Neuroradiology (1986) 28: 221-236

Computed tomography in cervical spondylotic myelopathy and radiculopathy: visualisation of structures, myelographic comparison, cord measurements and clinical utility

Y. L. Yu, G. H. du Boulay, J. M. Stevens, and B. E. Kendall

The Lysholm Radiological Department, The National Hospital for Nervous Diseases, Queen Square, London, England

Summary. Sixty-nine patients with cervical spondylotic myelopathy (CSM), radiculopathy (CSR), or both (CSMR) were studied with computed tomography (CT). Computer-assisted myelography (CAM) accurately determines the site and nature of spondylotic protrusions and provides good visualisation of the subarachnoid space and cord deformities even in areas with dilute metrizamide. However, excessive vertebral movement and bulging ligamenta flava with their effects on cord deformity, so easily visualised in myelograms, are completely or partially missed. In the assessment of CSM, metrizamide myelography (MM) followed by CAM should be performed, particularly when the myelographic images are unsatisfactory due to contrast dilution or blockage, when cord compression cannot be ascertained with MM and when cord atrophy is suspected. In CSR, the diagnostic information from MM and CAM is comparable. The diagnostic criteria in CAM are, however, less direct and since MM is adequate in uncomplicated cases, CAM is generally not necessary. The APD, APD/TD ratio, area and circularity are sensitive indices of cord deformity and the first two should be used more often to assist visual assessment of cord deformity. The relation between cord parameters and treatment response is better reflected in CSM cases managed conservatively and the results suggest that the degree of cord deformity is helpful in determining the outcome and hence the choice between surgical and conservative treatment. In plain CT, the osteophytes and calcified discs are adequately visualised and canal dimensions measured with accuracy, but the cervical cord and roots cannot be properly assessed and the diagnosis of CSM or CSR cannot be ascertained. At present, its role in cervical spondylosis is therefore limited.

Key words: Cervical spinal cord - Cervical spondylosis - Computed tomography - Computer-assisted myelography - Metrizamide

The advent of computed tomography (CT) of the cranium has transformed the radio-diagnosis of intracranial diseases and a logical extension would be its use in spinal conditions. Visualisation of the spinal cord and roots was not a success initially due to technical difficulties. This is because the soft tissues in the spinal canal, in contrast to the brain, are enclosed by an irregular and relatively thick ring of bone. Moreover, the spine is surrounded by an unknown amount of bone, air and soft tissues rather than the more uniform thickness of the skull and scalp. There has since been much improvement in CT technology, the notable advances being the scout-view facility, fan-beam scanning, high-resolution scan mode and computer-assisted myelography (CAM). Consequently, the clinical application of CT in the disorders of the spine increased and by 1980, Post [1, 2] and Pullicino [3] were able to discuss the experience accumulated and provided some guidelines in CT spine work.

Cervical spondylosis (CS) is a very common condition above age 40 [4]. Cervical spondylotic myelopathy (CSM) is considered to be the commonest cervical cord disorder during and after middle age [5], but cervical spondylotic radiculopathy (CSR) is undoubtedly more prevalent. While the clinical picture of CSR and CSM was clearly delineated more than three decades ago [6, 7], the clinical and radiological diagnosis may still be uncertain at times. It is natural that the investigative utility of CT in this field should be explored, and there have already been a number of reports [1, 8-17]. Few of these, however, attempt a detailed comparison with conventional myelography and in many, confirmation from operative findings is not available. Consequently, the clinical application of CT in the neural complications of CS has not been fully defined so far.

