Clinical Neuroscience & Neurological Research International Journal

Chembio Publishers
Right Choice for Researchers

Case Report *Volume 1; Issue 1*

Growing Skull Fracture and Diastatic Skull Fracture in Pediatric Age Group their Types and Neurosurgical Repair with Technical Note

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Received Date: August 07, 2018; **Published Date:** August 22, 2018

Abstract

Growing skull fracture or growing diastatic fractures are an important and not so common entity in infancy fracture of skull. It is characterized by the gradually enlarging fracture size with passage of time. When it becomes bigger enough it cause herniation and prolapse of brain structure and may lead to progressive neurological deficit. It treatment requires expertize in growing skull fracture micro neurosurgery and needs to close down the dural edges properly to prevent csf pulsations causing increase in size of fracture.

Keywords: Diastatic skull frature; Skull growing fracture; Childhood skull fracture; Craniocerebral erosion; Leptomeningeal cyst; Infant; Case series

Abbreviations: GFS: Growing Fracture of Skull; CSF: Cerebrospinal Fluid; DFS: Diastatic Fracture of Skull; MRI: Magnetic Resonance Imaging; SPECT: Single Photon Emission Computed Tomography; CT Scan: Computed Tomography Scanning

Introduction

Growing fracture of the skull (GFS) is a complication of head injury in pediatric age in which is skull fracture that grows with passing time. Growing skull fracture is recently termed as Craniocerebral Erosion. They are estimated to occur in 1% of linear skull fractures sustained under 3 years of age the most vulnerable age group [1]. They can present many years later with headache, seizures, and hemi paresis. It is characterized by progressive diastatic enlargement of the fracture line. This late complication is also known as a Leptomeningeal cyst because of its frequent association with a cystic mass filled with CSF [2]. The exact etiopathological process of growing skull fracture is unclear. The single most important factor in the pathogenesis of growing skull fracture is dural tear [3]. In 1961, Lende and Erickson reviewed the literature on this subject and emphasized on four essential features:

i. Skull fracture in infancy or early childhood
ii. Dural tear at the time of fracture
iii. Brain injury underlying the fracture and
iv. Subsequent enlargement of the fracture resulting in a cranial defect [4].

Citation: Pankaj K Upadhyay and G Tiwary. Growing Skull Fracture and Diastatic Skull Fracture in Pediatric Age Group their Types and Neurosurgical Repair with Technical Note. Clin Neuro Neurological Res Int J 2018, 1(1): 180003.

Definitions

Growing skull fracture

A growing skull fracture (GSF) also known as a craniocerebral erosion or leptomeningeal cyst due to the usual development of a cystic mass filled with cerebrospinal fluid is a rare complication of head injury usually associated with linear skull fractures of the parietal bone in children under 3.

Pseudomeningeocele

Abnormal collection of cerebrospinal fluid that communicates with the CSF space around the brain and spinal cord.

Diastatic skull fracture

Diastatic fractures occur when the fracture line transverses one or more sutures of the skull causing a widening of the suture.

Cranioplasty

Surgical repair of a defect or deformity of a skull.

Case Report

A 5 year old female patient presented with gradually progressive right parietal occipital swelling and seizures of 12 months duration. There was history of fall from height 12 months back following which she developed progressive, soft to firm, swelling of right parieooccipital region and episodic seizures and occasional vomiting along with tightness of swelling. The patient was initially managed with anti epileptics, and underwent radiological investigations. Plain X-ray skull (Figure 1), Computerized tomography (CT scan), M.R.I. Studies, clearly demonstrated the extent of bony defect and its configuration (Figure 2). She also underwent MRI study which demonstrated the extent of brain and arachnoid damage (Figure 3).

Figure 1: X-ray skull showing fracture site.

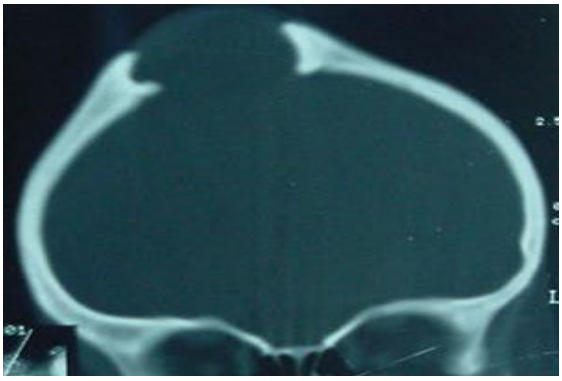

Figure 2: CT scan.

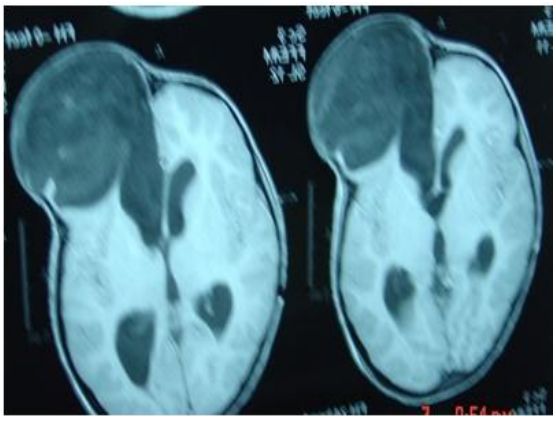

Figure 3: MRI.

