Original Articles

VALUE OF CT SCAN IN THE DIAGNOSIS OF MENINGITIS

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Objective: *To study the diagnostic test characteristics of computed tomography (CT scan) in differentiating tuberculous (TBM) and pyogenic (PM) meningitis.* ***Design:*** *Prospective diagnostic test evaluation.* ***Setting:*** *Teaching hospital.* ***Methods:*** *Children beyond 1 month of age admitted with meningitis were enrolled prospectively and CT scan done. Results of CT scan were compared with predefined gold standards for the diagnosis of either TBM or PM.* ***Results:*** *CT scan was performed in 154 patients with meningitis. Of these 94 were TBM, 52 had PM and 8 were indeterminate and excluded from analysis. Basal enhancement, ventriculomegaly, tuberculoma and infarction were all significantly more common in the TBM group, while subdural collections zvere seen more in the PM group. The highest sensitivity (89.2%) and specificity (100%) for diagnosis of TBM were found for basal enhancement or tuberculoma or both.* ***Conclusions:*** *CT scan can be used to effectively distinguish TBM and PM.*

Key words: Meningitis, Tuberculous meningitis, Pyogenic meningitis, CT scan.

MENINGITIS continues to be one of the most serious causes of hospital admissions in children in India. The illness accounts for about 9% of admissions to the children wards of the King George's Medical College Hospital in Lucknow. The gravity of the illness make an early diagnosis and aggressive therapy imperative.

Today, meningitis still poses a diagnostic problem. The reason for this is that partially treated pyogenic and tubercular meningitis may be indistinguishable. In about 30% of children admitted with meningitis, we initially find ourselves in a diagnostic dilemma as to whether the child has pyogenic or tuberculous meningitis. The diagnosis can often be made in retrospect after assessing the response to therapy and the patients' clinical course in the hospital. However, valuable time may be lost before the clinical picture becomes clear.

CT scan is now a widely available investigation with a low marginal cost in public sector hospitals. We found that the diagnostic difficulty faced in our patients with meningitis was often resolved after a CT scan. A prospective evaluation of the CT scan as a diagnostic test in the differential diagnosis of meningitis in our situation was, therefore, conducted.

Subjects and Methods

Children between 1 month and 12 years of age admitted to the pediatric wards of the King George's Medical College Hospital, Lucknow in whom the initial diagnosis based on CSF and clinical findings was either tuberculous meningitis (TBM) or pyogenic meningitis (PM) were enrolled in the study. These subjects were worked up according to a predesigned protocol. A cranial CT was planned in such patients. This could usually be arranged within 5 to 10 days of admission

to the hospital. The radiologist was blinded to the clinical diagnosis and CSF findings.

The patients' clinical course in the hospital was carefully observed. They could be classified into the three following groups: *(i) Pyogenic meningitis-diagnosed* on the basis of *(a)* CSF Gram stain or culture positive for pyogenic organisms; *(b)* Clinical and CSF response to exclusive antibiotic therapy; *(ii) Tuberculous meningitis*-diagnosed on the basis of *(a)* Absence of *(a)* and *(b)* above, *(b)* Clinical response to exclusive antitubercular therapy; and *(iii)* An indeterminate group in which neither of the above diagnoses could be made with confidence even after observing the clinical course in the hospital.

The CT findings were compared in groups *(i)* and *(ii)* to see which features were significantly more common in any one group. x^2 test was used and 'p' values were calculated using Epi Info programme on the computer. The sensitivity, specificity and predictive values of these findings singly and in combination were then calculated by comparing with the 'gold standard' for diagnosis described above(l). In addition, the proportion of cases in which CT was helpful in resolving the diagnostic confusion was calculated.

Results

CT scan was performed in 154 patients of meningitis. Of these 94 had TBM and 52 had PM according to the criteria outlined above. In the remaining 8 patients, a firm diagnosis of neither TBM nor PM could be made with confidence even after observing their clinical course in the hospital. These patients were excluded from the analysis.

Table I compares the CT findings in TBM and PM. Basal enhancement, ventriculomegaly, infarction and granulomas were all significantly more frequent in the TBM group. Of these, basal enhancement and granuloma were only found in TBM. The sensitivity, specificity and predictive values of these radiology findings singly and in combination are shown in *Table II.*

Of the 154 patients in whom CT was done, there was confusion about the diagnosis initially in 42. In 30 (71.4%) of these, the CT scan features were suggestive of the final diagnosis. Of the remaining 12 patients, 8 remained a dilemma even after following their course in hospital and in 4 patients the CT features were not specific for either diagnosis.

