Cranial Reconstruction with Titanium Mesh for Open Depressed Skull Fracture in Children: Reports of Two Cases with Long-term Observation

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Summary: In the treatment of open depressed skull fracture in pediatric cases, it is preferable to use the patient’s own bone material rather than artificial material. However, there are occasions when self-material reconstruction may be impossible. In such cases the safe option is to leave the defect until future replacement of the skull becomes possible, however this often causes such children to experience severe limitations to school life. We present two thought-provoking cases in which we solved such issues by early stage cranioplasty using a titanium mesh. The first case involved a 9-year-old boy who sustained a depressed fracture in the right temporal region after falling down a riverbank. Although he underwent surgical repair, bacterial infection forced removal of the bone flap postoperatively. His school life was severely restricted and sports activities were prohibited due to the residual regional bone defect. Cranial reconstruction with a titanium mesh made it possible for him to enjoy a more active lifestyle. The second case involved a 7-year-old boy who sustained a right frontal depressed fracture in a traffic accident. The fractured skull was promptly replaced by a titanium mesh at the initial surgery due to the extreme degree of bone fragmentation. Both boys returned to school life enjoying normal activities and without any complications for up to 8 years now. The cases presented here indicate that early cranioplasty even using artificial material is not only safe but enables school age patients to participate in physical activities. From the standpoint of physical and psychological development, early stage cranioplasty with titanium mesh may be a valuable treatment option for pediatric open depressed skull fracture.

Key words depressed skull fracture, titanium mesh, children, pediatric head injury

INTRODUCTION

Open depressed skull fractures require immediate attention to prevent further propagation of bacterial infection, while non-operative management is a treatment option in the case of closed depressed fracture. [1] In immediate reconstruction, it may occasionally be difficult to use the patient’s own bone material for various reasons. Use of artificial material in pediatric cases has not yet been widely accepted due to safety concerns. Leaving the bone defect without reconstruction is considered to be a safe option in general.

We report herein two thought-provoking cases in which cranial reconstruction using titanium mesh was performed for depressed skull fractures.

CASES REPORT

Case 1: A 9-year-old boy
The patient fell 3 m and hit the right temporal region of his head on a rock. On arrival at our hospital, he was alert and had no neurological deficit. Computed tomography (CT) revealed a round depressed fracture with a diameter of 3 cm in the ipsilateral temporal region (Fig. 1a,b). We initially chose...
conservative observation according to the treatment option of closed skull fractures because there were no apparent findings of either regional skin laceration or leak of cerebrospinal fluid.[1] After 10 days of observation, the patient underwent reconstructive surgery for cosmetic reasons. The depressed skull was hammered out following simple craniotomy encircling the depressed fracture, and then the reconstructed skull was re-fitted. Unfortunately, bacterial infection forced evacuation of the skull once again about 10 days postoperatively. The skull bone was kept under deep freeze for 6 months, then was re-fitted again after simple disinfection by washing and high temperature autoclaving. Infection was successfully prevented, but the skull slowly disintegrated. A protective hat was used over this defect for almost a year, despite considerably impeding his activity in school. At every outpatient visit the patient appealed to the attending doctor to be able to play baseball, volleyball or other school sports. To enable a more active lifestyle, skull-plasty using titanium mesh was performed 8 months after the third operation (Fig. 1c). No complications such as infection or allergic reaction have been observed as of 8 years after the last surgery. The strength of the mesh is sufficient to allow the patient to play an active role in high school activities.

