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Neurosurgical Management of Recurrent Meningitis in Children

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Abstract We report two cases of recurrent meningitis in children. One was caused by a congenital bone defect and the other was a traumatic bone fracture on congenital fragile bones of the cribriform plate, the skull base roof of anterior ethmoidal sinuses. Recurrent meningitis in two cases was completely cured by neurosurgical repair of the cribriform plate. Neurosurgical repair operations are useful for recurrent meningitis in children resulting from congenital anatomical lesions of the skull base.

Key Words : Children, Neurosurgical Repair, Recurrent Meningitis

Introduction

Recurrent meningitis occasionally results from congenital anatomical abnormalities, for example, skull base bone defects or fractures, which cause infection of the intracranial central nervous system[1]. We report two cases of recurrent meningitis in children caused by a congenital bone defect and a traumatic fracture on naturally fragile bones of the cribriform plate, the roof of anterior ethmoidal sinuses. Both cases were completely cured by neurosurgical repairs. Furthermore, we discuss the neurosurgical management of recurrent meningitis, especially the indication and operative techniques.

Case Reports

Case 1

A 9-year-old girl was admitted to our hospital for recurrent meningitis. She had previously had four episodes of bacterial meningitis (twice at six years old and once at seven and eight years old), which were complicated with typical meningitis symptoms of high fever, headache and vomiting. In three times, Streptococcus pneumoniae was detected in the cerebrospinal fluid (CSF). She recovered by treatment with intravenous antibiotics, ampicillin sodium (ABPC), infusions. She had no history of medical problems such as immunodeficiency diseases, nasopharyngeal diseases or head trauma. On admission, she had no symptoms or signs of meningitis, no liquorrhea and no neurological deficits. The results of a blood examination including immunological examination were all within normal limits. The CSF examination showed a protein level of 55 mg/dl, a sugar level of 51mg/dl, a cell count of 17/3. No bacteria were identified on CSF culture examinations. Plain craniography showed no abnormalities, but a bone defect of the roof of the right ethmoidal sinus was suspected on plain cranial tomography. Radioisotope cis-

ternography showed no image of leakage or accumulation of isotope tracers into the adjacent sinuses. A brain CT scan showed no abnormal intracranial lesions. However, high resolution direct coronal thin section CT (2mm slice) revealed a bone defect of the right cribriform plate, the roof of anterior ethmoidal sinuses (Fig. 1). A brain MRI scan (SE 400/30) showed no abnormal organic lesions which cause bone defect at the same region (Fig. 2). The recurrent meningitis would be caused by a focal bone defect of the right cribriform plate and we planned neurosurgical repair. We identified the small congenital bone defect on the right cribriform plate extradurally during the right frontal craniotomy. We repaired it closely with periosteum and a piece of an internal laminal bone from the frontal free bone (Fig. 3). In this operation, no other abnormal lesions or infected tissues were noted intra-and extradurally. After this operation, she was discharged without complications. To date, she has not suffered from meningitis over six years.

Case 2

A 4-year-old boy was involved in a traffic accident and hit his right mandible. Two days later, he suffered from high fever, headache and vomiting and was admitted to our hospital. On admission, he showed neurologically neck stiffness. A blood examination showed a white blood cell count of 11900/mm^3 and a CSF examination showed a sugar level of 56 mg/dl and a cell count of 1 152/3. Alpha streptococcus was identified in the CSF culture. He recovered at once with intravenous infusion of ABPC but after 12 days there was a recurrence of meningitis. Plain cranial tomography revealed a possible bone fracture on the roof of the right ethmoidal sinuses. Radioisotope cisternography showed no leakage or accumulation images of isotope tracers. High resolution direct coronal thin section CT (2 mm slice) revealed the bone defect or the thinning of bone of the right cribriform plate (Fig. 4). The recurrent meningitis would be caused by a focal bone fracture of the right cribriform plate, which was thin by nature, due to head trauma and surgical repair was planned. We

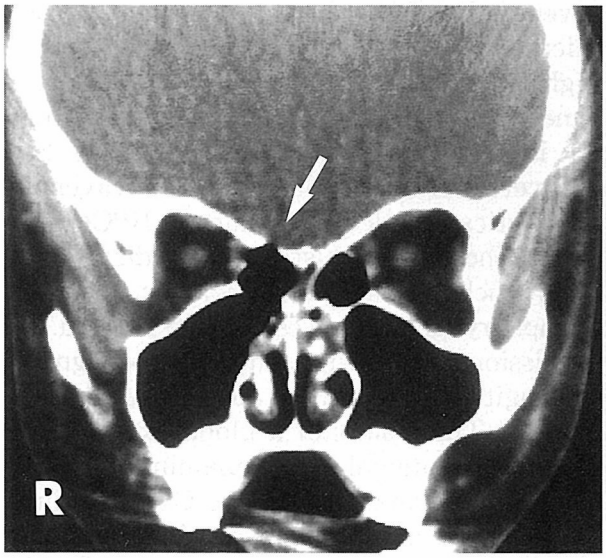

Fig. 1. Case 1. The high resolution CT (direct coronal thin section, 2mm slice) shows bone defect of the right cribriform plate, the roof of anterior ethmoidal sinuses (arrow).

