IMAGING IN CHILDREN WITH SPINAL TUBERCULOSIS

A COMPARISON OF RADIOGRAPHY, COMPUTED TOMOGRAPHY AND MAGNETIC RESONANCE IMAGING

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We compared the usefulness of radiography, CT and MRI in 25 children with spinal tuberculosis. Radiography provided most of the information necessary for diagnosis and treatment. Axial CT was the most accurate method for visualising the posterior bony elements. Sagittal MRI best showed the severity and content of extradural compression and helped to differentiate between an abscess and fibrous tissue.

The main value of CT and MRI is in the preoperative evaluation of the small proportion of patients who require surgical treatment for paraplegia.

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The current controversy surrounding the treatment of tuberculosis of the spine concerns the merits of anterior decompression with strut grafting compared with ambulant chemotherapy without surgery (Griffiths 1979, 1987; Leong 1988). The radiological features of spinal tuberculosis have been well documented (Allen, Cosgrove and Millard 1978; Goldblatt and Cremin 1978; Chapman, Murray and Stoker 1979). The role of CT and MRI has been addressed by various workers (Gropper, Acker and Robertson 1982; Herman et al 1983; Whelan et al 1983; La Berge and Brant-Zawadski 1984; de Roos et al 1986; Smith et al 1989) but their studies were on small numbers of mainly adult patients and only de Roos et al (1986) compared MRI and CT.

We have compared the three methods of imaging in 25 children with spinal tuberculosis and related the results to the clinical features in 11 patients with neurological involvement and to the operative findings in five patients who came to surgery.

PATIENTS AND METHODS

During 1989, 22 consecutive children with spinal tuberculosis were investigated by radiography, CT and MRI. Two of these patients had anterior decompression and strut grafting. In the two-year period from 1990 to 1991 a further 42 patients with spinal tuberculosis were seen and treated but only three had neurological abnormalities which warranted surgery and prior investigation by both CT and MRI. There was, therefore, a total of 25 patients in whom all three investigations were performed.

On admission to hospital all the children had a chest radiograph, full blood count, ESR, Mantoux skin test, and a Widal and Brucella complement-fixation test. No patient had a needle biopsy. The diagnosis was made from the radiological appearance, a raised ESR and a positive Mantoux test. The five patients who underwent anterior decompression all had histologically proven tuberculosis.

There were 7 boys and 18 girls; 17 were black and 8 coloured. Their average age was 4 years (13 months to 10 years 9 months). In all patients, treatment was with rifampicin (10 mg/kg body-weight/day), isoniazid
(15 mg/kg body-weight/day) and pyrazinamide (30 mg/kg body-weight/day) for nine months. The 11 patients with neurological deficit on admission were treated by bedrest until they recovered or underwent surgery; the rest were ambulant during their period of chemotherapy, but were kept in hospital for a minimum of three months to assess their response.

Lateral and anteroposterior radiographs and linear lateral tomography were performed in the 18 patients with thoracic involvement. The CT scans were performed with an Excel 2400. For MRI we used a 0.5 Tesla Gyrex 5000 (Elscint Inc, Israel) with spinal surface coils using spin-echo sequences with T1-weighted (TR 300 ms; TE 30 ms) and T2-weighted signals (TR 1800 ms to TR 2000 ms). CT was performed in the axial plane and MRI in the sagittal plane with coronal and axial scans as required.

RESULTS

The average ESR was 76 mm in the first hour (36 to 124). The Mantoux skin test was positive and the Brucella and Widal complement-fixation tests were negative in all patients. Chest radiographs showed active tuberculosis in 22 of the 25 patients.

