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Correlation of canal encroachment with neurological deficit in tuberculosis of the spine

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Abstract CT scans of fifteen patients with tuberculosis of the spine without neurological deficit were analysed for canal encroachment. We calculated that up to 76% encroachment of the spinal canal by tubercular pathological tissue is compatible with undisturbed neural status.

Résumé Quinze malades atteints de tuberculose de 1a colonne vertébrale sans insuffisance neurologique (quadriplégie ou paraplégie) on été examinés par scanner pour 1e pourcentage de l'empiètement du canal. D'après cette étude, soixante seize pourcent de l'empiètement du canal vertébral par le tissu pathologique tuberculeux est compatible avec l'état neurologique non derangé ou intact.

Introduction

Neurological deficit (paraplegia/quadriplegia) following tuberculous vertebral disease is caused by cord compression. The amount of disease tissue required to cause neurological deficit has not been determined.

The present study was aimed to calculate the degree of spinal cord compromise which is compatible with normal neurology.

Patients and methods

Fifteen patients diagnosed clinically and radiologically as having tuberculosis of the spine with disease between C_3–D_{12} without neurological deficit were studied. No patients had gross spinal deformity.

CT scans were performed in all cases. The axial sections showing maximum encroachment of the spinal canal were selected, scanned and transferred to a computer. The area of the canal was calculated from digitized sketches using autocad software.

The area of the canal (B) was measured at the level of maximum encroachment. The canal area at mid vertebral section of the proximal and distal vertebra was also calculated. The average of these two readings gave us the canal area at the diseased segment (B). The area occupied by the spinal cord (C) at the level of maximum encroachment was calculated. The area of encroachment (A) and the percentage canal encroachment was calculated by the formula given below: Area of encroachment (A)=Area of spinal canal (B)–Area of spinal cord (C).

$$\text{Percentage Canal encroachment} = \frac{A}{B} \times 100$$

These patients were treated nonoperatively with antituberculous drugs and spinal braces and all showed satisfactory regression of the disease.

Results

The CT scans of 15 patients (age range 15–65 years) were studied.

The cervical spine was affected in one, and cervicodorsal junction in two and the dorsal spine in twelve. In ten cases the boundary of the spinal canal could be marked out whilst in five cases the canal area at maximum encroachment was calculated from the average of the proximal and distal vertebrae. Seven cases had 65% or more canal encroachment with a maximum of 76%. Only three cases had 50% or less canal encroachment (Table 1).

Discussion

Neurological deficit is the most serious complication of tuberculosis of the spine [2]. The spinal cord appears to have the physiological reserve to withstand considerable pressure. The rapid onset of compression induces more pronounced effects on neurological tissue [9, 10].

Canal encroachment is an appropriate term as differentiation is possible between the compression caused by congenital or structural stenosis and compression caused by extradural pressure.

Hoffman [5] observed about 60% extradural compression in 10 cases of thoracic spine tuberculosis with paraplegia and concluded that neurological involvement in the tuberculous spine was associated with 60% extradural compression above the conus. It is not possible to know the degree of compression that induces neurological

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Table 1 Different measurements and percentage canal encroachment of tuberculosis of the spine (*VB* Vertebral body)

S. No.	Age/Sex	Disease VB	Maximum canal occupancy at VB	Canal area at proximal vertebral body	Canal area at distal vertebral body	Canal area at maximum encroachment (B)	Cord area at maximum encroachment (C)	Area of encroachment A = B – C	Percentage Canal encroachment A/B × 100
1	14/F	D_8	D_8	–	–	0.0942	0.0305	0.0637	68%
2	50/F	D_{6-7}	D_7	–	–	0.1951	0.1951	0.1122	55%
3	46/F	D_3	D_3	–	–	0.0852	0.0298	0.0554	65%
4	65/F	D_{9-10}	D_{10}	–	–	0.0896	0.0308	0.0588	66%
5	34/F	D_{10-11}	D_{10}	–	–	0.0952	0.571	0.0381	40%
6	29/F	C_7D_1	C_7	–	–	0.1132	0.34	0.0792	70%
7	40/F	D_{6-8}	D_7	–	–	0.1252	0.0376	0.0876	70%
8	35/M	C_7–D_1–D_2	D_1	–	–	0.0914	0.0457	0.057	50%
9	23/F	D_{10-11}	D_{11}	0.2427	0.2114	0.2271	0.0535	0.1736	76%
10	35/M	D_{6-8}	D_6	–	–	0.2304	0.0852	0.1452	63%
11	24/F	C_{6-7}	C_6	0.1107	0.1105	0.1106	0.0321	0.0785	71%
12	18/F	D_4	D_4	–	–	0.0934	0.0467	0.0467	50%
13	20/M	D_{4-5}	D_4	0.0924	0.093	0.0927	0.0334	0.0593	64%
14	28/M	D_{7-8}	D_8	0.184	0.1846	0.1834	0.0659	0.1178	64%
15	25/M	D_{6-8}	D_7	0.1567	0.1588	0.1578	0.0712	0.0866	55%

changes. In this regard comparisons with the effects of spinal trauma cannot be made. In the traumatic spine the damage to the spinal cord is by direct compression. Panjabi has calculated canal encroachment in experimentally produced thoraco-lumbar burst fracture in fresh cadaveric specimens. The dynamic canal encroachment during trauma was 85% higher than the static canal encroachment seen on post trauma computed tomography [10].

In pyogenic epidural abscess the inflammation is of rapid onset and presumably causes vascular damage before and in addition to the mechanical insult. In the tuberculous spine low grade inflammation and gradual extradural compression may allow the cord to adjust to the mechanical compression. The chronic compression of tuberculosis behaves like static canal encroachment. Olmarker has demonstrated in experimental studies that impairment of nutritional supply increases vascular permeability and reduces muscle action potential amplitude. All the factors responsible for neuronal impairment are exaggerated when compression builds up suddenly rather than slowly [7–9].

Fontijne has measured canal stenosis by calculating the normal sagittal diameter of the spinal canal (Y) and the smallest sagittal diameter (X) of the spinal canal at the level of injury and then calculated the percentage spinal canal stenosis ($\frac{X}{Y}\times100$), as also measured by Hashimoto et al. [4]. Hoffman measured the percentage canal encroachment in a mid sagittal MRI scan. We have calculated the area of the spinal canal and the spinal cord to determine the area and percentage canal encroachment.

It is theoretically preferable to measure cross sectional area to assess the degree of spinal canal encroachment. Lindahl et al. established a significant correlation between the degree of reduction of the spinal cross sectional area and the mid sagittal diameter [6]. Braakman et al. [2] and Lindahl [6] were of the opinion that the cross sectional area is difficult to measure by digital planimeter due to significant inter observer variations; whereas the measurement of sagittal diameter is more accurate. In tuberculous pathology compression does not always start anteriorly as the disease may penetrate the spinal canal through inter vertebral foramina or via the posterior elements. Thus measurements of mid sagittal diameter may not show encroachment.

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