A RADICULAR SYNDROME FROM DEVELOPMENTAL NARROWING OF THE LUMBAR VERTEBRAL CANAL

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Narrowing of the bony vertebral canal as a cause of compression of the spinal cord or of the cauda equina may be the result of bone disease, such as chondrodystrophia foetalis (Sumita 1910, Vogl and Osborne 1949, Spillane 1952) or of a developmental anomaly. In cases of developmental anomaly the narrowing of the canal may be associated with other bony deformities at the same level or at a different level of the vertebral column. Sarpyener (1947) described congenital stenosis of the vertebral canal associated with spina bifida. In his experience the narrowing of the canal was often found at a considerable distance from the spina bifida. In a later publication he described a small number of cases in which this narrowing occurred without any other developmental anomalies of the vertebral column.

In 1949 the author reported a particular form of narrowing of the lumbar vertebral canal not associated with any other anomaly of the spine. All the patients were men, and the age of onset of symptoms varied from thirty-seven to sixty-seven. The symptoms were characteristic. On walking and standing these patients presented signs of disturbance of the cauda equina: bilateral radicular pains, disturbances of sensation and impairment of motor power in the legs. When the patient was recumbent the symptoms immediately disappeared and neurological examination during rest revealed nothing abnormal. At first sight the complaints could be misinterpreted as intermittent claudication of vascular origin. It was not possible to recognise the anomaly in plain radiographs. Myelography showed a block with the appearance of extradural compression. Sometimes the form of the lower part of the column of radio-opaque fluid seemed to suggest a gradual narrowing of the vertebral canal, which was confirmed at operation.

In this paper our experience of seven cases of this anomaly is reported. Study of the earlier cases was less elaborate because the nature of the abnormality was not at first recognised. In the last four cases the diagnosis was made before operation and thus we had an opportunity to improve our method of diagnosis.

CASE REPORTS

Case 1. Narrowing of the spinal canal at L.1, 2 and 3—A man aged thirty-seven complained of low back pain radiating to the left buttock and the back of the left thigh, sometimes also to the right side, of eighteen months’ duration. The pain began only on standing and walking and disappeared at rest. On examination the only positive clinical sign was slight reduction of the left patellar reflex. Radiographs showed left lumbar scoliosis centred at L.3.

Lumbar puncture—The fluid was clear and colourless; the Queckenstedt test was normal; cells were 6/3 per cubic millimetre; protein was 31 milligrams per 100 cubic centimetres; the Nonne and Pandy tests were negative.

Myelography (lipiodol injected by lumbar puncture) showed slow passage of the fluid to the level of L.4–5 and a block at the upper border of L.4 (Trendelenburg position) (Fig. 1). The right border of the lipiodol column sloped towards the medial plane. In the lateral view the lipiodol column tapered off to a point; its anterior border was close to the vertebral body, and the posterior border sloped towards the anterior one (Fig. 2).

Operation—The vertebral canal was very narrow from the level of the caudal half of L.1–3. In this region the peridural space was absent, whereas more cranialwards it was normal. After laminectomy in the narrowed area the dura expanded. Exploration of the intervertebral discs showed no abnormality. The removed laminae were heavy, but the bone appeared to be normal. Progress—Since the operation five years ago the patient has remained free from complaints.
Case 2. Narrowing of the spinal canal at L.4 and 5, with narrowing of the dural sheath—A man aged forty-four complained of pain in the lumbar region of two years' duration. When standing he suffered from paraesthesiae in the legs and buttocks, then lost power in the legs and fell down.

While walking he suffered from severe pains in the buttocks and thighs, forcing him to stop. On examination there was atrophy of all the muscles of the left lower limb. The patellar reflex was more lively on the right. The calcaneal tendon reflex was absent on both sides. The Lasègue test
was negative on the right and positive on the left at 90 degrees. There was hypalgesia in the fourth left lumbar dermatome. Examination of the spine showed spasm of the lumbo-sacral muscles on the left. Flexion and rotation of the lumbar spine were restricted. Plain radiographs of the lumbar spine showed heavily developed vertebrae. **Lumbar puncture**—The spinal fluid was clear and colourless. The Nonne and Pandy tests were positive. Protein was 72 milligrams per 100 cubic centimetres. The Queckenstedt test gave only a slow and low response. **Cisternal puncture**—The fluid was clear and colourless. The Nonne and Pandy tests were positive. Protein 43 milligrams per 100 cubic centimetres.

**Myelography** (lipiodol injected by lumbar puncture) showed a block at the upper border of L5 (Trendelenburg position).