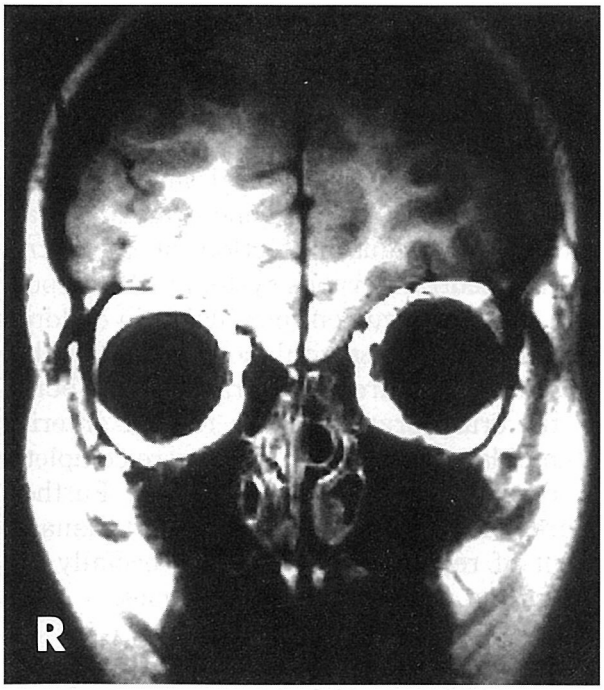

Fig. 2. Case 1. MRI image (SE 400/30) reveals no abnormal organic lesions causing the focal bone defects at the right cribriform plate.

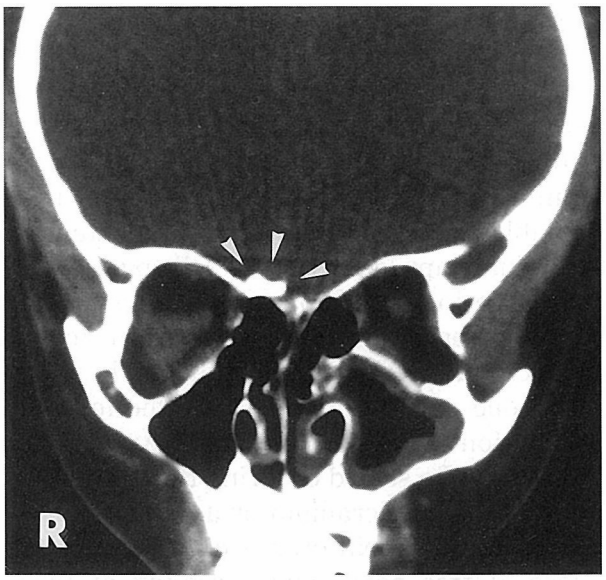

Fig. 3. Case 1. The post-operative high resolution CT shows cranioplasty with a piece of bone (arrowheads).

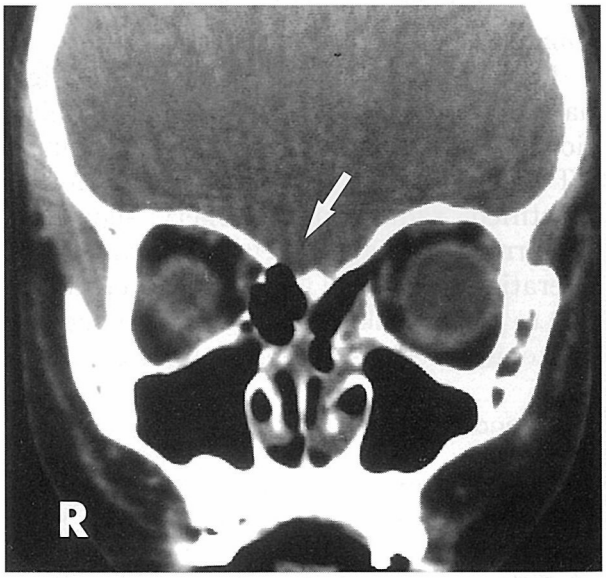

Fig. 4. Case 2. The high resolution CT (direct coronal thin section, 2mm slice) shows bone defect of the right cribriform plate (arrow).

identified the linear bone fracture and the small defect on the thin cribriform plate and repaired it with temporal muscle and femoral fascia. After this operation, he was discharged free of complications. To date, he has not suffered from meningitis over ten years.