The present investigation was therefore designed to assess the information obtained from CT through myelographic comparison and confirmation with operative findings, and to define the role of CT in the...
Table 1. Technical details of scanner operation in this study

<table>
<thead>
<tr>
<th></th>
<th>EMI CT 5005</th>
<th>GE CT 8800</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scanning mode</td>
<td>Standard resolution</td>
<td></td>
</tr>
<tr>
<td>Pixel matrix</td>
<td>160 x 160</td>
<td>320 x 320</td>
</tr>
<tr>
<td>Pixel size</td>
<td>1.5 mm</td>
<td>0.8 mm</td>
</tr>
<tr>
<td>Slice thickness</td>
<td>5 mm</td>
<td>5 mm</td>
</tr>
<tr>
<td>Scan time</td>
<td>20 s</td>
<td>12 s</td>
</tr>
<tr>
<td>Scan field</td>
<td>24 cm</td>
<td>25 cm</td>
</tr>
<tr>
<td>X-ray tube voltage</td>
<td>120 kV</td>
<td>120 kV</td>
</tr>
</tbody>
</table>

diagnosis and management of CSM and CSR. A preliminary account of part of the work has been published [18].

Patients and methods

Case selection

Sixty-nine patients with clinical and/or myelographic evidence of CSM, CSR or cervical spondylotic myelopathy and radiculopathy (CSMR), who were admitted into the National Hospitals between August 1981 and November 1982, were studied with informed consent. Those who declined to be investigated by CT were excluded.

Radiological methods

Metrizamide myelography. Metrizamide myelography (MM) was performed on a Philips 90/90 tilting table combined with an over-couch X-ray tube and lateral fluoroscopy facility. Metrizamide (8-10 ml) with iodine concentration at 250 mg/ml was introduced intrathecially via the lateral cervical or lumbar route.

The standard exposures, including flexion and extension views, were made. Cord compression was indicated by blockage of contrast flow, cord flattening in AP views, anterior or posterior cord indentation in the lateral views. Root compression was shown as occlusion, distortion or displacement of the root pouches and sleeves.

Computed tomography. Patients were scanned using the EMI CT 5005 or the GE CT 8800 scanner depending on availability. They underwent plain CT, CAM, or both. The technical details of scanner operation are as listed in Table 1.

CAM was performed between 1-4 h after the completion of MM in order to obtain optimum concentration of metrizamide in the cervical region. Level localisation and horizontal positioning of the spine were ensured. One to two slices were made at intervertebral levels C2/3 to C7/T1 plus consecutive and overlapping slices at affected levels in order to cover the whole intervertebral space and adjacent areas. Scans were imaged with the appropriate window centre settings ranging from +80 to +400 HU, depending on the attenuation of the metrizamide and the cord as described by Seibert et al. [19]. The window width was set either at 200 or 400 HU.

Assessment methods

All CT and myelographic films were studied without prior knowledge of the identity of the patients or their clinical data.

CAM cases. Visualisation of spinal canal structures in myelopathy and radiculopathy patients was assessed and the information obtained from MM and CAM was compared in order to determine the contribution of the two techniques towards clinical diagnosis. The criteria used were: the site and nature of spondylotic protrusions (i.e. disc, osteophyte, ligamenta flava), the presence and degree of cord and/or root compression. In the surgical group of patients, detailed operative findings were obtained as far as possible in order to ascertain the above findings, whereas for patients treated conservatively, the clinical picture was the arbiter.

Measurements of the cord were made at each intervertebral level from C2/3 to C7/T1 only for the 36 CSM and CSMR patients studied with the EMI scanner, with which cord values in control subjects had been obtained [20]. The measurements included anteroposterior diameter (APD) and transverse diameter (TD) measured with a ruler to the nearest 0.5 mm, and area (a) and circumference (c) using the MOP digital image analyser (Komtron and Messgeräte, Eching, FRG). The APD/TD ratio and circularity, as defined by the formula \((4\pi a/c^2)\) were calculated. Values of each parameter of both mildly and markedly deformed cords at various levels were pooled, having been adjusted with the appropriate correction factors to take into account the variation of cord size at different levels [20]. The pooled value of a certain parameter of the deformed cords was compared with the pooled value of the same parameter of the control cases. Cord parameters at the unaffected levels were also compared with control values in order to determine whether there was significant difference in cord size. Student's t-test was used in each case.

The influence of abnormal cord values on response to treatment was also studied. The 36 CSM and CSMR with the number of affected levels and their response to treatment are shown in Table 2. Though there were four categories of treatment response when all patients were considered, only three