. The antero-posterior diameter is measured several times for greater accuracy. Although the measurements obtained by this method are somewhat less precise in the living than in the skeleton, the error is within one millimetre. The absolute range of variation in normals is 10 millimetres at L.5, 11 millimetres at L.4, 15 millimetres at L.3, 7 millimetres at L.2 and 8 millimetres at L.1. Narrowing is encountered most frequently in the area L.3-5. The measurements found with our method enable us to classify a canal as deep, shallow or possibly too shallow.

The following patient, in whom the measuring instrument was applied, is a typical case of developmental narrowing of the lumbar vertebral canal.

**CASE REPORT**

**Case 1. Narrowing of the spinal canal at L.5**—A man of fifty-three complained of sciatic pain in both legs when walking or standing for a long time. The pain disappeared rapidly at rest. Examination of the spine showed flattening in the lumbar region and some limitation of movement. The straight leg raising test was positive on both sides at 75 degrees. Plain radiographs showed tilting of L.4 and 5 to the left. *Lumbar puncture:* The fluid was clear and colourless; the Queckenstedt test was normal. Protein content was 60 milligrams per 100 cubic centimetres. *Myelography:* The fluid injected by cisternal puncture passed slowly to the level of the lower border of L.4, where there was an almost complete block. The lower border of the column had a toothed appearance. *Operation:* The spinal canal was narrow at the level of L.3-4 and very narrow at the level of L.5. After laminectomy in this area the dural sac was still compressed laterally by the articular processes between L.4-5. After removal of the medial part of these processes the dura expanded completely. Before laminectomy the antero-posterior diameters of the corresponding vertebral foramina were measured. These lengths were 14 millimetres at L.3, 12 at L.4 and 10 at L.5. Comparing these values with those found by Huizinga et al. (1952) in normals, the antero-posterior diameters of L.3 and L.4 appear to belong to the small normal variants, while that of L.5 is definitely too small (Fig. 7).

**THE EFFECT OF SMALL DISC PROTRUSIONS OR POSTERIOR SPONDYLITIC SPURS IN PATIENTS WITH A NARROW LUMBAR VERTEBRAL CANAL**

**CASE REPORTS**

**Case 2**—A man aged forty complained of low back pain since falling from a roof in his twenties. Three months ago when riding on his bicycle he suddenly noticed a weakness in both legs. This sensation disappeared after a short rest. Since then he repeatedly complained of loss of power in the legs while walking or riding a bicycle. These disturbances always disappeared after a short rest.

There were no neurological symptoms. Examination of the spine showed a slight kyphosis in the upper, and an increased lordosis in the lower lumbar region. Plain radiographs of the lumbar spine showed a slight lateral shift of L.2 on L.3 and a lateral tilting of the upper lumbar vertebrae. The lateral view showed spur formation at the superior-posterior margin of the body of L.3 and of the inferior-anterior and posterior margins of the body of L.2. The second lumbar vertebral body was slightly wedged. *Lumbar puncture:* There was a slow response to the Queckenstedt test. The spinal fluid was clear and colourless. Protein was 30 milligrams per 100 cubic centimetres. *Myelography:* The fluid was arrested at the lower border of L.2. On the lateral view the contrast column was small at this point and the oil passed this level slowly by droplets (Figs. 2 and 3). The passage in the areas of L.2 and L.1 was also slow. *Operation:* The antero-posterior diameter was 13 millimetres at L.1, 13 millimetres at L.2, 12 millimetres at L.3 and 16 millimetres at L.4. Opposite the spur at the superior border of L.3 and the inferior border at L.2 the diameter was only 9 millimetres, and at this level the dural sac was much compressed. After decompression the dural sac expanded. The post-operative course was uneventful. *Progress:* The patient was completely relieved. Ten months after the operation he was free of complaints.

* All measurements of antero-posterior diameter presented in this paper have been determined by adding 0-75 millimetre for the thickness of the posterior longitudinal ligament to the values found with the instrument. Decimals have been rounded off upwards.

**VOL. 37 B, NO. 4, NOVEMBER 1955**
Comment—The antero-posterior diameters of L.2 and L.3 are equal to the smallest found in the normal, and that of L.1 is one millimetre smaller (Fig. 7). The intrusion of a spur of about three millimetres at the level of L.2-3 resulted in a narrowing of the vertebral canal to 9 millimetres. In this case the symptoms closely resembled those of developmental narrowing.

