Short reports

Repeat lumbar puncture in the diagnosis of meningitis

Case report

A 10-week-old baby boy was admitted with a 14-hour history of continuous screaming. He had vomited several times and passed a loose yellow stool. Before this illness he had been well. He was the first child of a 20-year-old mother and was a term normal delivery. Primary immunisation had been started.

On admission he was febrile (39°C), irritable, and cried throughout examination. Pulse 200/minute and regular. Head circumference 41·5 cm. Pupils were equal in size and reaction. Optic fundi were normal. There was no neck stiffness, but tone was increased. Blood pressure 105/60 mm Hg. Other abnormalities noted were an umbilical hernia and a moderately severe monilial napkin rash with satellite lesions. A provisional diagnosis of meningitis was made. Lumbar puncture was normal. WBC (13 000 mm<sup>3</sup> (13 × 10<sup>9</sup>/l) and 63% neutrophils), plasma electrolytes, calcium, and glucose were normal. Blood cultures were done (Table 1).

Eleven hours after admission the infant’s condition had deteriorated. He now had a cerebral cry and grunting respirations. Chest x-ray showed a patchy opacity in the right lower zone and a repeat WBC (14 000/mm<sup>3</sup> (14 × 10<sup>9</sup>/l) and 72% neutrophils) was suggestive of a bacterial infection. Intravenous gentamicin and penicillin were started.

One hour later the infant had a constricted left pupil and intermittently the eyes deviated to the right. Head circumference now was 42 cm. The fontanelle was full and the optic disc margins were blurred.

Bilateral subdural taps were performed and 0·5 ml blood-stained fluid was obtained on the right and only a few drops on the left. The glucose in this fluid was reduced (0·55 mmol/l; 9·9 mg/100 ml) and a second lumbar puncture was performed 14 hours after the first, and 28 hours after the onset of symptoms. This cerebrospinal fluid (CSF) showed changes compatible with bacterial meningitis (Table 1).

Treatment with gentamicin and penicillin was continued. The infant’s condition gradually improved, but on the third day of illness the head circumference increased to 42·8 cm and he again became pyrexial. Subdural taps were repeated and 5·0 ml fluid was obtained from the right side. He was discharged well on the 20th day. Six weeks after the onset of the illness he had increased tone on the right and a normal electroencephalogram. No organism was isolated from blood cultures. One CSF specimen grew a few colonies of a Gram-negative diplococcus, but these did not grow in subculture. No meningococcal antibodies were isolated from the CSF.

Discussion

The chances of unscathed survival from neonatal and infant meningitis are small (Heckmatt, 1976). The situation can be improved in three ways: swift diagnosis, improved therapy, or by prevention. Lorber (1976) has shown that intensive treatment

<table>
<thead>
<tr>
<th>Time after onset of illness (h)</th>
<th>Time after admission (h)</th>
<th>WBC (10&lt;sup&gt;9&lt;/sup&gt;/l)</th>
<th>RBC (10&lt;sup&gt;9&lt;/sup&gt;/l)</th>
<th>Protein (g/l)</th>
<th>Globulin</th>
<th>Sugar (mmol/l)</th>
<th>Culture</th>
<th>Gram stain</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>1</td>
<td>1</td>
<td>0.240</td>
<td>0.54</td>
<td>Slight increase</td>
<td>3·6</td>
<td>Nil</td>
<td>No organisms seen</td>
</tr>
<tr>
<td>27</td>
<td>13 (Subdural fluid)</td>
<td>--</td>
<td>Masses</td>
<td>--</td>
<td>--</td>
<td>0.55</td>
<td>Gram-negative diplococci</td>
<td>No organisms seen</td>
</tr>
<tr>
<td>28</td>
<td>14</td>
<td>4·8</td>
<td>1·8</td>
<td>6·0</td>
<td>Great increase</td>
<td>0·55</td>
<td>Nil</td>
<td>Polymorphs</td>
</tr>
<tr>
<td>70</td>
<td>56</td>
<td>25·0</td>
<td>0</td>
<td>6·0</td>
<td>Great increase</td>
<td>2·1</td>
<td>Nil</td>
<td>Polymorphs</td>
</tr>
<tr>
<td>94</td>
<td>80</td>
<td>0·154</td>
<td>0·004</td>
<td>2·8</td>
<td>Increase</td>
<td>2·85</td>
<td>Nil</td>
<td>Polymorphs</td>
</tr>
</tbody>
</table>

Conversion: SI to traditional units—Glucose 1 mmol/l = 18 mg/100 ml.
has much to offer. The purpose of this report is to emphasise the principal pitfalls in early diagnosis.

