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Influence of Spinal Posture on Abnormalities Demonstrated by Lumbar Myelography

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During spinal movements the dural end sac undergoes displacement and deformation, chiefly because of bulging of intervertebral disks and flaval ligaments in lumbar extension. Under normal circumstances these dural changes of form do not lead to clinical symptoms. However, in patients with spinal stenosis radiologic signs may be accentuated in lumbar extension. These tend to disappear in flexion. This implies that examination techniques performed in extension (prone lumbar myelography) tend to enhance abnormalities, while techniques in which the spine is more or less flexed (epidural phlebography, computed tomography) tend to mask them. In addition, there may be discrepancy between the picture during surgery (usually in lumbar flexion) and the situation in which a patient experiences symptoms (usually in lumbar extension in spinal stenosis).

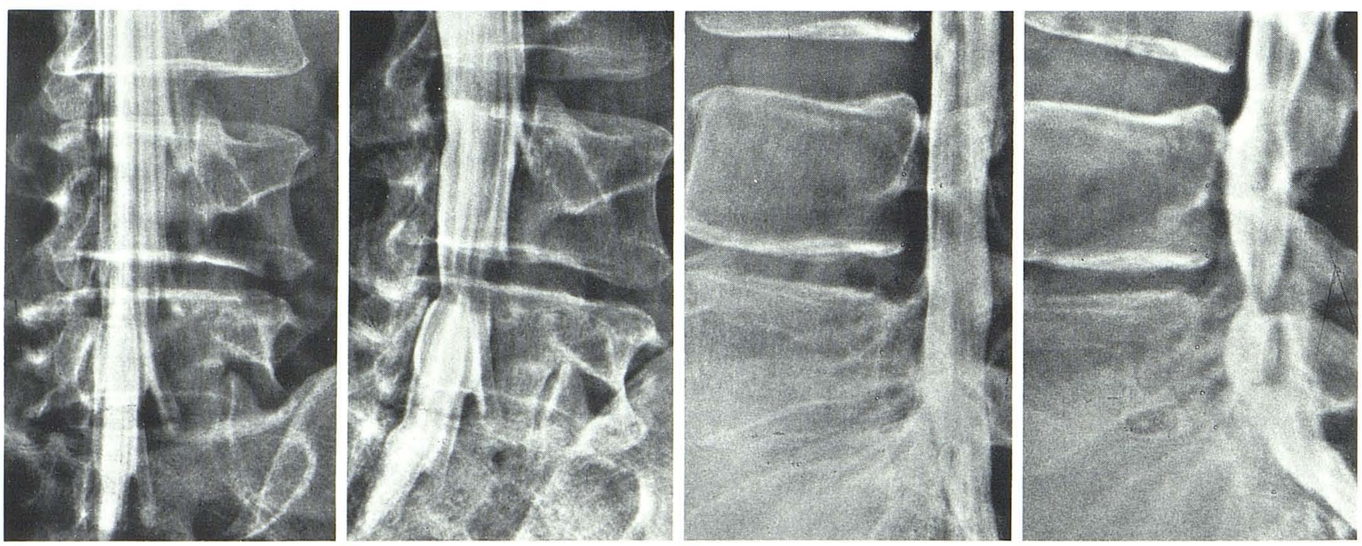
Lumbar myelograms may show marked variations in configuration of dural sac and root sleeves depending on the posture during the examination of the lumbar spine (fig. 1). The existence of such marked posture-related changes is of interest to the radiologist, because in certain disorders (the various types of lumbar spinal stenosis) symptoms may occur in lumbar extension (walking, standing) that are relieved in lumbar flexion (sitting, stooping) [1].

We analyzed postural changes occurring in the lumbosacral dural sac, based on the lateral myelogram in flexion and extension. The findings of this study have been reported elsewhere [2].

Materials and Methods

Measurements were obtained in 40 flexion-extension myelograms in lateral projection to assess displacement and/or deformation of the dural sac caused by spinal movements. Reference points were established at the midvertebral and intervertebral level (fig. 2). From these points distances were measured to the anterior and posterior dural borders in lumbar flexion and extension.