Discussion

Etiology

Recurrent meningitis generally means recurrence of meningitis twice or more after complete recovery of the symptoms, signs and laboratory data of bacterial meningitis[2,3]. The incidence of recurrent bacterial meningitis is 2.1-6.0%[2,4,5] in children.

The two main causes are considered to be from systemic diseases, for example, the immunodeficiency disease[6], and focal infections of the central nervous system. The latter include congenital anatomical abnormalities (meningoencephalocele or dermal sinus) [7-9], brain tumors, brain abscesses, extracranial nasopharyngeal infections and head trauma[10]. Furthermore, there are unknown origins that are difficult to detect in ordinary examinations. Practically, the recurrent meningitis would be caused by a congenital small bone defect or a small bone fracture due to some minor head trauma in the skull base. A CSF leak can occur wherever the dura is lacerated by head trauma. It is likely to persist or recur rather than to close spontaneously where a meningeal hiatus is maintained by bony spicules, by dura entrapped in the edges of a fracture, or by herniating brain and leptomeninges. On the other hand, nontraumatic leaks are usually confined to one region where an anatomical defect is demonstrable. It is usually easier to demonstrate the defect than the leak. The leak occurs where the skull bone is thinnest, usually in the cribriform fossa.

Imaging techniques

Imaging techniques used to detect intracranial air, fractures and defects in the skull base and mass lesions and to demonstrate flow through the fistula. Plain craniograms and CT scans are usually performed to delineate the anatomy and pathologic state of the skull base, sinuses and calvarium. In these imagings, plain cranial tomography and radioisotope or metrizamide cisternography are useful[11], but recently direct coronal thin section CT image with high resolution is the

most useful for detecting small focal anatomical abnormalities and other organic lesions[12], which demonstrate the evidence of CSF leaks. Modern progress of MRI also provides superb detail of pathological conditions of the soft tissues at the skull base. Direct coronal CT images are used together with MRI to make the final diagnosis of the cause of recurrent meningitis.

Initial management

The initial management of CSF leaks is intended to slow or stop the leak and prevent meningitis. The patients with CSF leaks should be cared intensively including keeping head-up position and administering antibiotics. Because the causative bacteria are most often Streptococcus pneumoniae and Haemophilus influenzae, cefotaxime is usually used for the initial treatment.

Surgical management

There is a continuing debate regarding the indication of surgical management. Three points of the debate are mainly considered; 1) most CSF leaks stop spontaneously and do not recur, 2) surgery is not universally successful and 3) modern antibiotics have significantly reduced the morbidity from any infection. However, active CSF leaks can not be cured by the conservative treatments. Indications of surgical repair for the treatment of meningitis with causative lesions are considered as follows; 1) continuing severe meningitis or liquorrhea for more than several weeks, or 2) recurrent meningitis. Therefore, if recurrent meningitis is diagnosed and the causative lesion is identified, the surgical repair operation should be performed. The efficacy of surgical repair is judged by no -recurrence for more than two years after the operation. In this point of view, the present two cases are completely cured by surgical repair.

Operative technique[13]

There are two major operative approaches in the intracranial craniotomy techniques currently in combination; 1) extradural and 2) intradural approaches. The extradural approach has several limitations; occurence of dural tears, existence of cerebral tissue herniation into bone defects and difficulty of dural repairs. For these reasons, the intradural approach is usually preferred in the neurosurgical repairs. In the anterior skull base repair, a bicoronal scalp flap is turned. A craniotomy is performed ipsi-lateral to a possible CSF leakage side. A satisfactory intradural approach allows full exposure of the anterior skull base including orbital roofs, sphenoid wings and cribriform fossae. The causative fistula is confirmed by a visible bone or dural defect, an adhesion or a herniation of cerebral tissue. An obvious fistula can be sealed covering the defect with a pedicle of pericranium or a piece of fascia or muscle. To reinforce a covered patch, a piece of free bones and a sealing of fibrin glue are used additionally. If a dural defect or fistula is visualized intradurally, it shoud be sutured or covered with a sheat of obtained or artificial dura. After these procedures, dural sutures are performed to obtain watertight seals of CSF leaks.

Conclusion

Recurrent meningitis of unknown origin has to be investigated by further examinations, the best of which are high resolution CT and MRI. If the causative lesion is identified, radical neurosurgery should be performed, because neurosurgical repair operations are useful for recurrent meningitis due to active leaks resulting from congenital anatomical lesions of the skull base.

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