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Case Report

Neglected Growing Skull Fracture: Details on Peroperative Findings and Surgical Repair

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Abstract

Growing Skull Fracture (GSK) is a rare but significant complication of pediatric head trauma. It commonly develops after a head trauma with a linear skull fracture and an underlying dural tear. Delayed diagnosis and improper management can lead to severe complications. Few reports provide details on peropeartive findings and surgical management of GSF. Herein we report the case of a neglected growing skull fracture in a 2-year-old infant who suffered from an abuse head trauma at the age of three months. A progressive bulging at the site of the fracture was neglected by the family for months. CT scan of the brain showed gliotic brain tissue herniated through a large ragged skull defect. Surgery was indicated and the goals of operation were to remove safely non-viable herniated brain tissue and to protect the neural elements by restoring dural and bone defect. Surgery should be performed acutely in children with GSF to reduce the morbidity and improve outcome.

Keywords: Growing skull fracture; Surgical repair; Duroplasty; Cranioploasty

Abbreviations

GSK: Growing Skull Fracture; MRI: Magnetic Resonance Imaging

Introduction

Growing skull fracture is a very rare complication following traumatic head injury in infants and toddlers below 3 years [1,2]. It commonly develops after a head trauma with a linear skull fracture and an underlying dural tear [3]. Delayed diagnosis and improper management can lead to severe complications [2,3]. Herein we report a case of neglected GSF treated in our department. We aim to highlight the details of preoperative findings and surgical repair.

Case Presentation

This 2-year-old boy was the product of a full term pregnancy in a mother diagnosed with psychosis. He was born without complications and was routinely discharged home. At the age of 3 months, the infant presented to the emergency room of a peripheral hospital suffering from an abuse head trauma, he was severely knocked to the ground by his mother. His neurological examination was not documented well initially. A CT scan of the brain confirmed a linear left parietal skull fracture, however at that time the patient didn't require any management. Since this dramatic accident, the infant was reared by his grandmother who noted 2 months after the injury a growing scalp swelling at the site of the fracture nevertheless this bulging was neglected by the family given that the baby did very well. On admission, he was developmentally normal with a normal neurological profile. Local examination showed a left parietal soft scalp swelling of 8x6cm dimensions through a large palpable skull defect with raised edges. The overlying scalp was normal (Figure 1a and 1b). Present CT scan of the brain confirmed the diagnosis of growing skull fracture. There was gliotic brain tissue herniated through the large ragged skull defect (Figure 1c-1e). Surgery was indicated, and the father was clearly informed about the necessity and the possible risks of the operation. After parents' consent, Patient underwent surgery in the park bench position with the head secured with a Mayfield holder. A large inverted U-shaped skin incision was made, subcutaneous dissection was carried out and the scalp flap was reflected (Figure 2a). The periosteum was intact it was incised at the margins of the ragged bone and reflected to be used for duroplasty (Figure 2b and 2c). There was part of brain parenchyma herniated into the expanded diploic cavity at the outer margin of the skull defect; it was sharply dissected and separated from the inner table of the bone (Figure 2d). Using a high-speed drill, four burr holes were drilled. The dura was peeled off the inner table of the bone then the elevated skull and ragged edges were removed by connecting the burr holes with the craniotome (Figure 2e and 2f). We use the Kerrison rongers to expose the dural edge over the superior sagittal sinus and thus we obtain a satisfactory intra operative view of the limits of the normal dura (Figure 2g). The amount of herniated cerebral tissue wasn't significant it was safely dissected from the periosteum and the part of brain which was gliotic and non-viable was removed (Figure 2h and 2i). Dural defect was closed in watertight fashion using periosteum graft (Figure 2j). Cranial reconstruction was performed with polymethyl methacrylate cranioplsty (Figure 2k). And finally the skin flap was sutured in two layers (Figure 2l). The patient experienced an uneventful post-operative course. He was discharged 3 days after surgery. A CT scan prior to discharge demonstrated a slightly low density in the surgical bed and we note the good aesthetic results (Figure 3). The patient was placed on anticonvulsant during 1 month.