Various examinations are carried out with the patients in different positions. In our department, lumbar myelography is routinely performed with the patient prone, head up, on a table tilted 30°. This technique entails a moderate to marked lumbar extension. In epidural phlebography, invariably performed supine, lumbar lordosis is flattened by the application of a compression balloon intended to block the flow of blood in the inferior caval vein. A similar spinal flattening is often desirable in lumbar computed tomography (CT), in order to bring the plane of the disk parallel to the tomographic plane. This implies that in posture-related disorders (such as spinal



A B C D

Fig. 1.—Lumbar myelograms. Oblique projection, flexion (**A**) and extension (**B**); and lateral projection flexion (**C**) and extension (**D**). Note normal aspect of L5 root sheath and dural sac in flexion, with root sheath obliteration, root widening, and dural indentations at same level in extension.

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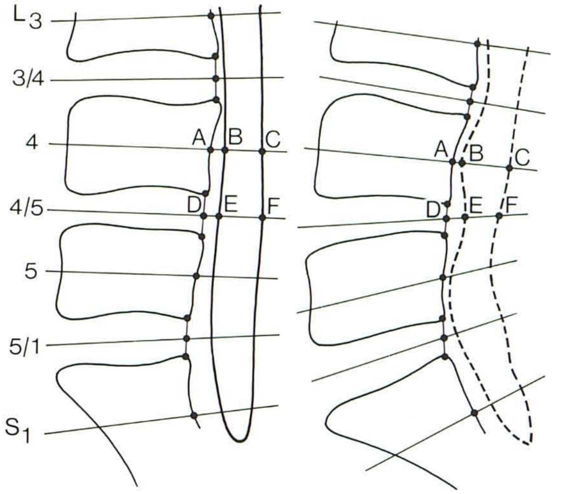

Fig. 2.—Illustration of measuring points. From reference points A and D distances were measured to anterior (B, E) and posterior (C, F) dural surfaces in lumbar flexion (*left*) and lumbar extension (*right*).

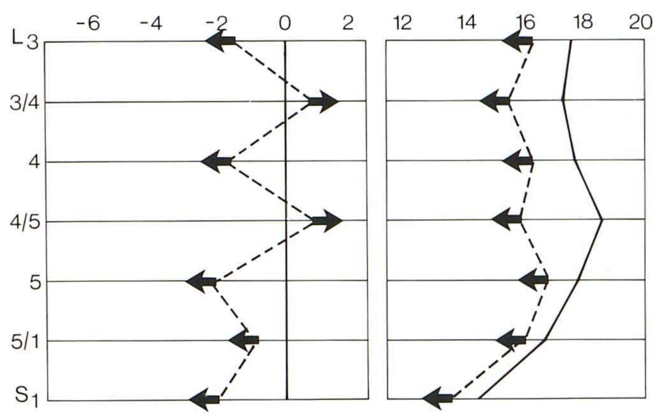

Fig. 3.—Movement diagram of dural sac in spinal flexion-extension movements, lateral projection. *Solid line segments* show dural borders in flexion; *straight line at 0* represents anterior border. *Broken lines* show dural margins in extension. *Arrows* indicate direction of movement of dural surfaces in extension. Whole dural sac is displaced anteriorly in extension, with anterior indentations occurring at disk levels and anterior bulging at midvertebral levels. AP dural diameter scale has been interrupted between 2 and 12 mm, thus giving a shortening effect and exaggerating movements.

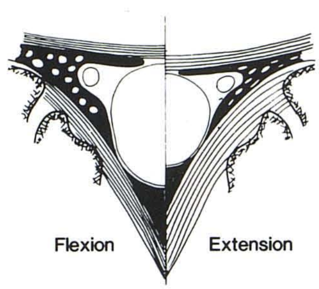

Fig. 4.—Cross section of spinal canal at level of L4–L5 disk. Dural sac and emerging nerve roots shown in white, epidural fat in black, annulus fibrosus and flaval ligaments as linear shading. Epidural veins in anterolateral region at this level. Decrease in cross-sectional area of spinal canal in extension is caused by bulging of flaval ligaments and annulus fibrosus. Compression of dural sac in extension here is compensated by anterior bulging at other levels.

stenosis, where symptoms occur in spinal extension), lumbar myelography, because of the position in which it is carried out, will tend to reproduce the pathologic situation more faithfully than epidural phlebography or CT.