Vertebral bodies. The number and levels of vertebrae partially or totally involved are given in Table I. In all patients at least two contiguous vertebrae were affected with some narrowing of the corresponding disc space (Fig. 1a). The CT scan showed large, irregularly defined 'cystic' areas of bone destruction (Fig. 1b). MRI always confirmed these appearances and sometimes showed preservation of disc material that had been compressed into the remnant of the vertebral body (Fig. 1c). In more advanced cases CT showed bursting of the vertebral body with dissemination of the bony fragments anteriorly, laterally and posteriorly (Figs 2, 7a). Lack of clear definition in the lateral projection due to overlying ribs necessitated linear tomography in the thoracic spine (Fig. 3). Cases of complete destruction of the vertebral body could always be diagnosed from the radiographs by noting the absence of a vertebral body against its adjoining posterior elements (Fig. 3).

In six patients MRI and CT both showed the vertebral involvement to be more extensive than was seen on radiography. In one patient in whom the radiographs showed lesions in T5 and T6 only, MRI and CT indicated involvement from T3 to T8. At operation T4 and T7 vertebral bodies had to be removed although

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A 5-year-old child with tuberculosis at L3 and L4. Figure 1a – Linear tomogram showing vertebral destruction and some narrowing of the disc space. Figure 1b – CT scan showing destruction of the vertebral body and 50% extradural compression of the spinal canal (arrow). Figure 1c – Sagittal T2-weighted (TR 2000 ms; TE 80 ms) MR scan showing 50% extradural compression and the extent of involvement of L3 and L4. Remnants of the nucleus pulposus remain (arrow).
patients (13 of the 22 consecutive patients seen in 1989). Pedicle lesions were best seen on axial CT which also showed involvement of the lamina and adjacent rib (Figs 2, 5b). Posterior element involvement was always unilateral (one pedicle and/or lamina) (see Fig. 2) except in the one patient shown in Figure 5 in whom both pedicles and laminae were destroyed. MRI did not show these destructive bony lesions any better than CT.

Soft tissue. Soft-tissue (paraspinal) expansion was seen on the radiographs in 23 cases and in all by CT and MRI. Anterior, lateral and posterior soft-tissue features were well delineated by both CT and MRI but their extent was best seen by MRI because both sagittal and coronal planes (Fig. 6) could be visualised.

Neurological involvement. All patients had extradural compression ranging from 20% to 100%. There were neurological signs in 11 (8 of the 22 consecutive patients seen in 1989). Of these, ten had thoracic involvement and extradural compression of at least 60% of the intraspinal canal. CT and MRI both showed similar amounts of compression (Figs 7, 8). In the two patients with more than 60% extradural compression below L2 (cauda equina) there were no neurological signs.

Positive neurological signs were present on admission in 11 patients, all of whom were classified as paraplegic as they could not walk 5 m unaided (Pattisson 1986). Ten patients had a partial motor deficit (grade 2 to 3 MRC), intact sensation, hyper-reflexia and clonus, and one had complete paraplegia.

Of these 11 patients, six began to recover within one
A 5-year-old child with tuberculosis of T10 and T11. Figure 5a – Anteroposterior radiograph showing bilateral absent pedicles of T10 and T11, resulting in posterior instability. Figure 5b – Axial CT scan of T11 showing total destruction of both pedicles and laminae. There is posterior extradural compression (arrow). Figure 5c – Sagittal T2-weighted (TR 1800 ms; TE 80 ms) MR scan showing destruction of T10 and T11. There is posterior extradural compression.

A 7-year-old child with tuberculosis of L4 and L5. A coronal T1-weighted (TR 300 ms; TE 20 ms) MR scan showing large abscesses distorting and displacing the psoas muscles.

A month of starting antituberculous therapy and eventually recovered fully. The other five either showed no sign of recovery at one month or deteriorated while on treatment. They underwent anterior decompression and strut grafting. The one patient with posterior instability had anterior decompression followed by posterior stabilisation. In three of the patients the cause of the compression was found to be fluid or caseous pus, granulation tissue, and the kyphos deformity. In the other two (one with a delay of one year) the compression was due to a combination of the kyphos deformity and scar tissue which did not give an increased signal on T2-weighted MRI.

The patient with the one-year delay had total obliteration of the spinal cord. In three patients the compression ranged from 60% to 80%, and in this range there was no correlation between the severity of the neurological involvement and the amount of compression. The patient illustrated in Figure 5 had 40% compression, mainly posterior, and the neurological deficit was due to the posterior instability. All these patients made a full recovery, except the one who had a one-year delay in presentation.

