AN ANATOMIC STUDY OF THE LUMBOSACRAL REGION IN RELATION TO LOW BACK PAIN AND SCIATICA

WILLIAM A. LARMON, M.D.

CHICAGO, ILL.

FROM THE KEMPER FELLOWSHIP IN INDUSTRIAL SURGERY, NORTHWESTERN UNIVERSITY MEDICAL SCHOOL, CHICAGO, ILL.

FOR MANY YEARS the syndrome of low back pain with associated sciatic nerve radiation has been a subject for investigation. The complex anatomy of the lumbosacral and sacro-iliac regions, combined with numerous anatomic variations, has complicated the problem of etiology of this clinical entity.

Two etiologic factors are now generally accepted as the basis for low back pain and sciatica. It has been conclusively shown that pain may arise in the joints, ligaments and muscles of the lumbosacral region and be referred throughout the distribution of the sciatic nerve. Pain may also arise from compression or irritation of the sciatic nerve at its roots. This may occur in the spinal canal, in the intervertebral foramina where the nerve roots are in contact with the intervertebral joints, or along the course of the nerve after its exit from the spinal canal.

This latter factor of compression of the nerve components has, in recent years, been emphasized by the widespread advocation of the theory of herniation of the intervertebral disk into the spinal canal. It is a fact, however, that compression or irritation of the nerves may as readily take place in the intervertebral foramina where the nerve roots and ganglia are confined in a relatively smaller space. The anatomy and relationships of the sciatic nerve components to the structures composing the intervertebral foramina predispose to compression when pathologic changes occur in this region.

It was this fact which led us to take up the study of anatomic and pathologic changes in the lumbosacral joints and foramina. Ten unselected lumbosacral spines were obtained at autopsy, and dissected to determine the variations in anatomy and pathology which may affect the spinal nerves as they course through the foramina. The fourth and fifth lumbar intervertebral foramina were studied to determine: (1) The relative size of the nerves to the foramina; (2) the effect of swelling and effusion in the intervertebral joint capsules on the nerves and ganglia; and (3) the effect on the nerves of variations in ligamentous or osseous structures in the region of the foramina.

The fourth and fifth lumbar spinal nerves emerge obliquely from the spinal canal (Fig. 1). The nerve with its ganglion as it lies in the foramen is bounded above and below by the pedicles of the adjacent vertebrae, anteriorly by the body of the vertebra and intervertebral disk, posteriorly by the capsular ligamentum flavum. The capsular ligamentum flavum forms the

capsule and ligamentous support of the anterior portion of the intervertebral joints.

Measurements were made of the fourth and fifth lumbar foramina and the respective nerves, to determine the relative size of each. The diameter measured between the vertebral pedicles was found to average 12 Mm. in the fifth lumbar foramen and 19 Mm. in the fourth. The largest diameter measured between the capsular ligamentum flavum posterior and the vertebral body anterior averaged 7 Mm. in the fourth and fifth foramina.

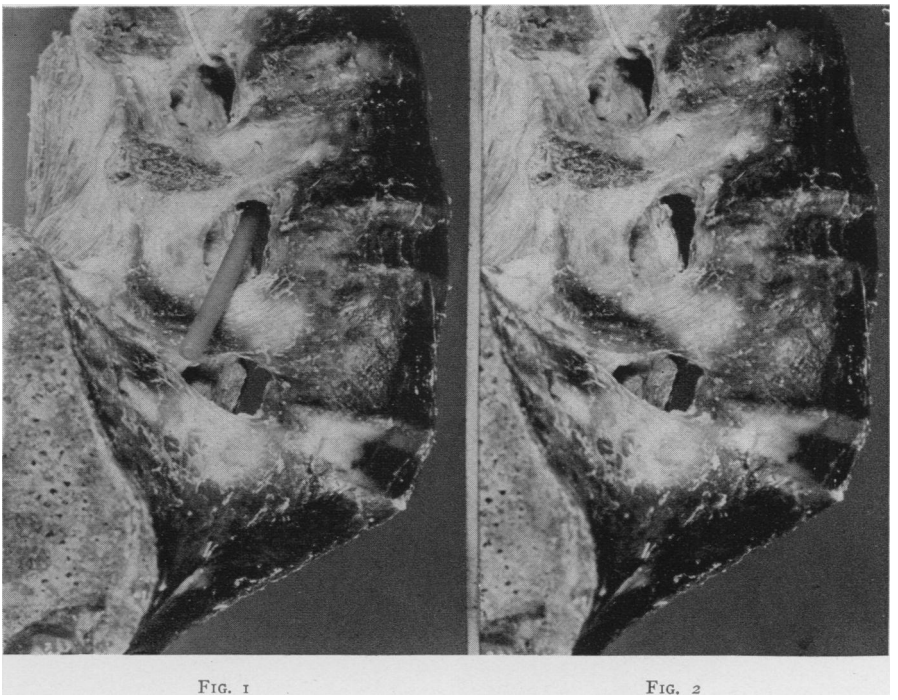

FIG. 1 FIG. 2

FIG. 1.—Illustrates the oblique course of the spinal nerve through the fourth lumbar foramen, as represented by rubber tubing inserted; and shows the relationship of the nerve to the capsular ligamentum flavum.