Discussion

The growing skull fracture terminology was put forth by Pia and Tonnis in the German literature in 1953 [4]. However, this entity also known as "posttraumatic leptomeningeal cyst" or "cranio-cerebral erosion" was first described in the year 1816 by Howship in an 8-month-old baby [5]. It's a rare complication of pediatric head trauma that accounts for less than 1% of all skull fractures [6].

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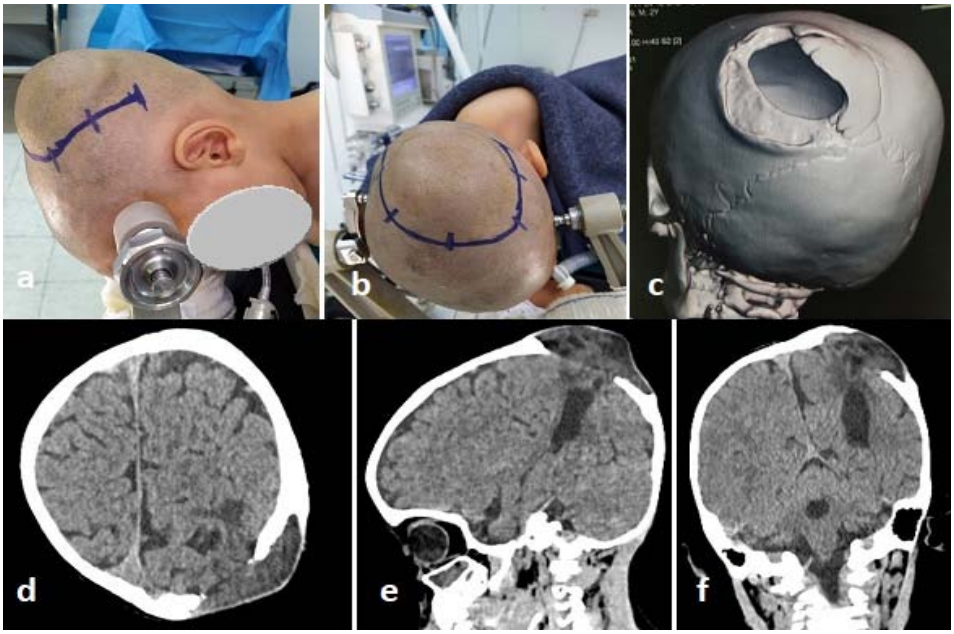

Figure 1: (a, b) photographs of a 2-year-old infant showing a large parietal scalp swelling of 8x8cm dimensions with normal overlying scalp; (c) 3D CT skull reconstruction showing more detailed information about the skull defect with ragged raised edges; (d) axial CT sections; (e) sagittal CT reconstruction; (f) coronal CT reconstruction showing retracted lateral ventricle (arrows) and brain tissue protruding from the fracture into the subgaleal space.

Three factors are necessary for the occurrence of GSF: a cranial bone fracture, an underlying dural tear and entrapment of the arachnoide membrane or brain tissue through fracture edges [7]. The rapid growth of brain during the first two years of life and the tight adhesion of the dura to the bone are well admitted hypothesis to explain the higher incidence of GSF during infancy rather than in adulthood [2,8]. The most frequent location of GSF is the parietal bone [6,9]. Common clinical features include tense scalp swelling at the site of the fracture, skull defect, seizures and progressive neurological deficits. Clinical manifestations occur within few weeks to months [1,9]. GSF is often misdiagnosed or the treatment is delayed or wrong [2]. Delayed diagnosis is typically related to the lack of awareness by front-line health care personnel.