Many authors have stressed the insidious onset of meningitis in early life. The symptoms have included virtually any alteration in the infant's pattern of behaviour. Often irritability or loss of interest in feeds is the only clue (Yu and Grauau, 1963). The signs may be slight and the temperature may be raised, normal, or low. Neurological signs appear only later (McCracken and Shinefield, 1966).

The case presented, although just out of the neonatal period, illustrates all these points. In addition it demonstrates the rapid progression from nonspecific ill-health with negative blood and CSF bacteriology to grave illness with classical CSF changes of purulent meningitis.

Heckmatt (1976) described 2 patients with neonatal meningitis and negative CSF findings. The first blood culture and repeat CSF examination were positive. Rapkin (1974) described 5 patients with bacterial meningitis of diverse aetiology, aged between 10 hours and one year. All 5 had a negative lumbar puncture, but the initial blood culture was positive. After the blood culture a second lumbar puncture was performed at a varying time after the first and all showed changes of purulent meningitis. He concluded that bacteraemia or septicaemia implied the likelihood of meningitis and that it was essential that meningitis be excluded with certainty.

A positive blood culture made a repeat puncture mandatory. Fischer et al. (1975) reported 11 patients in whom the initial CSF was negative, but both the blood culture done at that time and the second CSF sample grew an organism.

These papers raise two questions. Does a lumbar puncture in the presence of bacteraemia produce meningitis? A cisternal puncture in bacteraemic dogs may produce meningitis but there is no evidence that this occurs with lumbar puncture in bacteraemic children (Shinefield, 1975). Does a positive blood culture make a second lumbar puncture mandatory? Fischer et al. (1975) felt that a positive blood culture made careful observation of the patient essential and that any deviation from the expected clinical course warranted a repeat lumbar puncture. However the exception is the neonate, who because of the paucity of clinically reliable signs should have a repeat CSF when blood culture is positive.

The case presented here differs from the 18 cited in that the initial blood cultures were negative and the CSF changes were more rapid (Table 2). It emphasises that a single negative lumbar puncture does not rule out meningitis, and that a repeat examination is indicated if the clinical condition deteriorates. If meningitis is suspected blood cultures should be taken at the time of the initial CSF examination. In the newborn and the very young child a positive blood culture indicates the need for a repeat CSF puncture without waiting for clinical deterioration. Other indications for repeat CSF examinations are the differentiation between blood of traumatic origin and that arising from the pathological process of *Escherichia coli* meningitis (Heckmatt, 1976), or between bacterial and viral meningitis (Feigin and Shackleford, 1973); as a guide to the effects of treatment; or an indication when to stop treatment (Lorber, 1976).

Repeat puncture can help diagnosis and management. It should be considered wherever clinical and laboratory evidence appear to be in conflict.

### Summary

Meningitis may be difficult to diagnose. If it is suspected clinically and a first lumbar puncture is normal, a second cerebrospinal fluid (CSF) sample may be required within a few hours to confirm the diagnosis. A child is presented in whom CSF was normal 14 hours after the onset of illness, but who 14 hours later showed the characteristic changes of purulent meningitis. This case differs from those previously cited in the literature, in that the blood cultures taken at the time of the first lumbar puncture were also negative.

### Table 2 Relationship between initial blood culture and second CSF

<table>
<thead>
<tr>
<th>Age of onset</th>
<th>Initial blood culture result</th>
<th>Result of second CSF sample* (WBC)</th>
<th>Time interval† (h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 months</td>
<td><em>Diplococcus pneumoniae</em></td>
<td>110/mm³; Gram-positive diplococci</td>
<td>16</td>
</tr>
<tr>
<td>1 year</td>
<td><em>Haemophilus influenzae</em></td>
<td>8000/mm³; Gram-negative rods</td>
<td>48</td>
</tr>
<tr>
<td>2 months</td>
<td>Group A β-haemolytic streptococcus</td>
<td>950/mm³; No growth</td>
<td>48</td>
</tr>
<tr>
<td>10 hours</td>
<td><em>Listeria monocytogenes</em></td>
<td>6400/mm³; Gram-positive rods</td>
<td>14 days</td>
</tr>
<tr>
<td>15 days</td>
<td><em>Escherichia coli</em></td>
<td>1500/mm³; Gram-negative rods</td>
<td>20 days</td>
</tr>
<tr>
<td>8 months</td>
<td><em>Neisseria meningitidis</em></td>
<td>4250/mm³; Gram-negative diplococci</td>
<td>24</td>
</tr>
<tr>
<td>15 months</td>
<td><em>Haemophilus influenzae</em></td>
<td>2554/mm³</td>
<td>24</td>
</tr>
<tr>
<td>1 day</td>
<td><em>Escherichia coli</em></td>
<td>1880/mm³</td>
<td>24</td>
</tr>
<tr>
<td>4 years</td>
<td><em>Haemophilus influenzae</em></td>
<td>3970/mm³; Gram-negative rods</td>
<td>4 days</td>
</tr>
</tbody>
</table>

Cases 1–5 from Rapkin (1974); Cases 6–9 from Fischer et al. (1975).