Discussion

In children hospitalized with meningitis in India, the major differential diagnoses are PM and TBM(2). The two may have a similar presentation especially if prior antibiotic therapy has been administered. Antibiotic administration can prolong and distort the course of PM, render the CSF culture sterile and even change the cellular reaction in the CSF to lymphocytic. This difficulty has been recognized for long and has led to a search for newer diagnostic tests(3). However, most of these newer tests are unlikely to be available where they are needed most for at least the next decade or two. Further, the accuracy of these newer tests is also still under study.

The 'gold standard' for the diagnosis of TBM and PM in this study is the clinical course in the hospital and response to exclusive antitubercular or antibiotic treatment. Bacteriological proof of either TBM or PM would only be available in a minority of patients and these would then not be representative of the entire spectrum of the illness. Response to therapy and follow up often has to substitute for investigations as a 'gold standard' and this is universally accepted as a valuable

TABLE I–*Comparison of CT Findings in TBM and PM.*

CT findings	TBM No.	TBM (%)	PM No.	PM (%)	p value
Normal	5	(5.4)	14	(26.9)	
Basal enhancement	77	(82.7)	0	(0)	0.000
Ventriculomegaly	75	(80.6)	23	(44.2)	0.000
Tuberculoma	22	(23.6)	0	(0)	0.000
Infarction	18	(19.3)	4	(7.7)	0.06
Subdural effusion	1	(1.1)	7	(13.5)	0.001
Cerebral atrophy	6	(6.45)	2	(3.8)	
Cerebritis	2	(2.1)	2	(3.8)	–
Meningeal enhancement (peripheral)	2	(2.1)	9	(17.3)	–
Post ictal edema	0	(0)	2	(3.8)	–
Ventricilitis	0	(0)	1	(1.8)	–
Superficial exudates	2	(2.1)	8	(15.2)	–
Sylvian enhancement	18	(19.3)	2	(3.8)	–
Basal enhancement ± tuberculoma	83	(89.2)	0	(0)	0.000

TABLE II–*Diagnostic Indices of CT Findings for TBM*

Feature	Sensitivity (%)	Specificity (%)	Positive predictive value(%)	Negative predictive value(%)
Basal enhancement	82.7	100	100	76.4
Tuberculoma	23.6	100	100	42.2
Ventriculomegaly	80.6	55.7	76.5	61.6
Infarction	19.3	92.3	81.8	39.0
Subdural collection*	13.4	98.9	87.5	67.1
Basal enhancement and/or tuberculoma	89.2	100	100	83.8

* Values are for PM.

as a valuable tool for retrospective diagnosis.

A number of our patients admitted with meningitis either died too soon or could not have their CT done due to other reasons. This was especially true for patients with PM. Thus the findings seen in our patients with PM may not be entirely representative of PM but are still significant in so much as the striking abnormalities seen in TBM were not observed in this group of patients.

Qur results indicate that CT findings in TBM are more distinct and specific than in PM. Basal exudates, hydrocephalus, granulomas and infarcts are the important

findings in TBM as has been pointed out earlier(4-7). Basal enhancement is not entirely specific for TBM, being seen also in torulosis, neurosarcoidosis, neurosyphilis and coccidiodal meningitis(6). However, it was not reported in PM in earlier studies(8,10) and was not seen in any of our PM cases also. Basal enhancement thus may be specific for TBM in this situation. It was found in almost 80% of our patients, a proportion similar to that reported earlier(4,5). The sensitivity was 83% and when combined with tuberculoma it rose to 89%.

Earlier authors have commented on the utility of CT in understanding the pathology of TBM, for delineating the extent of the pathologic process, in detecting complications and evaluating effectiveness of treatment(4-6,ll-13). However, the role of CT scan in differentiating TBM and PM and its diagnostic accuracy has not been adequately highlighted. In our set up bacterial culture of CSF is seldom positive (possibly because of prior antibiotic intake, among other things). The course of illness and CSF reaction in PM may be altered by therapy and TBM often shows polymorphonuclear reaction in the CSF initially, further compounding the problem. The high sensitivity and specificity of certain CT findings in this situation make us feel that the CT scan may prove useful in resolving this dilemma. The CT scan thus compares well with many of the recent diagnostic tests developed to differentiate TBM and PM and provides useful additional information.

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