**Operation**—The vertebral canal was very narrow at the level of L4 and 5. After removal of the heavy laminae the dural sheath did not expand sufficiently. It was opened by a longitudinal incision as a means of decompression. No disc protrusion and no signs of bone disease were noticed.

**Progress**—Since the operation five years ago the patient has remained free from symptoms.

**Case 3. Narrowing of the spinal canal at L.A; narrowing and congenital anomaly of the dural sheath**—A man aged forty-eight years complained of sciatic pains in both lower limbs while standing or walking. The pains disappeared on sitting or lying down. On examination, the patellar reflexes were normal but the calcaneal tendon reflex was absent on the right. There was no loss of motor power. Apart from a slight disturbance of vibratory sense on both sides there was no disturbance of sensibility. The Lasègue test was positive on both sides at 75 degrees. Examination of the spine showed restriction of lumbar movements, especially extension. Plain radiographs showed hemisacralisation of the fifth lumbar vertebra on the left side. The vertebral column was well developed. Osteoarthritic changes were present. **Lumbar puncture**—The spinal fluid was clear and colourless. The Queckenstedt test was normal. The Nonne and Pandy tests were positive. Protein was 84 milligrams per 100 cubic centimetres.

**Myelography** (lipiodol injected by lumbar puncture, Trendelenburg position) showed a block at L4. In the lateral view the block was uneven: in the anterior part of the vertebral canal the fluid extended as far as the pedicles of L4, whereas in the posterior part of the canal it stopped at about the level of the lower border of the laminae of L4. The fluid column thus showed a posterior filling defect in the area of the laminae of L4 (Fig. 3).

**Operation**—The vertebral canal was very narrow at the level of L4. After laminectomy at that level an unusual malformation of the dural sheath was apparent—namely a constriction and a cone-shaped pouch on the posterior aspect. The caudal roots protruded as soon as the dural sheath was opened. It was therefore left open and covered with "Gelfoam." As in the foregoing cases, the removed laminae were heavily developed, but the bone seemed to be normal.

**Progress**—Since the operation four and a half years ago the patient has been free from complaints.

**Case 4. Narrowing of the spinal canal at L.3 and 4**—A man aged sixty-one complained of paraesthesiae on the lateral side of the left foot which occurred when he walked a short distance. The paraesthesiae spread upwards along the postero-lateral side of the leg and the lateral side of the thigh to the buttock. At times he had similar sensations in the right leg. These sensations, accompanied by a feeling of tiredness, made him stop. After a short rest the sensations disappeared. The distance he could cover without complaints varied greatly. Coughing or abdominal pressure had no influence on his complaints. The patient had suffered for years from diabetes, which was kept under control by dieting and insulin. Six years previously he had been treated for gangrene of the toes. On examination there were no neurological signs. Oscillometry on the legs gave normal values, despite the presence of obvious arterial inadequacy in the feet. There was no clinical abnormality in the spine. Plain radiographs showed osteoarthritis in the thoraco-lumbar region, with osteophyte formation. **Lumbar puncture**—The spinal fluid was clear. The Queckenstedt test showed a small and slow rise of pressure followed by a slow decline. The Nonne and Pandy tests were positive. Protein content was 136 milligrams per 100 cubic centimetres. **Cisternal puncture**—Nonne and Pandy tests were negative.

**Myelography** (lipiodol injected by cisternal puncture)—There was a block at L3 (Fig. 4). In the lateral view the block appeared to be localised at the level of the lower border of L3. After twenty-four hours' rest in bed the fluid passed the obstruction.

**Operation**—The vertebral canal was very narrow at the level of L4 and at the lower border of L3. After removal of the laminae of L4 and of the lower border of L3 the dural sac was still compressed by the bulging articular processes between L3 and 4. The medial parts of these processes were removed, after which the dura expanded and pulsed.

**Progress**—After the operation the patient complained of low back pain, which disappeared with physical therapy within six months. Since then he has been able to do his work and remains free from complaints four years after the operation.
Comment—The coincidence of vascular disease in the feet was confusing, because it suggested that the patient's complaints of paraesthesiae and tiredness when walking might arise from vascular disease. The absence of neurological signs did not make diagnosis easier. Nevertheless the normal oscillometric values, the slow response of the spinal fluid pressure to jugular compression, the high protein content of the spinal fluid, and the block found at myelography indicated the presence of narrowing of the lumbar vertebral canal.