Case 3—A man of twenty-nine had complained of low back pain for nine years. During the past two years he had suffered from bilateral sciatica and weakness of both legs while standing or walking. These disturbances immediately disappeared in the recumbent position. Apart from a bilateral positive straight-leg raising test at 80 degrees there were no neurological disturbances. Examination of the spine showed restriction of all lumbar movement. The low back pain was exaggerated by retroflexion. The spinous processes of L.5 and S.1 were painful on percussion. Plain radiographs revealed no abnormality. Lumbar puncture: The spinal fluid was clear and colourless. The Queckenstedt test showed a small and slow rise of pressure. Protein content was 33 milligrams per 100 cubic centimetres. Myelography: There was an arrest of the contrast medium at the level of the lower border of L.4. In the mid-line the fluid passed slowly by droplets to the termination of the dural sac.

Operation—The antero-posterior diameter was 15 millimetres at L.3, 11 millimetres at L.4 and 13 millimetres at L.5. The disc between L.4 and L.5 formed a small solid ridge across the spinal canal and protruded for not more than two millimetres. This resulted in a local narrowing of the lumbar canal to 9 millimetres, and at this level the dural sac was greatly compressed and did not contain fluid. Decompressive laminectomy of L.4-5 was performed.

Comment—The lumbar vertebral canal of this patient represented the smallest normal variation of L.4. At L.5 the antero-posterior diameter was only one millimetre longer than the smallest normal (Fig. 7). A small ridge formed by the intervertebral disc L.4-5 caused severe compression.

Progress—At the last examination four months after the operation the patient was free from complaints.

Case 4—A man of forty-two suffered for seven months from low lumbar pain radiating to the sciatic area of the right leg. This pain immediately disappeared in the recumbent position. Examination revealed a positive straight leg raising test on the right at 40 degrees. Straight leg raising on the left produced pain in the right leg. No other neurological symptoms were found.
The lumbar lordosis was obliterated. Movements of the lumbar spine were restricted in all directions. The spinous processes of L.4 and L.5 were tender on percussion. Plain radiographs showed lipping of the vertebral body of L.4, inclination of the lumbar spine to the left and rotation of the vertebral bodies to the left. Lumbar puncture: The spinal fluid was clear and colourless. There was a slow response to the Queckenstedt test. Total protein was 88 milligrams per 100 cubic centimetres. Myelography was not performed.

Operation—The spinal canal was narrow at the level of L.4-5. The antero-posterior diameter was 14 millimetres at L.3, 11 millimetres at L.4 and 13 millimetres at L.5 (Fig. 7). The disc between L.4-5 showed a small protruding solid ridge of not more than 2 millimetres. The distance between the lower border of the fourth lumbar arch and the ridge was 9 millimetres. The dural sac did not contain fluid at this level. Decompressive laminectomy of L.4-5 was performed and the medial parts of the encroaching articular processes were also removed.

Progress—At the last examination three months after the operation the patient was free from complaints.

Case 5—This patient, aged forty-seven, was a brother of the patient described in Case 1. He had complained of low lumbar pain for six years. This pain had its onset when he lifted a heavy weight. After a fall he suffered from pain in the left sciatic area, aggravated by sneezing and coughing, but present only while he was walking or standing and disappearing immediately at rest. On examination straight leg raising was impaired on the left. Straight leg raising on the right elicited pain in the left sciatic area. No other neurological signs were present. The lumbar lordosis was obliterated. All movements of the lumbar spine were restricted. Retroflexion accentuated the pain. Plain radiographs of the lumbar spine showed no abnormality. Lumbar puncture: The fluid was clear and colourless. There was a normal response to the Queckenstedt test. Total protein was 45 milligrams per 100 cubic centimetres.

Myelography—There was a block at the level of the lower border of L.4. After some hours part of the contrast medium had descended to the terminal part of the dural sac (Fig. 4).

Operation—The antero-posterior diameter was 12 millimetres at L.4 and 14 millimetres at L.5. Thus the canal was narrow at these levels although not abnormally so (Fig. 7). The intervertebral disc formed a solid ridge which protruded about two or three millimetres into the spinal canal. Decompressive laminectomy of L.4 and L.5 was performed.

Progress—At the last examination four months after the operation the patient was free from complaints.

