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# Ultrasonographic Study in Meningitis

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Cranial ultrasound has been shown to give useful information of intracranial pathology in various meningitides in infants and young children(1-9). We studied cases of acute bacterial and tuberculous meningitis ultrasonographically to find out if this technique could be useful in: (*a*) suggesting the cause, *i.e.*, acute bacterial or tuberculous; (*b*) monitoring the course; and (*c*) indicating the outcome of these diseases.

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## Material and Methods

Thirty five consecutive children with meningitis, 20 acute bacterial (ABM) and 15 tuberculous (TBM) with open anterior fontanallae (AF) admitted into the pediatric wards were studied prospectively by cranial ultrasonography (CR-USG) soon after the initial diagnosis. ABM was diagnosed by: (*a*) suggestive clinical picture; (*b*) routine CSF examination showing polymorphonuclear pleocytosis, protein >40 mg/dl and sugar <40 mg/dl; and (*c*) positive CSF or blood culture or positive latex agglutination test (this however was not considered a must). TBM was diagnosed by: (*a*) suggestive clinical picture; (*b*) routine CSF examination showing lymphocytic pleocytosis, protein >40 mg/dl and sugar <40 mg/dl; and (*c*) finding of at least one of the following evidence of tuberculosis–positive tuberculin test, positive *X*-ray chest, positive contact survey and recovery of AFB from gastric aspirate or CSF.

CR-USG was done by Siemen Sonolyne SL II Real-Time Grey Scale Sector Scanner with a 5 MHz transducer using standard technique. AF was used as the acoustic window. The scans were performed in coronal, sagittal and parasagittal planes. The time gain compensation controls were set to obtain adequate penetration to pick up even the far field parenchymal echoes. During the scans,

notes were made of abnormal echogenicity of various structures like sulci, brain parenchyma, ependyma, choroid plexus, ventricular size, ventriculitis, abscess, infarct, any fluid collection, encephalomalacia, *etc.* Images were recorded by a multiformat camera on a single coated film.

The initial CR-USG findings were correlated to coma, duration of hospital stay, neurological deficit (at discharge and persisting throughout follow up) and death to look for any influence of abnormal CR-USG on the course and prognosis of these diseases. All the discharged cases were followed up for a period of 12-24 months. When initial CR-USG was abnormal, it was repeated after treatment for 10 days in cases of ABM and 28 days in cases of TBM. These intervals before repetition of CR-USG were chosen on the expectation that there would be appreciable recovery of the intracranial pathology in 10 days in cases of ABM and 28 days in cases of TBM, where the process was likely to be slow.

## Results

The age of the patients ranged from 3 to 33 months (median 7.5) in ABM and 7-18 months (median 12) in cases of TBM. Only 1 child was more than 2 years of age; however, with open AF probably due to associated malnutrition.

In ABM cases the median duration of illness was 3 days and mean CSF cell count was 1112/mm$^3$ with polymorphonuclear pleocytosis. Etiological diagnosis by culture and latex agglutination was possible in 6 (30%) cases, the organism being *S. pneumoniae* (n=3), *Klebsiella* (n=2) and *N. meningitidis* (n=1).

In TBM the median duration of illness was 20 days. The mean CSF cell count was 131/mm$^3$ with lymphocytic predominance. Eleven cases had positive evidence of tuberculosis in chest *X*-ray, 5 had positive tuberculin test and 3 had positive contact survey. Thus, besides clinical features and CSF findings suggestive of TBM, all the cases had some other evidence of tuberculosis in the body. AFB could not be isolated in any case.

The initial CR-USGs were done within 48 hours of hospitalization in most of the cases; in a few cases, mostly TBM, this period had to be extended upto 72 hours because of initial diagnostic dilemma and technical difficulties like intervening holiday. The CR-USG findings in ABM and TBM are shown in *Table I.* Ten out of 20 (50%) cases of ABM and all the 15 (100%) cases of TBM had abnormal initial CR-USG. The abnormalities occurred in combination in most of the cases. Abnormal CR-USG was more common in TBM than ABM. Ventricular dilatation was the most common finding in both the groups; it was generalized in all (100%) cases of TBM and 5 (25%) cases of ABM. Ventriculitis and abscess were seen only in ABM.

CR-USG could be repeated in 8 out of 10 cases of ABM with abnormal initial CR-USG (2 cases died before 10 days) and 9 out of 15 cases of TBM (6 cases died before 28 days). The findings of repeat CR-USG are shown in *Table I.* Several abnormalities present in the initial CR-USG disappeared in the repeat ones in both ABM and TBM. In one case of ABM all the initial abnormalities disappeared; in TBM, however, none showed complete normalization.