*All initial CSF examinations gave negative results.

†The time interval between first and second CSF examinations.
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References


Note added in proof: Since submission of this report we have seen a febrile, unwell 4-year-old boy in whom the interval between the negative initial lumbar puncture and the positive (*Neisseria meningitidis*) second lumbar puncture was 8 hours. The first blood culture was sterile, while the second blood culture grew the organism.

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Significance of intracranial bruits in neonates, infants, and young children

The presence of an intracranial bruit (ICB) was first recorded by Fisher (1834). Reports suggest several possible causes of ICBs in infants and children. Local factors include cerebral arteriovenous fistulae and meningitis (Allen and Mustian, 1962; Mace et al., 1968). General factors that have been incriminated are anaemia, pyrexia, hyperthyroidism, and exercise (Allen and Mustian, 1962; Ford, 1966).

In studies confined to children, ICBs have been heard in 5–29% of otherwise normal children (Moore and Baumann, 1969). On closer analysis, some workers have found an equal incidence in young infants and older children (Hughes and Todd, 1953), while others report a lower incidence in infants (Mace et al., 1968).

Furthermore, controversy also exists regarding the frequency of ICBs with associated cardiac murmurs (Hughes and Todd, 1953; Farahmand et al., 1964).

The present study was therefore undertaken to analyse the aetiology and significance of ICBs in the age range one day to 3 years, as well as the relationship of ICBs to cardiac murmurs which was felt to have some relevance in the diagnosis of cerebral arteriovenous fistulae in children presenting with cardiac failure.

Patients and methods

Initially 76 children aged one day to 3 years chosen randomly from a children's hospital and neonatal section of a maternity hospital were examined. In each case the patient was auscultated for the presence of an ICB as well as a cardiac murmur. General factors which could possibly predispose to ICBs were noted, particularly anaemia. All the patients were normothermic.

The results showed that it was necessary to increase the numbers of subjects with cardiac murmurs, particularly the very young infants. A further group of patients with cardiac murmurs and associated cardiac abnormalities, also chosen randomly, was therefore examined.

The patients were divided into two main groups. Group A consisted of 56 subjects who were normal neonates, premature infants, or children with medical conditions—such as respiratory distress syndrome, gastroenteritis, cerebral damage, nutritional disorders, and neonatal jaundice—but who had no cardiac murmurs. Group B consisted of 102 subjects with cardiac murmurs.

The patients in each group were further subdivided into three age ranges: 1 day to 1 month (36 in group A, 38 in group B), >1 month to 4 months (7 in group A, 31 in group B), and >4 months to 3 years (13 in group A, 33 in group B) (Figure).

Using the bell and diaphragm of the stethoscope, and with the patient quiet and at rest, the skull was auscultated over the vertex, the temporal areas, and the occiput. ICBs were classified into three grades according to the classification of Mace et al. (1968): grade I, short systolic bruit heard only between respirations after careful auscultation; grade II, systolic bruits easily heard but obliterated by respiratory sounds; and grade III, pansystolic or continuous bruits heard above the sounds of respiration. Carotid artery compression was not applied.
Repeat lumbar puncture in the diagnosis of meningitis.

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**Erratum**

Table 1 p. 590 (July issue) in the Short Report 'Repeat lumbar puncture in the diagnosis of meningitis' should be as follows:

<table>
<thead>
<tr>
<th>Time after onset of illness (h)</th>
<th>Time after admission (h)</th>
<th>WBC ($\times 10^6$/l)</th>
<th>RBC ($\times 10^6$/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>1</td>
<td>1</td>
<td>240</td>
</tr>
<tr>
<td>27</td>
<td>13</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(Subdural fluid)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>14</td>
<td>4800</td>
<td>1800</td>
</tr>
<tr>
<td>70</td>
<td>56</td>
<td>25000</td>
<td>0</td>
</tr>
<tr>
<td>94</td>
<td>80</td>
<td>154</td>
<td>4</td>
</tr>
</tbody>
</table>