Case 5. Narrowing of the spinal canal at L.3, 4 and 5—A man aged forty-six complained of painful anaesthesia and loss of power in both legs after long standing or walking, of four years' duration. The symptoms disappeared immediately at rest. On examination there were no motor or reflex signs but there was an unusual disturbance of sensibility. When standing or walking a bilateral anaesthesia developed in the third, fourth and fifth sacral dermatomes as well as in the right second sacral dermatome. These disturbances disappeared promptly when he sat or lay down. Lumbar spinal movements were limited. Plain radiographs showed heavily developed vertebrae and osteoarthritic changes at L.3-4, L.4-5 and L.5-S.1. Lumbar puncture had been performed elsewhere. Examination of the fluid revealed no abnormalities.

Myelography (Trendelenburg position)—There was a block at the upper border of the laminae of L.3. Anteriorly the lipiodol column reached as far as the pedicles of L.5, whereas posteriorly it stopped more caudal (Fig. 5). A diagnosis of narrowing of the lumbar vertebral canal was made.

Operation—The vertebral canal was exceptionally narrow at the level of L.3, 4 and 5. After laminectomy in this area the dural sheath appeared to be compressed by the articular processes. Only after removal of the medial part of the processes did the dura expand sufficiently.

Progress—The patient was completely relieved. Two years after the operation he took part in a 25-kilometre walking tour without any trouble and at the last check four years after operation he was still completely free from complaints.

Case 6. Narrowing of L.3, 4 and 5—A man aged fifty-eight complained for eighteen months of pain in the legs, occurring when standing or walking and immediately disappearing at rest. The pains were localised in the calves and at times radiated to the buttocks. When the patient continued to walk in spite of the pain, the legs became weak, and the gait was staggering. There was no lumbar pain. On examination the Lasègue test was positive on the right side at 45 degrees and on the left at 70 degrees. There were no other neurological signs. Oscillometry of the legs gave normal values. Spinal movements were full, but on bending forwards pain was felt in the area of L.5. Plain radiographs showed heavily developed vertebrae. There was left lumbar scoliosis with its centre at L.4 and with rotation of the bodies to the left. There was slight lateral shift of L.4 on L.5, and there was lipping of the anterior margins of the vertebral bodies of L.3, 4 and 5. Tomographs showed that the antero-posterior diameter of the vertebrae was unusually small at L.4 and 5. Lumbar puncture—The fluid was clear and colourless; the Queckenstedt test was normal. Cells 4/3; protein 24 milligrams per 100 cubic centimetres.

Myelography—The lipiodol injected by cisternal puncture passed slowly to the level of the lower border of L.3.
where there was a complete block. In the antero-posterior radiograph the lower border of the column had a toothed appearance and the left border slanted towards the medial plane; the right border was perpendicular (Fig. 6). In the lateral view the column tapered to a point on the lower border. A diagnosis of narrowing of the lumbar vertebral canal was made.

Operation—The canal was unusually narrow at L.3, 4 and 5. After laminectomy in this region the dural sheath still appeared to be laterally compressed by the articular processes between L.3 and 4. Removal of the medial part of these processes allowed the dura to expand completely.

Progress—Since the operation two and a half years ago the patient has been able to do his work which entails long hours of standing, and to take long walks without symptoms.

Case 7. Narrowing of the spinal canal at L.2, 3, 4 and 5—A man of sixty-seven complained of tiredness in both legs with pains in the calves and paraesthesiae in the toes when walking. After three minutes he was obliged to stop because of feebleness and pains in the legs. These disturbance-

![Fig. 7](image1)
![Fig. 8](image2)

Case 7—Myelograms. Obstruction to downward flow of opaque fluid at lower margin of L.2.

had been present for twelve years. In the last few months before the examination he also complained of pains in the legs at night. Neurological examination revealed no abnormalities. Oscillometry showed normal oscillations of the upper and lower legs and normal pulsations of the dorsalis pedis artery. The colour of the feet was normal. The Buerger test showed no abnormalities. Normal venous filling test: right leg 15 seconds; left leg 20 seconds. The history was suggestive of intermittent claudication from vascular disease. But, since the examination did not give support to this supposition, the possibility of narrowing of the lumbar vertebral canal was considered. Examination of the spine showed flattening in the lumbar region and some limitation of movements. Plain radiographs showed lumbar scoliosis with rotation of the bodies to the right. Lumbar puncture—Only a few drops of fluid could be obtained in spite of repeated punctures. The Queckenstedt test was negative. Cells 5,3; protein 26 milligrams per 100 cubic centimetres.

Myelography (lipiodol injected suboccipitally)—There was a complete block at the lower border of L.2. The oil passed the impediment after the patient had rested (Figs. 7 and 8).