Neurosurgical Operation

Patient was operated for exploration and repair. During exploration, the scalp was stripped off the swelling. The bone was cut with bone nibbler all around to identify the arachnoid and dural edge. The Duramater was separated from underlying brain. Arachnoid mater is sutured and Duramater margins were also cleared all around and were repaired using artificial dural graft (in case it can primarily be sutured without any substitute will be better. Substitutes are used if it can't be closed primarily or if it causes tightness). Bone defect was closed by using artificial bone graft.

Results

Post-operative course of the patient was uneventful. Scalp wound was healthy and sutures were removed on 9th postoperative day. The patient was kept on oral antiepileptic for 2 year postoperatively. She was weaned of antiepileptic thereafter and did not report any new episode of seizure or any neurological deficit during his follow up.

Discussion

Growing skull fracture, also known as "posttraumatic leptomeningeal cyst" or "craniocerebral erosion," was first described by How ship in 1816. It is a rare complication following head injury and its incidence is less than 0.05% to 1.6% of cases [5]. It is common below the age of one year (50%), and nearly 90% of the patients are below the age of 3 years, after which the condition is rare [6]. Common etiologies include fall, vehicular accident, and child abuse; cases following difficult vacuum extraction and corrective surgery for craniosynostosis have also been described. Growing skull fracture commonly involves the calvarial bones. Rarely, it can occur at basiocciput and orbital roof [7]. Most important factor in GSF pathogenesis is skull fracture, with its dural tear and entrapment of arachnoid membrane and brain tissue within the fracture margin. There are two main hypotheses to elucidate why the incidence of GSF is higher in infancy and early childhood than in adulthood. One hypothesis is that during the first 2 years of life, rapid growth of the brain and skull occurs; the duramater adheres more tightly to the bone and thus is more easily torn when the skull is fractured [8]. The other hypothesis proposes that the skull is thinner, less stiff, and more deformable, and in deforming can more readily tear the duramater. In the early stage of GSF, the main damages to the brain and bone are caused by the injury itself. However, the damages as well as the neurological deficits will increase during the progression of GSF, especially in the late stage. The neurological deficits cause the main disruption in the quality of life for most patients with GSF. Xiu et al divided the progression of GSF into 3 stages during treatment of the disease. Stage 1 is the prephase of CSF. The time frame for this stage is from the time of injury to the time just before enlargement of the fracture. Patient with GSF at this stage must have the following conditions:

a.Skull fracture with dural tear and

b. Herniation of brain tissue or arachnoid membrane through the fracture.

Traditionally, this stage would not be included in the diagnosis of GSF because there is no enlargement of the fracture. However, Xiu et al. [9] argue that the patients who have suffered skull fractures and meet these 2 conditions have the highest risk of GSF, especially when the patient is younger than 3 years of age. Stage 2 is the early phase of GSF. The time frame extends from the initial fracture enlargement to 2 months after the beginning of enlargement. Based on our observations and according to other studies, gross enlargement of the fracture occurs about 2 months following the initial fracture enlargement. Therefore, in this stage, the bone defect is small, and the deformity of the skull and the neurological deficit are mild. Growing skull fracture diagnosed and treated during this stage will have a better prognosis. Stage 3 is the late phase of GSF. It begins at 2 months after initial enlargement. During this stage, the bone defect becomes larger, and skull deformity and neurological disorder become severe if left untreated. Every infant/child who has sustained the trauma should undergo a plain X-ray to rule out any fracture. If a fracture is found, CT scan should be done to rule out injury to the brain. Based on the CT appearance, growing skull fractures are subdivided into three types: Type I refer to growing skull fracture with a leptomeningeal cyst, which may be seen herniating through the skull defect into the subgaleal space. Associated brain damage or gliosis is seen in type II, while type III is associated with porencephalic cyst [10]. The surgical techniques for treating GSF are well described. The procedure includes resection of the leptomeningeal cyst and degenerated brain tissue, repair of the dural defect, and cranioplasty. If hydrocephalus or seizures have occurred, VP shunt placement or resection of the scar tissue inducing the seizures, respectively, should be performed. The most important step of surgery is water-tight closure of the dural defect [11]. During surgery, the surgeon should avoid excising any functional brain tissue exposed under the skull defect, especially during the early stages of GSF. If a patient has suffered seizures before the operation, one should perform electrophysiological monitoring during resection of the lesions inducing the seizures. Ventricul operitoneal Shunt placement may be necessary for patients who develop hydrocephalus due to GSF.

Conclusion

Diastatic Skull fracture with pseudomeningocle is a complex disorder involving chronic white matter loss, disturbances of cerebrospinal fluid and chronic ischemic changes. Surgical repair of dura mater and bony defect prevents further neuronal damage. The natural course of an untreated case is progressive in nature. There is progressive cranial and cerebral damage and thus there is a need for early surgical intervention. However the ischemic effects of initial trauma continue to persist for long time requiring long-term surveillance.

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