Five patients had a follow-up MRI after they had recovered (four after conservative treatment and one after surgery). These showed significant improvement of the extradural compression which correlated with the clinical response (Fig. 8).

DISCUSSION

Plain radiography remains the corner-stone of diagnosis. In all cases the affected vertebral disc spaces showed narrowing, involvement of the vertebral body was central and collapse commenced anteriorly. CT was the best method for showing the degree of bone destruction (Herman et al 1983; La Berge and Brant-Zawadski 1984). The central, lytic lesions were initially contained and later spread gradually through the vertebra leading eventually to complete collapse, with the remnants of the disc buried in the crumbling vertebra. Spinal canal involvement was well seen on CT and with correct window settings, the thecal sac could be identified. The technique also accurately showed involvement of the posterior element and ribs.
The multiplanar images of MRI best demonstrated the spine and spinal cord. The findings in the vertebral bodies were similar but more extensive than those already described in adults (Smith et al 1989). They consisted of a focal decrease in signal intensity on T1-weighted images and an increased signal on T2-weighted images. MRI also showed best the extent of the disease and the spread of tuberculous debris under the anterior and posterior longitudinal ligaments (Fig. 9). Even in severely affected disc spaces the signal from the fluid portion of the disc, the nucleus pulposus, sometimes persisted (Fig. 1c).

MRI also demonstrated most accurately the pathological tissue causing spinal cord compression, liquid pus giving areas of increased signal on T2-weighted images (Angtuaco et al 1987). Gadolinium as a contrast medium was not available for children at the time of these examinations. Its role has not been fully established but fibrous tissue would be expected to give greater enhancement on T1-weighted images (Smith and Blaser 1991). Focal myelopathy giving a discrete T2-weighted signal in the cord has been considered to indicate a poor neurological prognosis (Corr, Handler and Davey 1991). Severe prolonged compression, causing cord ischaemia, was not seen in the present series but we have subsequently observed it in a child who had a delayed presentation, a severe kyphos and marked neurological signs.

Needle biopsy was not considered necessary to confirm the diagnosis of spinal tuberculosis. Apart from the classical radiological appearances, we had supporting
evidence from a positive Mantoux skin test in all cases, active tuberculosis on chest radiographs in 88%, and good response clinically and radiologically to antituberculous chemotherapy. The five patients who did not respond were operated on, and tuberculosis was confirmed in them all.

Patients with atypical radiological features require needle biopsy or exploration to exclude other diseases. Atypical changes have been described by Naim-ur-Rahman (1980) and Babhulkar, Tayade and Babhulkar (1984) and include involvement of the neural arch with sparing of the vertebral bodies, and disease of a single vertebra in which the adjacent disc and vertebra are not included. None of our cases had these appearances and although the posterior elements were affected in more than half of our patients, this was always associated with vertebral body involvement.

In a quarter of our patients CT and MRI showed more extensive involvement than radiography; this was of practical value in planning the placement of strut grafts during anterior decompression. The extent of this involvement is most vividly shown on sagittal MRI and may be useful, in the lower thoracic spine, to show disease below T12, necessitating a thoraco-abdominal rather than a transthoracic approach.

Although unilateral destruction of one pedicle occurred in three of our cases this did not cause lateral deviation. All six cases of lateral deviation were due to unilateral destruction of a vertebral body, and they were all cases of lower thoracic or lumbar disease, as noted by Hodgson (1975).

A paraspinal soft-tissue abscess is an indication of active tuberculous disease. Hodgson (1975) found an abscess at operation in every patient, although it was not visible on the radiograph in 10% of cases. Similarly, in two (8%) of the patients in our series no paraspinal abscess was seen on the radiographs although it was visible on MRI and CT in them all.

The spread of pus under the anterior longitudinal ligament was well demonstrated by MRI. Hodgson (1975) thought that this caused the scalloping of the anterior vertebral body originally referred to as the aneurysmal syndrome by Ghormley and Bradley (1928).

