SHORT ARTICLE

Meningitis complicated by subdural empyema and deafness caused by pneumoccoccal serotype 7F in a 17-month-old child: a case report

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Key words

Meningitis • Pneumococcal conjugate vaccines • *Streptococcus pneumoniae*

Summary

Despite the availability of effective antibacterial agents and vaccines, pneumococcal meningitis and sepsis are still associated with high mortality rates and a high risk of neurological sequelae. We describe the case of a 17-month-old boy vaccinated with heptavalent pneumococcal conjugate vaccine (PCV7) who developed bacterial meningitis complicated by subdural empyema and deafness caused by Streptococcus pneumoniae serotype 7F. The 7F strain is not contained in PCV7 (the only vaccine on the market at the time of the onset of meningitis) but is included in the new pediatric 13-valent PCV, which may therefore prevent cases such as this in the future.

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Introduction

The most frequent cause of bacterial meningitis in many countries is *Streptococcus pneumoniae* [1], which is estimated to be responsible for about 10% of all deaths of children aged 1-59 months worldwide [2]. In Italy, the average annual incidence of meningitis due to *S. pneumoniae* is 4/100,000 inhabitants among children aged less than one year, and 1-1.5/100,000 inhabitants among those aged 1-4 years [3].

Despite the availability of effective antibacterial agents and vaccines, pneumococcal meningitis and sepsis are still associated with high mortality rates [4, 5] and serious sequelae, including 30% of the cases of neurological handicap (i.e. spasticity, paresis or epileptic disorders), 19% of the cases of mental retardation, and frequent loss of hearing [6].

The heptavalent pneumococcal conjugate vaccine (PCV7) has played a major role in reducing the incidence of diseases related to pneumococcal infection [7, 8]. It is estimated that it is 91% efficacious in preventing invasive pneumococcal diseases due to the strains covered by the vaccine [2], and it has also been found to protect unvaccinated children and adults as a result of herd immunity [9]. However, there has recently been an increase in the incidence of pneumococcal meningitis related to serotypes not contained in PCV7 [10].

We describe the case of a 17-month-old child vaccinated with PCV7 who developed bacterial meningitis complicated by subdural empyema and deafness caused by *S. pneumoniae* serotype 7F. The 7F strain is not contained in PCV7 (the only vaccine on the market at the time of the onset of meningitis) but is included in the new pediatric 13-valent PCV, which may therefore prevent cases such as this in the future.

Case report

The 17-month-old boy was born by means of eutocic delivery, and experienced a physiological neonatal period and normal psychomotor development. He was vaccinated with three doses of hexavalent vaccine, PCV7 and meningococcal C vaccine after three, five and 12 months of life. His remote pathological anamnesis was not characterised by any disease of note.

The child was brought to our Emergency Department because of the appearance of a convulsive crisis in hyperpyrexia (maximum rectal temperature 39.5°C) associated with vomiting. Upon admission, mild rigor was observed with a positive Brudzinski sign in the absence of any other focal signs of infection. A lumbar puncture was performed and revealed the presence of turbid liquor, hyperproteinorrhachia and hypoglycorrhachia (white blood cell [WBC] count 1,460/mm^3; proteins, 234 mg/dL; glucose 1 mg/dL), with evidence of soluble *S. pneumoniae* antigen positivity. Blood chemistry tests revealed an increase in the indices of inflammation (WBCs 7,660/mm^3; neutrophils 75.1%; C-reactive protein 268 mg/L). An electroencephalogram showed the presence of diffuse slow anomalies in the absence of focal or paroxysmal anomalies.

Intravenous antibacterial therapy with ceftriaxone (100 mg/kg/day) and vancomycin (40 mg/kg/day) was started. Vancomycin was discontinued after three days

because the cerebrospinal fluid (CSF) and blood cultures were positive for ceftriaxone-sensitive *S. pneumoniae*. Polymerase chain reaction (PCR) typing of the bacterial strain subsequently identified an infection due to serotype 7F.