Naim Ur Rahman et al. [10] classified GSF into 3 types based on radiological findings and the predominant factor herniating through the dural defect. Type I if there is a leptomeningeal cyst containing CSF, type II in case of herniated brain tissue and type III if there is a dilated underlying ventricle with porencephalic cyst. Liu et al. [2] identified 3 stages according to the interval between the time of the head injury and the diagnosis of GSF. Prephase is the interval from injury and before the enlargement of the fracture, the early phase is during the first 2 months in fracture enlargement and the late phase is after 2 months in fracture enlargement. In our case diagnosis was performed at the late phase and we think that it was Naim type II-III.

CT with 3D skull reconstruction is the most useful investigation tool to describe the skull defect. Most cranial defects have ragged and scalloped edges with markedly thickened or divided bone margins [3,7]. Careful examination of the herniated contents is needed since it has implications in treatment modalities to choose [1]. MRI, when available, provides more details such as the extent of dural defect, leptomeningeal cyst, encephalomalacic herniated brain, porencephalic cyst and dilatation of the ipsilateral ventricle [2, 3].

The goals of surgery are to remove safely non-viable herniated brain tissue or a leptomeningeal cyst and to protect neural elements by restoring dural and bone defect. The scalp incision must be well chosen to allow for adequate bony removal and dural repair. Thus, a large skin galea flap is recommended to obtain a satisfactory intraopeartive view [1,3,7]. Chen et al. [11] described an extremely rare case of intradiploic encephalocele following a linear skull fracture in an 8-year-old boy. They provide the imaging data of early injury confirming fractures of both the inner and outer tables of the occipital bone. The authors postulated that an intact periosteum may prohibit the protrusion of intracranial contents and could give rise to intradiploic encephalocele. In our case we noted the intact periosteum covering the herniated brain; we also noted that there was brain tissue herniated into the expanded diploic cavity. This detail was not mentioned in other reports. However we think that an intact periosteum may also explain the divided bone margins of GSF with scalloped edges. Large craniotomy encircling the deformed bone must be enough to allow the surgeon to examine the dural defect clearly and to visualize the intact dural margins [3]. The dural tear almost always extends beyond the margins of the fracture until it reaches a dural sinus and thus we have to be more careful to avoid sinus injury [2,7]. Sharp dissection of the herniated contents is needed. A leptomeningeal cyst or gliotic and non-viable brain tissue were removed [1,2].

Dural repair is an important step of the surgery [2]. Regardless the type of the dural graft used, a watertight closure is mandatory [2,3,8]. However it's usually preferred to use autologous graft [1,3]. In our case, the periosteum was taken off the bone and then reflected to be used for duroplasty. Autologous bone graft is also preferred for bone reconstruction: Rib grafts, transposition of the craniotomy flaps, split