Results

There proved to be a consistent pattern of dural displacement. At the disk level the dural sac is displaced anteriorly in extension by thickening of the flaval ligaments and the epidural fat pad. At the same time the intervertebral disk bulges posteriorly, indenting the anterior surface of the dural sac. The reduction in cross-sectional area of the dural sac at the intervertebral level in lumbar extension is compensated by the bulging of the anterior dural surface at the midvertebral level, where there is anterior epidural venous plexus in the midline. Such a midline plexus is not present at the intervertebral levels, with the exception of the L5–S1 disk, where there is usually a network of veins separating the posterior surface of the disk from the anterior dural surface. This factor, added to the smaller size of the dural sac and larger volume of the spinal canal at the L5–S1 level, explains why there is much less anterior indentation of the dural sac at L5–S1 compared with the higher disk levels. Average excursions measured in the 40 myelograms are shown in figure 3; figure 4 demonstrates the dynamics of the displacement.

Myelographic postural effects are compared with CT in figure 5. The CT examination has been performed with the patient's knees drawn up and the hips flexed. In this situation the localized CT image shows the lumbar spinal curve to lie somewhere between the extremes indicated in the flexion-extension myelogram. The anteroposterior (AP) dural diameter at L4–L5 calculated by CT likewise occupied a position between similar diameter measurements measured on the myelogram in flexion and in extension. In figure 6 CT has been performed with the hips extended and the legs outstretched, thus increasing lumbar lordosis. The computer localization view now shows a spinal configuration virtually identical to that of the myelogram in extension, and the AP dural diameters obtained by the two techniques tally closely.

Discussion

While myelography in lumbar extension most accurately reproduces the pathologic situation in patients with spinal stenosis, flexion views depict the situation that the surgeon is likely to encounter at operation. In patients with posture-related disorders there is almost invariably a significant discrepancy between the myelographic picture in lumbar extension, where pathologic features are accentuated, and that in lumbar flexion, where these features are diminished and may disappear completely. For this reason we routinely include in every lumber myelogram sitting flexion-extension films in lateral projection and, if considered necessary, also in oblique projections. This positional comparison is quickly and easily performed during myelography, but difficult to achieve accurately with CT and virtually impossible with epidural phlebography.

As stated, flexion-extension changes are the most striking in patients with spinal stenosis. In patients with unilateral nerve root compression due to disk prolapse the myelographic picture does not vary greatly between lumbar flexion and extension, although this may be due largely to the reduced spinal mobility usually present in such patients. A clear distinction between spinal stenosis and disk prolapse is not always easy, however, and various combinations of mild bony stenosis with annular bulging or flaval hypertrophy may produce a myelographic picture of root compression, albeit nearly always bilateral.

We recommend that every lumbar myelogram be concluded by a sitting functional study in the lateral projection, with additional oblique views if necessary. The myelogram in lumbar extension reproduces the posture in which complaints are provoked, while the flexion study depicts the situation as it prevails during surgery. CT studies, especially in patients suspected of spinal stenosis, should