Case 6—A man aged fifty-four had suffered for nine years from paraesthesia and a sensation of numbness in both legs, occurring when standing or walking and disappearing immediately at rest. Six months before his admission to hospital he suddenly experienced, while working, severe low lumbar pain, radiating down the left leg in the sciatic area. On examination, the ankle jerk was absent on both sides. There was a bilateral slight paresis of the calf muscles. After myelography a complete paralysis of the left anterior tibial, extensor hallucis, and peroneal muscles developed. Both feet and the antero-lateral side of the left leg were hypoesthetic. The lumbar curve was obliterated and lumbar spinal movement was limited. The spinous processes of L.4 and L.5 were tender on percussion. Plain radiographs showed lipping of the bodies of L.3, L.4 and L.5. Lumbar puncture: The spinal fluid was clear and colourless. The Queckenstedt test was positive. Protein content was 24 milligrams per 100 cubic centimetres.

Myelography—The contrast medium showed a block at the lower border of L.2. During the following hours part of the oil descended to the lower border of L.4, where there was a complete block. On the lateral view the contrast medium arrested opposite L.2 had a pointed inferior limitation.
The accumulated contrast medium opposite the body of L.4 gives an impression of the shallowness of the canal (Figs. 5 and 6).

**Operation**—The lumbar vertebral canal was very narrow at the level of L.2-5. Decompressive laminectomy was performed in this area. The medial parts of the encroaching articular processes were also removed. The disc between L.4-5 formed a small ridge protruding about three millimetres into the spinal canal. This small elevation contributed considerably to the compression of the dural sac as the canal was already narrow. The antero-posterior diameter was 13 millimetres at the superior and 11 millimetres at the inferior border of the arch of L.2, and 11 millimetres at L.3-5.

![FIG. 5](image1)

**Case 6—**Myelographs showing incomplete arrest of the contrast medium opposite the lower border of L.2 and a complete block opposite the lower border of L.4.

**Comment**—The antero-posterior diameters at L.2-5 were less than the smallest normal (Fig. 7). The history of eight and a half years of typical complaints of developmental narrowness of the lumbar canal are in accordance with these findings. A small disc protrusion of not more than two millimetres reducing the antero-posterior diameter to 9 millimetres produced signs of lumbo-sacral root compression simulating a tumour.

**The interpedicular distance**—Of the thirty interpedicular distances measured in these six patients, twenty-three corresponded to the mean or higher values found in normal skeletons; four varied from 1·4 to 2·5 millimetres below the mean and from 1 to 3 millimetres above the minimal normal values. Only the interpedicular distance at L.2 in Case 2 was abnormal, being 1·5 millimetres more than the corresponding maximal normal value (Table I).

**DISCUSSION**

The foregoing observations enable me to draw the following conclusions.

1) Developmental narrowing of the lumbar canal caused by an abnormally short antero-posterior
diameter does exist—In Case 1 the antero-posterior diameter of L.3-4 corresponded to normal lowest values, but at L.5 the diameter was definitely too small.

In Case 6 the antero-posterior diameter was abnormally small at L.1-5. At the level of L.4 the antero-posterior diameter corresponded to the lowest normal value. As there were no signs of bone disease both cases demonstrated a developmental narrowness of the lumbar spinal canal. These patients presented a typical symptomatology as described in my earlier paper.

2) In the presence of a narrow, although not abnormally narrow, lumbar vertebral canal additional slight deformities, such as posterior lipping or small disc protrusions, can produce symptoms of compression—The first suggestion for this conception was furnished by the experience with

<table>
<thead>
<tr>
<th></th>
<th>L.1</th>
<th>L.2</th>
<th>L.3</th>
<th>L.4</th>
<th>L.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shortest</td>
<td>19</td>
<td>20</td>
<td>20</td>
<td>19</td>
<td>20</td>
</tr>
<tr>
<td>Longest</td>
<td>28</td>
<td>26</td>
<td>28</td>
<td>29</td>
<td>32</td>
</tr>
<tr>
<td>Mean</td>
<td>23.4</td>
<td>23.4</td>
<td>23.5</td>
<td>23.5</td>
<td>23.8</td>
</tr>
</tbody>
</table>

