Radiology of spinal stenosis

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Diagnostic imaging plays an important role in the evaluation of patients who have back pain with varying degrees of leg pain and a claudicant presentation. For many years the plain radiograph of the lumbar spine taken in the lateral and AP projection was used to define the canal dimensions. The AP diameter was measured from the posterior aspect of the vertebral body to the line joining the upper and lower tips of the articular process (Eisenstein 1977). With 13 mm as the mean at L4 (16–10 mm) in the coronal plane, the interpedicular distance increases from L1–L5 with a mean measurement of 23 mm at L4 (27–19 mm). Other authors have described alternate methods (Roberson et al. 1973) and recent comparison with CT suggests that the measurements at L4 and L5 were similar with the two methods (Dailey and Buehler 1989). The alignment of the facets can be assessed on the AP view and the interpedicular distance measured. A sagittal alignment, particularly with a relatively narrow lamina, is particularly prone to degenerative spondylolisthesis (Sato et al. 1989) and this group with sagittally aligned facets but a wide lamina (Sato et al. 1989).

Plain radiographs, however, are unable to demonstrate the true shape of the canal or the relationship of the bone and soft tissue components. This can be achieved with computed tomography, which enables the assessment of the total cross sectional area of the bony canal, its shape and the effect of the disc and ligamentum flavum on its functional capacity.

Measurements of the canal dimensions have been undertaken and an AP diameter of 11.5 mm and an interpedicular distance of less than 16 are consistent with stenosis (Ullrich et al. 1980).

The shape of the canal is, however, of major relevance and the overall area of the canal is more important than individual linear measurements. An overall cross section of the bony canal of less than 1.45 square cm is considered small (Ullrich et al. 1980).

However, the importance of the soft tissue within the canal to its overall dimension is stressed by Schonstrom et al. (1985) who found that 80% of cases with stenosis had the minimum cross-sectional area at the level of the facet joints and the bulging disc and ligamentum flavum were the main causes of stenosis in 70% of patients. These authors also performed experimental pressure studies within the dural sac, which sugggested that 65 mm^2 at L4 was the criritcal size below which a further constriction would cause impairment of the circulatory and/or nerve function of the cauda equina (Schonstrom et al. 1984).

It is therefore important on CT to measure not only the area of the bony canal but also the area of the dural sac. Measurement of the AP diameter on CT will be incorrect in 80% of cases (Bolender et al. 1985). If it is not possible to measure the dural sac on CT, water-soluble myelography may be necessary to outline the canal. Water soluble contrast agents in the dural sac also provide a dynamic element in that flow can be assessed and the effect of movement of the spine on its column can be demonstrated. Magnetic resonance images will also provide an effective demonstration of the dural sac. The Gradient echo T2 sequence which produces a high signal for CSF is the most valuable sequence and can be undertaken in both sagittal and axial planes. T1 weighted sagittal images also are unsatisfactory as they may give a false impression of the canal dimensions.

The axial projection of CT and MR is particularly important for the evaluation of narrowing of the lateral region of the spinal canal. Stenosis of the entrance zone may be due to hypertrophic osteoarthritis of the facets, developmental variation of the facets, annular bulging or an osteophyte ridge. Posterior indentation of the dural sac is seen on myelography. Narrowing of the mid zone of the nerve root canal under the pars interarticularis may be due to osteophyte formation at the attachment of the ligamentum flavum, which may be enhanced by a trefoil shaped canal. On CT an AP distance of 3 or less is considered significantly narrowed but 3–5 mm may also be associated with clinical symptoms (Mikhael et al. 1981). The lateral sections of the sagittal T1 or the axial weighted MR sequences show this area well as the nerve root is surrounded by high signal intensity epidural fat. Loss of this signal by compression of low signal bone and osteophyte will indicate stenosis.

Foraminal narrowing may be difficult to appreciate in all its dimensions on axial scans but AP narrowing due to hypertrophic osteoarthritis of the facets or by osteophyte formation on the posterior vertebral rim will be clear. Loss of disc height with upward displacement of the superior articular process of the vertebra below associated with hypertrophic changes can produce cranio-caudal stenosis, which will be difficult to appreciate on the transaxial scans (Hertoff and Ray 1984). Reformatting the transaxial images in the sagittal planes will permit evaluation of these changes (Heitoff and Ray 1984).

Sagittal and axial plane MR images display nerve root entrapment in the intervertebral foramina with good resolution and contrast. There is a decrease in the epidural fat content and the overall bony canal dimensions, with osteophytes appearing low signal on T1 and T2 if composed of compact bone.

Myelography is unhelpful in foraminal stenosis as the contrast does not outline the root due to the fact that the root sleeves do not extend into the foramen. The diagnostic accuracy for spinal stenosis for myelography and unenhanced CT has been variously reported as 93% and 89% (Bell et al. 1984), 54% and 79%, respectively (Modic et al. 1986) and 83% for both (Bolender et al. 1985). Comparison of myelography and CT for lateral canal entrapment alone, however, showed accuracy of 63% for myelography and 75% for CT. No correlation for sagittal reformatting were performed in the study. Comparative studies between CT and MR have shown a good correlation between the two studies for both central and lateral stenosis (Schnebel et L. 1989).

In conclusion, therefore, the diagnosis and evaluation of spinal stenosis is best performed by means of an axial imgaing technique. Both CT with reformatting and MR are effective for both central, lateral and foraminal stenosis. However, the precise comparison between clinical symptoms and degree of narrowing on these images requires further study.

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