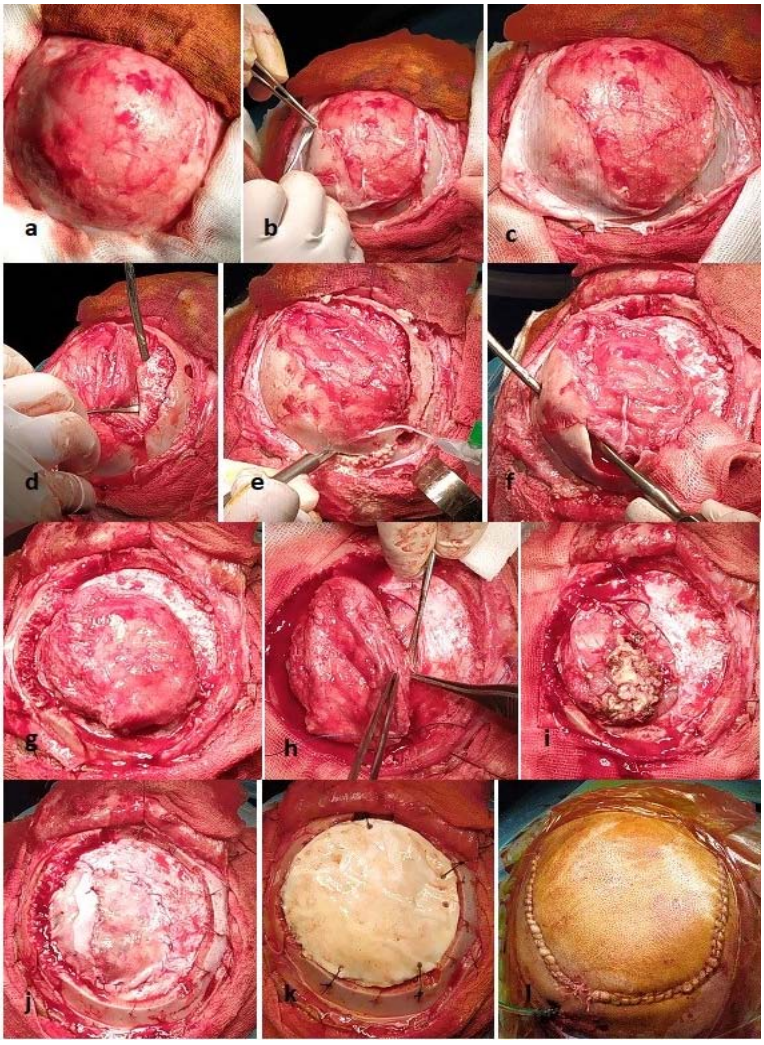

Figure 2: Intraoperative photographs presenting the steps of the surgical procedure. a) Scalp flap reflected showing the intact periosteum; b, c) The periosteum dissected at the margins of the ragged bone (stars); d) herniated brain parenchyma sharply dissected and separated from the inner table of the bone (black arrow); e, f) The dura peeled of the inner table and the everted bone removed; g) Limits of the normal dura (white arrows); h, i) Herniated cerebral tissue safely dissected from the periosteum and the gliotic tissue removed; j) Watertight suture of the dural defect using periosteum graft; k) Cranioplsty; l) Skin sutured.

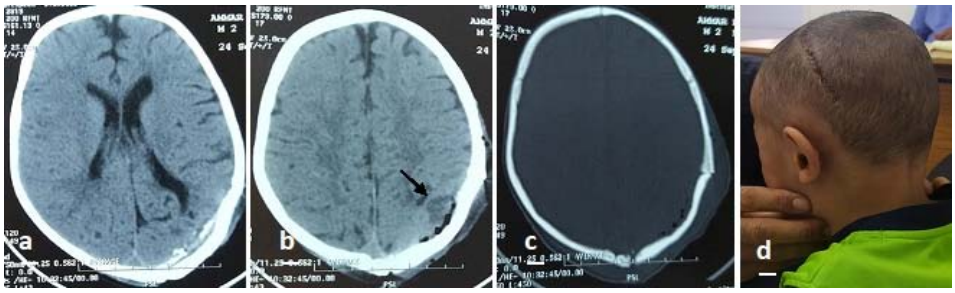

Figure 3: a, b, c) Post-operative CT scan showing a slight hypo density in the surgical bed (arrow) and the cranioplasty; (d) aesthetic results.

calvarial grafts [2,3,7]. Alloplastic materials are not recommended in growing children. In our case the bone defect was about 10 cm diameter thus to obtain a single graft we used artificial material. In Naim type 3 GSF ventriculoperitoneal shunt placement may be also needed [1,2,8].

Early recognition and meticulous repair of this type of fracture usually gives gratifying results and would reduce the morbidity and improve outcome [1,2].

To ovoid misdiagnosis, it is recommended to follow up closely all patients under the age of 3 years with a linear skull fracture with

a width of more than 4mm specially when it is located in the parietal region or associated with cephalhematoma [1,8].

Conclusion

To improve the outcome of children with GSF, front-line health care personnel must be aware about this a rare but serious complication of pediatric head trauma. Surgery should be performed acutely to reduce the morbidity.

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