FIG. 2.—Swelling occurring in the capsular ligamentum flavum in the fourth and fifth lumbar foramina following injection.

Comparing the average size of the fourth and fifth nerves, which measured a fraction of a millimeter less than 7 Mm. to the average anteroposterior diameter of the foramina, which measured 7 Mm., one is impressed by the intimate relationship of the nerve to the foramen. It may be concluded from these measurements that moderate swelling of the capsular ligamentum flavum can cause compression of the nerve in the foramen.

To determine the degree of distention or swelling of the intervertebral joint capsule necessary to compress the spinal nerves, the joint capsules of the fourth and fifth lumbar joints were injected with radiopaque oil under pressure. Roentgenograms were made and measurements of the foramina were repeated.

Figure 2 illustrates the point where swelling of the capsular ligamentum flavum was most marked. The anteroposterior diameter of the foramina was reduced from an average of 7 Mm. to an average of 5 Mm. in the 40 joints injected. Roentgenograms made before and after injection clearly show the distention of the joint capsule and protrusion of the ligamentum flavum into the foramen (Fig. 3). This distention took place regularly at a point intimately in contact with the ganglion of the spinal nerve.

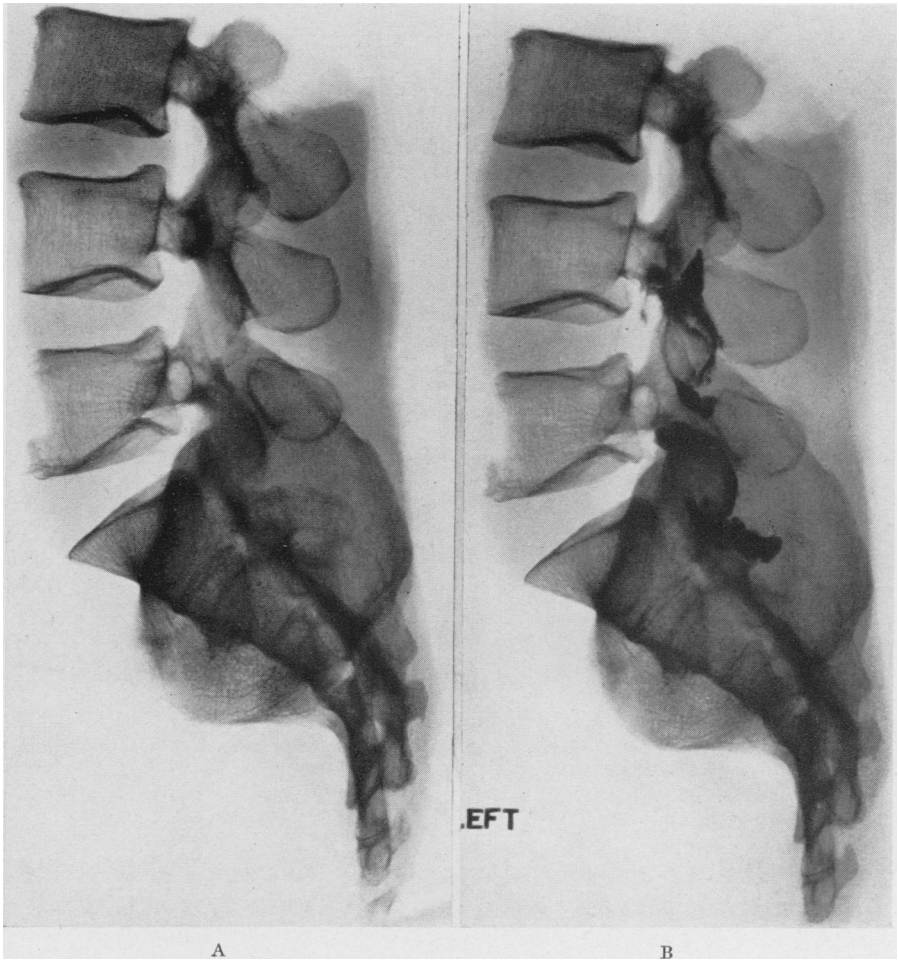

FIG. 3.—A and B: Demonstration of radiopaque oil producing protrusion of the joint capsule into the fifth lumbar foramen: before and after injection.