The child initially showed a fair clinical response, with an improvement in blood chemistry parameters (WBCs 5,840/mm^3; neutrophils 65.4%; C-reactive protein, 110 mg/L) and an improvement in the CSF obtained 72 hours after the beginning of therapy (WBCs 100/mm^3; proteins 178 mg/dL; glucose 39 mg/dL; negative CSF culture). However, although there were some signs of a response to the chosen treatment, he continued presenting daily peaks of fever, and a physical examination revealed the persistence of slight rigor nuchalis and difficulty in maintaining a seated or erect posture. For this reason, despite the improvement in blood chemistry values (WBCs 4,970/mm^3; neutrophils 52.3%; C-reactive protein 33 mg/L), a further lumbar puncture was performed about ten days after admission that revealed clear CSF with WBCs 60/mm^3, proteins 78 mg/dL and glucose 43 mg/dL; the CSF culture was negative, as was a PCR search for *S. pneumoniae*.

Brain and spinal magnetic resonance (MR) imaging with contrast revealed the presence of a pool of purulent fluid along the right hemisphere without any apparent mass effect and the absence of parenchymal injuries (Fig. 1A). Consequently, ceftriaxone was discontinued, and double intravenous antibacterial therapy with meropenem (100 mg/kg/day) and vancomycin (40 mg/kg/day) was started. A control electroencephalogram showed the presence of a substantial amount of polymorphic, slow and intermittent theta-delta activity with a medium-large amplitude on the left occipital sector, particularly during sleep and awakening.

After about 10 days of the new treatment, hyperpyrexia persisted and was associated with occasional episodes of vomiting. The neurological picture was stationary, and there was a new increase in the inflammation indices (WBCs 12,890/mm^3; neutrophils 82.3%; C-reactive protein 173 mg/L). It was therefore decided to repeat the brain and spinal MR imaging, which revealed a worsening in the radiological picture with an increase in the narrow, extra-cerebral, right hemisphere parieto-occipital pool (Fig. 1B). Brain computed tomography (CT) confirmed the presence of a narrow (maximum width 3 mm), hypodense extracerebral pool with a right parieto-occipital subdural localisation that was compressing the underlying parenchyma.

For this reason, the child underwent emergency neurosurgery and the fluid was removed by means of burr hole drainage. The subsequent control brain CT scan was negative for intracranial hemorrhaging and alterations in the encephalic parenchyma.

The post-operative course was characterided by the immediate complete remission of fever, and the normalisation of the inflammation indices. Antibiotic therapy with meropenem and vancomycin was continued for seven days. There was a significant neurological improvement, and the child recovered his ability to walk. However, brainstem auditory evoked responses (BAERs) and audiometry revealed profound sensory hypoacusia and the child received a cochlear implant. One year later, he is attending speech therapy and psychomotricity sessions with good results. No underlying immunological disorder was detected to explain this complication.

Fig. 1A. MR image showing a pool of purulent fluid along the right hemisphere without any apparent mass effect, and the absence of parenchymal injuries.