The correlation between the CR-USG findings and the parameters of course and prognosis are shown in *Table II.* The incidence of coma (all grades taken together), the duration of hosptial stay and the incidence of neurological deficit were more common in cases of ABM with abnormal

**TABLE I**—*Initial and Repeat CR-USG Findings in ABM and TBM*

| Findings | Initial CR-USG in ABM (n=20) | Repeat CR-USG in ABM (n=8) | Initial CR-USG in TBM (n=15) | Repeat CR-USG in TBM (n=9) |
|---|---|---|---|---|
| Dilated ventricles | 8 (40) | 7 | 15 (100) | 9 |
| Aqueductal block | 3 (15) | 3 | 5 (33) | 5 |
| Echogenic sulci | 5 (25) | 4 | 5 (33) | 0 |
| Ventriculitis | 3 (15) | 2 | 0 | 0 |
| Abnormal parenchymal echogenicity | 2 (10) | 1 | 1 (7) | 0 |
| Abscess | 2 (10) | 1 | 0 | 0 |
| Infarct | 0 | 0 | 1 (7) | 0 |
| Subdural effusion | 0 | 0 | 1 (7) | 0 |
| Normal study | 10 (50) | 0 | 0 | 0 |

Figures in parentheses indicate percentages.

**TABLE II**—*Ultrasonographic Abnormality and Course and Outcome in ABM*

| CR-USG status | Coma (No. of cases) | Hosptial stay in days (Mean ± SD) | Death (No. of cases) | Neurological deficit (No. of cases) |
|---|---|---|---|---|
| ABM with abnormal CR-USG (n=10) | 8 (80) | 18.5 ± 11.1 | 3 (30) | 7 (70) |
| ABM with normal CR-USG (n=10) | 3 (30) | 11.3 ± 3.4 | 0 (0) | 3 (30) |

Figures in parentheses indicate percentages.

initial CR-USG than those having normal sonograms. There were three deaths and all had abnormal initial CR-USG, the important findings in them being ventriculitis (n=2) with dilated ventricles and abscess (n=1). The neurological deficits were most severe in 2 cases in the form in multiple motor and cranial nerve deficits and marked developmental delay; one of them had ventriculitis and the other had abscess in the initial CR-USG. Out of the 17 discharged cases of ABM 7 did not have any neurological deficit and all of them had normal initial CR-USG.

CR-USG was abnormal in all the cases of TBM and no definite correlation was

ound between the sonographic findings and he prognostic parameters studied.

## Discussion

The CR-USG findings in our study are more or less similar to those in some earlier observations in ABM(1,2,4-6,7,9) and TBM(3,8). Higher incidence of abnormal CR-USG in TBM found by us has also been observed by Fisher *et al.*(3). The individual abnormalities were more or less similar in both ABM and TBM except ventriculitis and abscess which were seen only in ABM. The occurrence of ventriculitis and abscess only in ABM which has also been noted earlier(3,8) can probably be considered strongly suggestive of ABM.

The improvements noted in the repeat sonograms show the usefulness of CR-USG in motitoring the course of ABM as well as TBM. This has been shown by some earlier studies in ABM(2,4) and few in TBM(3).

Most of the earlier studies on sonographic evaluation of meningitis were done at different times after diagnosis and also mostly in complicated meningitis. The present study shows that sonographically detectable abnormalities can develop in ABM and TBM quite early in the course of these diseases even before one suspects a complication (all the CR-USGs in this study were done within 72 hours of hospitalization). Rosenberg *et al.*(2) who studied 23 cases of ABM sonographically soon after initial diagnosis, also observed abnormalities in almost all of them.

Analysis of the study parameters on course and outcome shows that cases of ABM having abnormal CR-USG done soon after initial diagnosis are likely to have increased morbidity, mortality and sequelae. If the initial CR-USG is normal, better outcome can be expected. CR-USG done early in the course of ABM can thus be used as a prognostic indicator of the disease. Abnormal CR-USG in cases of ABM should act as a warning to the caring physician. Of the individual abnormalities, ventriculitis and abscess appear to carry poor prognosis.

It is felt that because of being safe, non-invasive, easy to repeat and cheaper than CT, CR-USG should be done in all cases of ABM and TBM with open AF soon after initial diagnosis as has also been suggested by Rosenberg *et al.*(2).

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