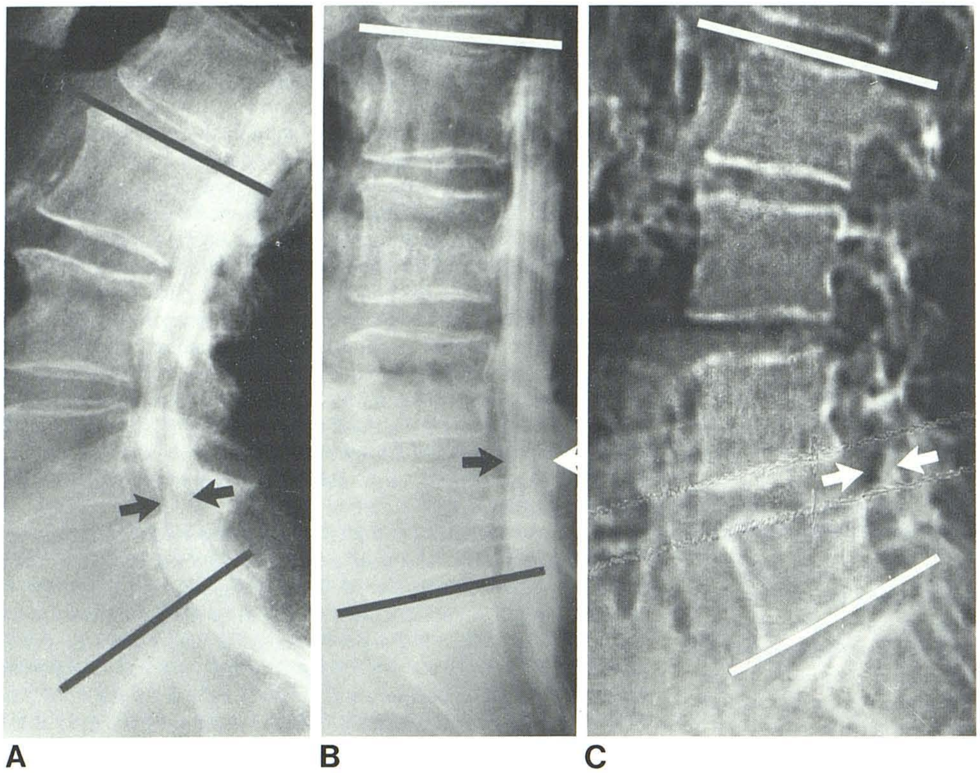

Fig. 5.—Extension myelogram (**A**), flexion myelogram (**B**), and CT image obtained with knees drawn up (**C**). Lumbar postures and AP dural diameters are 65°, 5 mm (**A**); 20°, 12 mm (**B**); and 45°, 8 mm (**C**). Spinal curvature was estimated by measuring angle between superior end-plate of L2 and inferior end-plate of L5. Lines used for measurements are shown, and angles were subtended by these lines. AP dural measurements at L4–L5 (*arrows*) were obtained directly from films and corrected for magnification. CT measurement was determined by computer on axial image (not shown). Diameter on **A** is significantly smaller than on **C**, where measured value and spinal curve lie between extension and flexion.

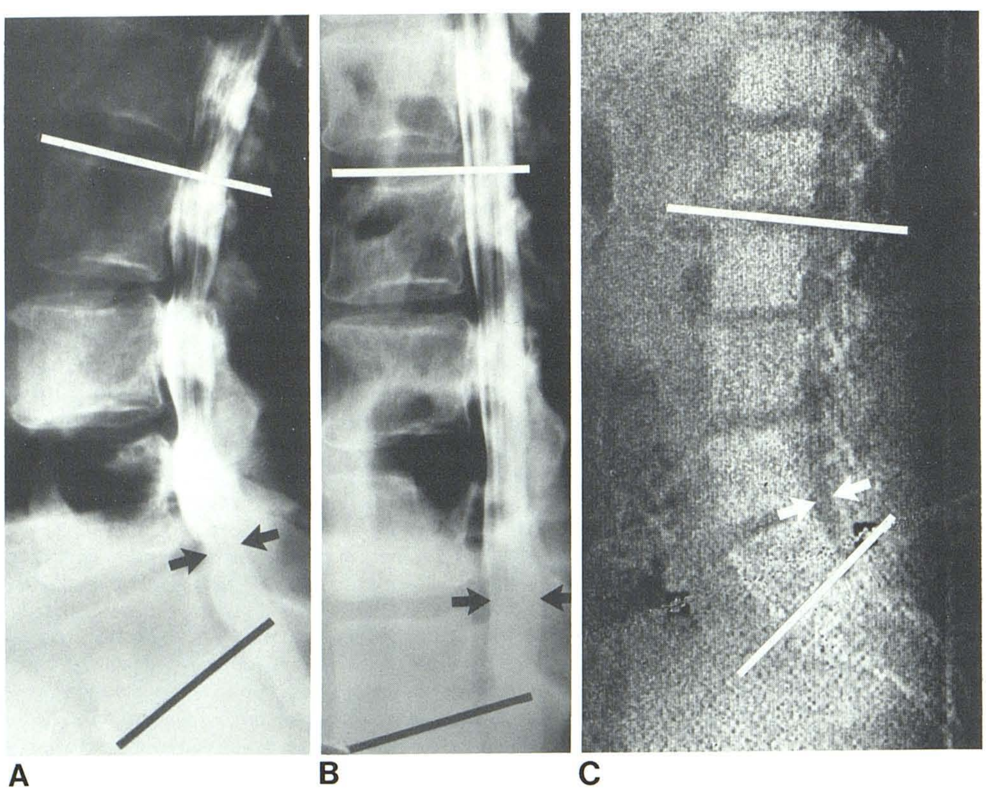

Fig. 6.—Extension myelogram (**A**), flexion myelogram (**B**), and CT image obtained with legs stretched out flat (**C**). Lumbar postures and AP dural diameters are now 53°, 8 mm (**A**); 15°, 12 mm (**B**); and 52°, 7 mm (**C**). (Measurements were obtained as in fig. 5.) Lordotic curve is now more marked and almost identical to posture in extension myelogram. AP dural diameters coincide very closely.

be performed with the legs stretched out flat in order to obtain a sufficient degree of lumbar extension.

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