Interpedicular distance in Cases 1-6

<table>
<thead>
<tr>
<th></th>
<th>L.1</th>
<th>L.2</th>
<th>L.3</th>
<th>L.4</th>
<th>L.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1</td>
<td>26</td>
<td>24</td>
<td>23</td>
<td>24</td>
<td>30</td>
</tr>
<tr>
<td>Case 2</td>
<td>26</td>
<td>27.5</td>
<td>25</td>
<td>27</td>
<td>31</td>
</tr>
<tr>
<td>Case 3</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>25</td>
<td>32</td>
</tr>
<tr>
<td>Case 4</td>
<td>23</td>
<td>25.5</td>
<td>25</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>Case 5</td>
<td>25</td>
<td>23</td>
<td>21</td>
<td>27.5</td>
<td>27.5</td>
</tr>
<tr>
<td>Case 6</td>
<td>24</td>
<td>26</td>
<td>25</td>
<td>26</td>
<td>24</td>
</tr>
</tbody>
</table>

Case 7 reported in my previous paper. This was the only patient at that time in whom the antero-posterior diameter was measured. The values found were low, but not abnormally so. Taking the operative findings into consideration, I thought it justifiable, in that case, to ascribe the cause of the abnormal narrowness to encroachment of the heavily developed articular processes on the vertebral canal. Cases 2, 3, 4 and 5 presented in this paper support this conception. At some level the spinal canal of these patients presented the smallest antero-posterior diameter and probably such a narrowness alone would not have caused symptoms. A small protruding deformity at these levels, however, resulted in disturbances. In these patients the apparent contrast between the severity of complaints and the scarcity of neurological signs was most impressive.

In Cases 2 and 3 the clinical picture was similar to that of developmental narrowness. In Cases 4 and 5 the symptoms appeared in only one lower extremity, but in accordance with the symptomatology of developmental narrowness, both patients complained of sciatic pains only while standing or walking and these pains immediately disappeared at rest.

Three patients also complained of low lumbar pain (Cases 3, 4 and 5) and in Cases 3 and 5 low backache preceded the symptoms of radicular pains by seven and four years respectively. The low back pain was exaggerated by retroflexion in Cases 3 and 5. Movement of the lumbar spine was restricted in Cases 3, 4 and 5.
All the patients showed some deviation of the curvature of the lumbar spine. Neurological signs were few in all patients: positive straight leg raising test on both sides in Case 3 and on one side in Cases 2 and 4, and an increased total protein content of the spinal fluid in Cases 4 and 5. Myelography showed an almost complete block at the level of the protrusion.

The surgeon who does not take the narrowness of the canal into account may be astonished at the fact that the presence of such a small disc protrusion has been the cause of a complete block during myelography.

3) In the presence of an abnormally narrow lumbar canal, a small disc protrusion may cause considerable damage to the caudal nerve roots—This is demonstrated by Case 6. The antero-posterior diameters at L.2, 3 and 5 were definitely too small and that at L.4 was the smallest normal. For the last nine years this patient had suffered from typical disturbances as encountered in developmental narrowing of the lumbar canal. The presence of a small disc protrusion between L.4–5 had caused persistent disturbance of motor and sensory functions from damage to the lower lumbar and sacral caudal nerve roots.

The nature of the narrowing—From the data collected in this paper it appears that the narrowness depends mainly on shortness of the antero-posterior diameter. No sign of bone disease has been found. The fact that the patients in Cases 1 and 5 were brothers gives support for the hypothesis that the lesion is developmental. It may be that wedging or posterior lipping of the vertebral bodies, as found in our patients, bears some relation to developmental narrowness of the spinal canal because a similar association has, for instance, been described several times in achondroplasia (Spillane 1962). As in our previous series, the narrowness was most pronounced in the area where normally the canal is at its narrowest. As before, all patients were men. I want to stress the fact that the ligamentum flavum was carefully examined in all cases and that this ligament did not show any abnormal thickness.
or hypertrophy. Consequently I do not think that in my patients the ligamentum flavum played a special role in provoking the disturbances.

**Medico-legal aspect**—The patients in Cases 2, 5, and 6 blamed a heavy exertion during work or an injury as the cause of their disability. Judicial interpretation will have to take into account that in such patients the narrowness of the canal is the main factor determining the pathological condition.

**SUMMARY**

1. A measuring instrument is described which enables the surgeon to determine the antero-posterior diameter of the vertebral canal during operation.
2. Developmental narrowness of the lumbar vertebral canal is shown to exist and to be caused by an abnormally short antero-posterior diameter.
3. In patients with a narrow, although not abnormally narrow, lumbar vertebral canal, slight deformities such as posterior spur formation or small disc protrusions may produce particular symptoms, which are interesting from a clinical as well as from a medico-legal point of view.

**REFERENCES**