Isolated involvement of the posterior elements in tuberculosis of the spine has a reported incidence ranging from 0.8% (Adendorff, Boeke and Lazarus 1987) to 10% (Babhulkar et al 1984). Other authors make no mention of posterior element involvement when reporting their CT studies (Herman et al 1983; Whelan et al 1983; La Berge and Brant-Zawadski 1984), and Smith et al (1989) report only two patients who showed both pedicle and vertebral body involvement on MRI.

Of our 25 patients, 16 had posterior element disease. Pedicle involvement was visible on the anteroposterior radiograph in all but two, but axial CT gave the best definition of changes in the pedicle and lamina.

Only one of our patients had bilateral pedicle involvement. The significance of bilateral posterior element destruction and associated body involvement is that it results in an unstable spine (Travlos and Du Toit 1990). The sagittal MRI of the patient illustrated in Figure 5 showed less than 50% spinal extradural compression (Fig. 5c), which was mainly posterior, and which, as discussed below, is insufficient to cause neurological deficit. This patient, while on treatment, developed almost total motor paralysis which was probably due to the spinal instability and not to extradural compression. She was treated first by an anterior decompression and strut grafting but this produced a totally unstable situation. This was remedied by posterior decompression and stabilisation with Harrington distraction rods and sublaminar wiring. At operation circumferential granulation tissue was found, especially posteriorly, but without significant spinal cord compression, confirming that instability was the main cause of the paralysis.

Patients on whom anterior decompression is contemplated and in whom the pedicles are not clearly visible on the anteroposterior radiographs, require axial CT to determine the state of the posterior elements. Travlos and Du Toit (1990) advised that when there is bilateral pedicle involvement a posterior stabilisation should be performed before anterior decompression.

Only compression of 60% or more, above the level of the conus, resulted in neurological deficit. This finding is similar to that of Pattisson (1986) who reviewed 89 cases of Pott's paraplegia, 92% of them due to spinal
disease above L1. The peripheral nerves of the cauda equina are less likely to be affected by extradural compression. It can therefore be assumed that a patient with Pott's paraplegia, and no evidence of posterior instability, has extradural compression of 60% or more above the level of the conus. Although MRI and CT were equally effective in depicting the amount of spinal cord compression, sagittal T1-weighted MRI gave the most vivid and extensive images (Figs 1c, 7c, 8 and 9).

Griffiths (1979, 1987) summarised the results of the controlled clinical trials carried out by the Working Party of the British Medical Research Council and concluded that properly controlled chemotherapy was the vital factor in the effective treatment of spinal tuberculosis. Of the 11 patients in our series with paraplegia, MRI revealed that eight had pus and granulation tissue as the main cause of compression, the effective resolution of which by chemotherapy alone is well illustrated in Figure 8. Two patients came to operation because they had deteriorated in the first month of treatment, but if we had waited longer, the condition may have resolved without surgery (Pattisson 1986). The two patients, however, with dural fibrosis, who had histories of paraplegia of six months and one year, probably had no chance of recovery without surgery, and the value of MRI was in allowing us to define the obstructing pathology, whether fibrous tissue or pus.

Conclusions. Radiography still provides most of the information required for the diagnosis and treatment of spinal tuberculosis in children. Lateral linear tomography is helpful in the thoracic spine where overlying ribs obscure the vertebral bodies.

Axial CT gave the best definition of posterior element involvement and is indicated if posterior instability with bilateral pedicle involvement is suspected on the anteroposterior radiographs, and if surgery is contemplated.

If anterior decompression is indicated in the lower thoracic spine, MRI can be useful to warn of the need for a thoracolumbar approach. Neurological involvement implies 60% extradural compression above the conus, and is most vividly seen on sagittal MRI. MRI can also be used to differentiate between compression due to pus and granulation tissue (which may respond to conservative treatment), and that due to fibrosis, which requires surgical decompression.

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REFERENCES