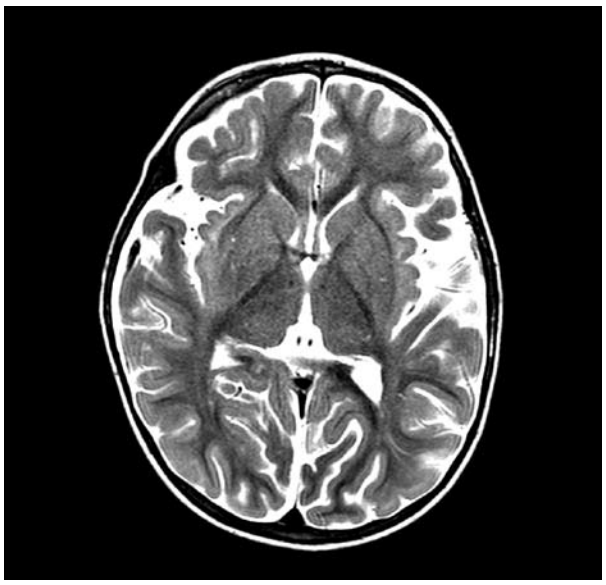
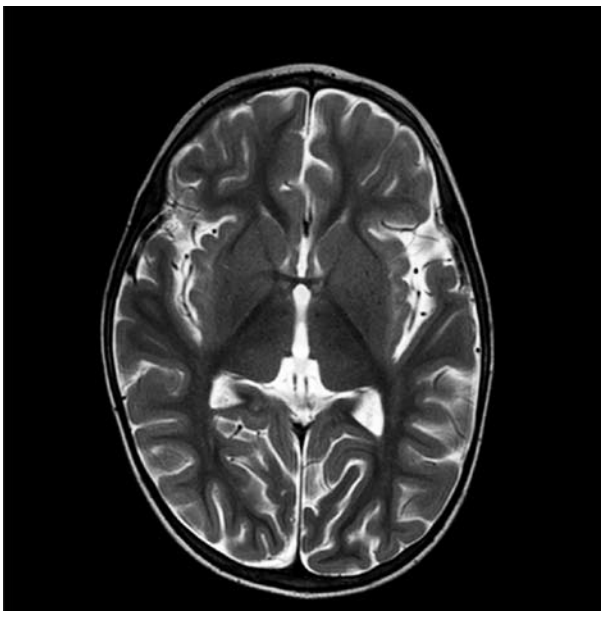


Fig. 1B. MR image showing the worsened radiological picture, with an increase in the narrow, extra-cerebral, right hemisphere parieto-occipital pool of fluid.



Discussion

Subdural empyema is a serious complication of pediatric bacterial meningitis, accounts for 15-20% of all localised intracranial infections, and represents a neurosurgical emergency. Its appearance is rarer in children than adults [11] but, as in our case, it seems to be more frequently associated with persistent fever during adequate antibacterial therapy and no neurological improvement. In the case of bacterial meningitis, the persistence of fever with pathological neurological symptoms should therefore arouse a suspicion of subdural empyema and all of the emergency diagnostic procedures should be carried out because an early diagnosis infact makes it possible to undertake appropriate neurosurgery with the aim of improving the prognosis.

To diagnose subdural empyema in the presence of any clinical suspicion, brain CT is generally used because it is usually the most rapidly available neuroimaging technique, although MR is more sensitive in revealing anomalies of the cerebral parenchyma. Once the diagnosis has been made, it is equally important to drain the empyema as soon as possible in order to improve the prognosis of the patient. This may be done by means of burr hole drainage (as in our case) or craniotomy, but recent studies have shown that the former is the least invasive and most effective neurosurgical procedure, and particularly suitable for infants and young children [12].

Our case also showed that pneumococcal meningitis can be associated with deafness. Hearing loss is still a major cause of disability among the survivors of meningitis due to *S. pneumoniae*, even in the case of adequate antibiotic therapy [13]. *S. pneumoniae* can cause cochlear ossification, which can subsequently hinder surgical correction and prevent a favourable outcome. It is therefore essential to correct the defect promptly: the rapid placement of a cochlear implant can reduce the risk of ossification and favour surgical success [13, 14].

The introduction of PCV7 has reduced the incidence of pneumococcal meningitis, but there are still many pneumococcal serotypes that are not covered by the vaccine. The use of PCV13 can further reduce the incidence of invasive pneumococcal disease, but it is still necessary to continue active surveillance of the circulating pneumococcal serotypes using new and highly sensitive diagnostic methods such as PCR. The collection of complete epidemiological data will provide the basis for the development of vaccines that can provide broader protection and therefore further reduce the mortality and sequelae due to pneumococcal meningitis.

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