Many anatomic variations have been reported in the lumbosacral region. In our series of spines a number of anatomic and pathologic variations were found. Four main pathologic processes were noted which produced compression of the spinal nerves in the intervertebral foramina or of closely related structures: (1) Posterior lipping or spur formation of the vertebral bodies at the foramen; (2) anomalies of the vertebral bodies, particularly

the first sacral; (3) degeneration of the disk substance, with collapse of the intervertebral space; and (4) variations in the ligamentous structures at the exit of the nerves from the spine.

Posterior lipping of the fifth lumbar vertebra occurred in four specimens. In each case the osteophyte formations were located in the foramina and produced narrowing of the anteroposterior diameter. All cases were associated with moderate to severe degenerative changes in the disk substance. Compression of the nerve was evident in two of the spines. (Refer to Magnuson's article, Fig. 8, p. 887.)

Anomalies of the first sacral vertebra were found in two spines. Spur formation on the posterior surface of the vertebra with impingement on the nerve at the exit from the foramen was noted in one case. A deep sulcus, formed by the body and transverse process of the first sacral vertebra, confined the fifth lumbar spinal nerve in the second case. The nerve was bent sharply at the point of exit from the foramen, and was bound tightly into the sulcus by firm ligamentous strands. Compression of the nerve in each case was only moderate. (Refer to Magnuson's article, Fig. 11, p. 889.)

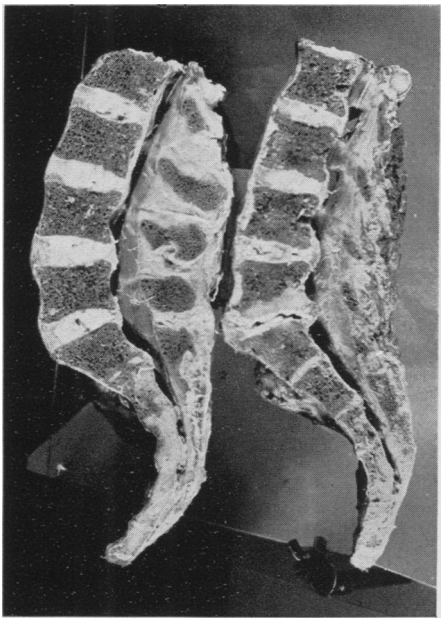

FIG. 4.—Comparison of normal vertebral canal and disks, with extreme degeneration of the disk and sclerosis of the vertebral bodies.

Degenerative changes in the disk substance between the fifth lumbar and the first sacral vertebrae (Fig. 4) were a prominent finding in this series of spines, occurring in four cases. Collapse of the intervertebral disk, without protrusion into the spinal canal, produced the most marked narrowing of the fifth lumbar foramen with compression of the nerve. Extreme sclerosis of the involved vertebral bodies with marginal lippings was a prominent feature in the pathology. Figure 9 of Magnuson's article, p. 887, illustrates the marked reduction in the size of the foramen that takes place with collapse of the disk substance, particularly the distance between the pedicles.

The ligaments which join the fifth lumbar vertebra with the first sacral vertebra are subject to great variation, as was confirmed by our series of spines. In three cases it was noted that one ligament connected the transverse process of the fifth with the body of the fifth and the first sacral vertebrae. This ligament lay directly over the intervertebral foramen at the exit of the fifth lumbar nerve. The extent to which the ligament was

developed varied considerably. (Refer to Magnuson's article, Fig. 10, p. 888.) The ligaments in each case bound the nerve firmly to the body of the first sacral vertebra. Evidence of compression could not be demonstrated in the two similar cases.

Numerous other changes were found in this series of unselected spines, including advanced arthritic changes in the articular facets, anomalous facets, variations in the angle of articulation of the fifth lumbar and first sacral vertebrae, and irregularities of the contour of the spinal canal. None of these anatomic variations produced compression of the spinal nerves.

It is of interest to note that although advanced degeneration of the disk substance was present in four cases, there was no rupture of the annulus fibrosus with protrusion of the disk into the canal. Compression of the cauda equina was not demonstrated in any specimen.

SUMMARY

A series of ten unpreserved autopsy spines were dissected to determine the factors which may produce compression or irritation of the spinal nerves in the intervertebral foramina.

By injection of oil into the joints of the fourth and fifth lumbar vertebrae, sufficient swelling was produced in the capsular ligamentum flavum to compress the spinal nerves in the foramina.

Four anatomic and pathologic factors produced compression of the spinal nerves in the spines of this series: (1) Posterior lipping of the vertebral bodies; (2) anomalies of the first sacral body; (3) narrowing of the intervertebral foramen due to collapse of the disk; and (4) variations in ligamentous structures adjacent to the fifth lumbar foramen.