Case 2: A 7-year-old boy

The patient fell off his bicycle and was hit by a metal hook in the right frontal bone. No focal neurological deficit was observed, through pulsating brain beneath the lacerated dura mater was readily visible (Fig. 2a). CT definitively diagnosed open depressed fracture (Fig. 2b). Emergency operation was performed, making a hemicoronal incision in the right frontal region. The depressed part of the fracture consisted of small fragments penetrating the dura and arachnoid, causing hemorrhage and contusion inside the parenchyma. All free fragments were collected, and the lacerated dura mater was tightly sutured. Hoping to minimize any restriction of physical activity, a 5 × 5 cm square of titanium mesh was used to cover the skull defect after getting informed consent from the patient’s family (Fig. 2c). The patient was discharged without any complications and rejoined school after a minimal absence. Regarding cosmetic features, a gap was initially palpable at the edge of the mesh (Fig. 2d), but this gradually dissipated and had totally disappeared by about 3 years postoperatively as a result of good adaptation of the metal substance to the skull curve (Fig. 2e).

DISCUSSION

In pediatric neurosurgery, cranial reconstruction using original autologous bone has been advocated as a first choice because it maintains the proper contour of the skull and safety of the use of foreign materials in the skull is not established yet for young children. The cases presented here have three things in common. The patients were both elementary school age, their bone flaps were non-reusable for reconstruction, and cranioplasty with artificial materials was performed at an early stage. Generally, in cases where progression of bacterial infection may impede cranial reconstruction, or the comminuted fracture no longer allows robust reconstruction, the safe option is to leave the defect without replacing the skull, and simply wait for completion of the maturation process for about half a year. However, children with a skull defect usually experience severe limitations to physical activity at school, which may deeply impact the child’s development. School life with too many restrictions may have profound implications in young and growing children. This may substantially hinder the opportunities of the child to engage in activities, particularly physical activities at school, which may even carry a risk of unexpected alterations in the development of...
motor function or psychological profile compared to what normal counterparts may achieve or acquire. In Case 2, we decided to implement one stage cranioplasty with titanium mesh at the initial stage to avoid any psychological disadvantages that might be associated with leaving the bone defect in place, providing excellent postoperative course without infection, cosmetic problems, and psychological dysfunction. Performing immediate cranioplasty without additional steps seems to prevent the undesirable effects associated with limiting daily activity in pediatric cases. Considering children’s quality of school life, the availability of artificial material for cranioplasty could encourage performing one-step surgery at an early stage.

Titanium mesh offers distinctive advantages in terms of both lightness and plasticity, particularly in emergency situations as in case 2, which required rapid modeling with sufficient strength. Because of its plasticity, such mesh has been successfully used in undulating or morphologically complex sites such as the facial region, including reconstruction of the orbit in the case of blowout fracture.[2,3] Marbacher et al. reported five cases of open skull fracture in patients over 17 years old treated with titanium mesh as the sole reconstruction method, with no cases experiencing complications and achieving uniformly excellent results in terms of patient satisfaction.[4] Surgical site infection is a key concern,[5] however, immediate titanium mesh cranioplasty at the time of craniotomy has been shown to be safe and feasible in adult patients with postcraniotomy infections.[6,7] On the other hand, there are few reports about cranial reconstruction with titanium mesh in young children.[8] Consideration must be given to adaptations for the growing skull and robustness of the fine but fragile immature skin over the metal implant. As a small modification, we used a pair of absorbable screws in addition to metal screws to allow eventual movement of the skull underneath the mesh as the cranium grows and changes contours. In fact, Case 2 revealed that adaptation and durability of the curvature of the mesh was better than expected after 3 years of observation.

According to a recent systematic review with regards to outcomes of cranioplasty in the pediatric population, use of freshly harvested autograft results in full-recovering of skull defect without any infections or cosmetic problems, cryopreserved or autoclaved bone flaps may lead to a lower rate of infection but higher rate of bone resorption, and there are insignificant data to assess the effect of storage circumstances, timing of cranioplasty, and material used.[9] Reconstruction with autologous bone flap or graft is still reported to be the safest and most practical way to treat cranial defect in young children, however cranioplasty using titanium mesh is an optional treatment which may help improve a child’s quality of life.

CONCLUSION

In the treatment of open depressed skull fracture in young children, initial or early reconstruction with titanium mesh, based on the families’ informed consent, may help to improve the child’s physical and psychological development.

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