Operation (with Dr Mulder of the Anna Clinic, Leyden)—The spinal canal was narrow at the level of L.2, 3, 4 and 5. After laminectomy in this area the dural sheath appeared to be compressed laterally by the articular processes between L.2-3, L.3-4 and L.4-5. After removal of the medial part of these processes the dura expanded completely and pulsed normally. Before the laminae were removed the length of the perpendicular from the upper border of the vertebral arch to the vertebral body was measured at L.3 and 4. These lengths were 15 and 13 millimetres respectively.

Progress—The post-operative period is too short to allow assessment of the result.

**DISCUSSION**

All seven patients were men; their ages at the time of treatment varied from thirty-seven to sixty-seven and the first complaints appeared between thirty-five and fifty-six. All patients were of a hyperplastic normosome type.
Clinical picture—The most typical symptoms were: tiredness and loss of power in the legs (Cases 2, 4, 5, 6 and 7), anaesthesia and a feeling of numbness in the sacral dermatomes (Case 5), and bilateral sciatica (Cases 1, 2, 3, 6 and 7). The symptoms were present only on standing or walking. Orthostatic lumbar pain was the main symptom in Case 1.

In some patients the disturbances while walking had a resemblance to intermittent claudication as seen in vascular disease. After walking for a while they had to stop because of severe pain in the calves; after a short rest they were able to continue. For this reason the patient in Case 6 had been treated for some time for supposed arterial insufficiency.

While at rest the patients had no complaints, except in Case 7, in which the patient had suffered from pains in the legs at night. Neurological examination showed nothing characteristic. The Lasègue sign was negative in four patients, slightly positive in two and positive in one. Tendon reflexes were normal in some patients and reduced or absent in others. Only in one patient were movements as well as posture of the vertebral column entirely normal. The orthostatic factor in the origin of the symptoms may be explained by an increase of compression during the upright position. This view is supported by the myelographic and spinal fluid findings in some of the patients.

The cerebro-spinal fluid—in four cases the Queckenstedt test was normal. There was probably less compression in the horizontal position in which the lumbar puncture was performed. In three cases the protein content of the spinal fluid was moderately increased; in the other four it was normal. The frequent finding of a normal protein content could be explained by the fact that a complete block existed in the upright position only.

Radiographic findings—It is very difficult to obtain exact measurements of the diameters of the spinal canal from radiographs. The lumbar spinal canal has the form of a pentagon, with its greatest diameter between the pedicles. Behind the pedicles its width is determined by the articular processes and the interlaminar angle. The distance between the pedicles can be measured on radiographs, but neither the measurement of the distance between the articular processes nor that of the interlaminar angle can be determined accurately. The interpedicular distance was measured in our seven patients. The measurements, compared with those determined by radiographic examination of 100 Netherlanders free from spinal disease, appeared to be normal. We therefore concluded that the narrowing could be accounted for only by a reduced antero-posterior diameter or by constriction of the canal behind the pedicles. We could not obtain measurements of these parts of the canal on the routine radiographs. Stereoscopic views were of little help in this respect. Tomography was used in two cases, but it was difficult to obtain reliable sagittal projections, because of scoliosis of the lumbar spine in most of the patients.

Myelography—An absolute block was found in all seven patients. In some patients the films were taken after lumbar, in others after cisternal, injection of lipiodol. In all patients the block had the characteristics of extradural compression and was toothed or fringed, as seen in the antero-posterior projection. In some patients lateral compression by the articular processes was suggested by the slanting of the lateral borders of the lipiodol column (Cases 4 and 6). In the lateral projections in Cases 3 and 5 (taken in the Trendelenburg position) the anterior part of the lipiodol column reached as far as the pedicles, whereas the posterior part was blocked at a more caudal level. In the other patients the block was at the edge of a vertebral body and suggested the presence of a disc protrusion. In all these cases, however, the anterior limit of the lipiodol was close to the vertebral body and was not pushed backwards.

In Cases 4 and 7, in which myelography was not followed immediately by operation, the lipiodol had passed the impediment after the patient had rested in bed, showing an orthostatic influence on the degree of compression.

Findings at operation—The extent of the narrowing is represented schematically in Figure 9. In two patients (Cases 2 and 3) the dural sheath showed a constriction which did not disappear.
after removal of the bony compression; in Case 2 there was also a posterior cone-shaped diverticulum of the dura. In every patient the exploration of the vertebral canal began with the removal of the ligamentum flavum and of the lower and upper borders of the adjacent vertebral arches. After this the dural sac was palpated and in all cases a characteristic doughy consistency was felt; this was attributed to the reduced quantity of spinal fluid in the dural sac. The next stage was to remove the laminae in the narrowed area. In Cases 4, 5, 6 and 7 laminectomy alone did not give sufficient decompression, and the medial part of the articular processes had to be removed as well. The operative reports of the first three cases are less precise because the nature of the pathological condition was not recognised until later.

![Fig. 9](https://example.com/fig9.png)

To show the extent of the narrowing as found at operation (shaded areas). The head of the arrow indicates the level of the block as shown by myelography:

→ Lipiodol injected by cisternal puncture; ← Lipiodol injected by lumbar puncture.

The nature of the lesion—The affection described here is limited to the lumbar vertebrae. Anthropometric examination of the first six patients did not reveal any abnormality, either in absolute or in relative measures (Huizinga et al. 1952). There were no signs of a generalised bone disease. Although spondylosis deformans or arthritis of the vertebral joints was found radiographically in Cases 3, 4, 5 and 6, at operation these changes appeared to have no part in the causation of the narrowing. It may be that the anomaly is developmental. The fact that the disturbances become manifest only in adults is not at variance with this conception as similar facts are observed in other developmental anomalies such as cervical rib, the Arnold-Chiari malformation and in narrowing of the achondroplastic vertebral canal (Vogl and Osborne 1949).

It was difficult to determine what part of the vertebra was the cause of narrowing. It has been mentioned already that the measurements of the distance between the pedicles in radiographs were within normal limits. At our request Huizinga et al. (1952) measured the diameters of the lumbar vertebrae of fifty-one skeletons of adult Dutch subjects. It appears that in general the lumbar vertebral canal is narrowest at the level of L.3 and 4, at least in the antero-posterior diameter. It was at the borders of this region that the obstruction to the lipiodol was located in our patients. The obstruction, however, indicated only the region of greatest narrowing, because at operation it was nearly always found that the narrowing affected other vertebrae in less degree.

In Case 7 the antero-posterior diameter of L.3 and L.4 were measured and compared with the statistical data reported by Huizinga et al. The antero-posterior diameter of L.3 (15 millimetres) corresponded to the lower limit of this diameter in Huizinga’s series, and that of L.4 (13 millimetres) was only 2 millimetres greater than the minimum length in the normal
skeletons. Although in this case the antero-posterior diameter of L.3 and L.4 appeared to be small, it was not abnormally so. The interpedicular distances also came within normal limits. Taking into consideration the operative findings, it seems justifiable to ascribe the cause of the narrowing to encroachment of the articular processes on the vertebral canal. We did not measure the antero-posterior diameter in the other patients, but in Cases 4, 5 and 6 the medial part of the articular processes had to be removed to decompress the dural sheath. Some of the myelographic pictures also showed signs of a postero-lateral compression at the level of the articular processes.

We observed that the effects of the encroachment of the articular processes were most pronounced in the areas of L.3 and L.4. This may be accounted for by the fact that the normal canal is narrowest in this region. Many problems concerning this abnormal condition still need elucidation.

The main purpose of this paper is to show that there is a form of narrowing of the lumbar vertebral canal, with a typical clinical picture, in which a decompression of the dural sheath may be followed by complete relief.

Only one reference to a similar condition has been found—namely a paper by Van Gelderen (1948). One of his two patients was a man of sixty who, after walking, showed symptoms of compression of the second, third, fourth and fifth roots. At rest the symptoms disappeared almost completely. The patient was cured after a laminectomy of L.2 (caudal half), L.3 (total) and L.4 (cranial half). A thickened ligamentum flavum was found between L.3 and L.4. Van Gelderen thought that in the upright position this hypertrophic ligament pressed on the dural sheath. It is questionable whether a hypertrophic ligamentum flavum can cause such severe compression in a vertebral canal with normal dimensions and I support the statement by Jackson (1948): “In the writer’s own humble opinion the ligamentum flavum is most unlikely to contact any spinal root unless this root is distorted from its regular path.” Since Van Gelderen performed a complete laminectomy, there is no proof that the hypertrophic ligamentum flavum was the real cause of the symptoms.

**SUMMARY**

1. A clinical condition is described in which there are symptoms of compression of the caudal nerve roots on standing or walking, but not at rest. Seven cases are reported.
2. Myelography showed a block in the lumbar region in every case.
3. At operation narrowing of the spinal canal in part of its lumbar course was found.
4. The nature of the abnormality is discussed. It is suggested that the narrowing is due to encroachment on the spinal canal by the articular processes.

**REFERENCES**


