Use of Split Thickness Cranial Bone Grafts in Surgical Treatment of Growing Skull Fractures

MOHAMAD AMR EL-TAYEB, M.D. and TAREK A. TAREEF, M.D.
The Department of Neurosurgery, Faculty of Medicine, Cairo University.

Abstract

Background: Acute skull fracture can be complicated by a dural tear. This results in an expanding cystic mass with the dura and CSF resulting in the fracture diastasis. The position of the cystic swelling prevents the osteoblast from migrating and this prevents fracture healing. The continuous pulsatile CSF pressure causes resorption of adjacent bone. Trivial trauma in the history is often missed.

Objective: The aim of this retrospective study was to evaluate the role of early diagnosis and surgical repair using autologous split thickness skull grafts for cranioplasty, in the prevention of complications and improving the outcome of growing skull fractures.

Methods: Ten patients with growing skull fractures managed from 2005-2010. Plain skull X-Rays, CT scan of the brain including bone window, and MRI of the brain were done for all patients in the study. All cases undergone surgery with duroplasty using pericranial grafts and cranioplasty using autologous split skull grafts.

Results: 6 girls and 4 boys with a mean age of 11 months were included in this study. Postoperative follow-up wa done for all patients with a mean follow-up period of 1 year. No neurological deterioration or recurrence of cyst occurred in any in the patients of this study with good outcome.

Conclusion: All patients under the age of 3 years with linear skull fractures should be closely monitored and followed-up at monthly intervals for the development of growing skull fractures. Surgical intervention by duroplasty using pericranium, and cranioplasty using autologous split thickness skull grafts is recommended. Early intervention prevents progressive neurological sequelae and complications.

Key Words: Craniocerebral erosion – Growing skull fractures – Leptomeningeal cyst.

Introduction

SIMPLE skull fractures in childhood ordinarily heal without sequelae. However in rare cases, the fracture line widens with time and appears to be growing, a condition known as growing skull fracture or recently termed craniocerebral erosion [1-3]. This complication of skull fractures was also known as post-traumatic leptomeningeal cyst because of its frequent association with a cystic mass filled with cerebrospinal fluid (CSF) [4].

Growing skull fractures are very rare with an overall incidence ranging from 0.05 to 1% of skull fractures in childhood [4-10]. 50% of which occur in infants less than 1 year of age, and over 90% occur before the age of 3 with an age range starting from birth till the age of 7 [4,7,9,11], although rare adult cases have been described [4,12,13].

The pathophysiology of growing skull fracture remains unclear [4,5,14,15]. The growth of the fracture line is due to resorption of adjacent bone as a result of continuous pulsatile wedge pressure from tissue herniating through the fracture line [11,16]. A dural laceration is an essential factor for the development of growing skull fracture. The dural laceration must be along the fracture line and usually extends beyond [4,5,16,17]. Another essential factor is the presence of an outer driving force such as rapidly growing brain, hydrocephalus and edema. The lack of resistance at both the dura and the skull defects results in a local amplification of intracranial pressure pulse waves causing herniation of cerebral tissue or subarachnoid space through the fracture line [9,11,15,17]. This accounts for the focal dilatation of the lateral ventricle (porencephalic dilatation) near the growing fracture that is seen on neuroimaging studies. Another risk factor is the severity of head trauma. A linear fracture associated with a hemorrhagic contusion of the brain suggests a trauma severe enough to cause dural laceration and thus increase the possibility of growing skull fracture [9]. The brain at the growing fracture site frequently shows cerebro-meningeal cicatrix formation, loculated subarach-
A growing skull fracture commonly presents as a progressive, pulsatile scalp swelling most commonly in the parietal region that appears sometime weeks to months head trauma sustained in infancy and early childhood [4,9,10,18-20]. Neurological disorders related to growing skull fracture include seizures, hemiparesis, and psychomotor retardation [4,9]. Some cases may be complicated with hydrocephalus [21]. A growing skull fracture in the skull base may present with ocular proptosis, CSF rhinorrhea or otorrhea [18,22].

The aim of this retrospective study was to evaluate the role of early diagnosis and surgical repair using autologous split thickness skull grafts for cranioplasty, in the prevention of complications and improving the outcome of growing skull fractures.

**Patients and Methods**

The study included ten patients with growing skull fractures managed from 2005-2010 at the Neurosurgery department, Cairo University Hospitals, six females and four males with age range from 2-36 months (mean age of 11 months). The time range between the initial head trauma and the diagnosis of growing skull fracture ranged from 2 weeks to 1 year. The mode of trauma was falling from a height in 8 patients and road traffic accidents in 2 patients. All 10 patients were admitted to the hospital following the initial trauma with 5 out of 10 patients having a Glasgow Coma Scale of 11 or less.

All patients presented with a scalp swelling mostly involving the parietal bone, 2 patients presented with seizures, 2 presented with contralateral weakness, and 1 patient presented with squint. Plain skull X-Rays, CT scan of the brain including bone window, and MRI of the brain were done for all patients in the study. All patients were followed on outpatient basis at monthly intervals with a mean follow-up period of 1 year. All cases underwent surgery with duroplasty using pericranial grafts and cranioplasty using autologous split skull grafts. One patient had postoperative hydrocephalus and was managed by CSF diversion using a ventriculoperitoneal shunt.

**Surgical technique:** The scalp incision should be large enough to expose the entire length of the growing skull fracture. A scalp flap is reflected subgaleally, and the edge of the cranial defect is then dissected by incising the pericranium along the edge of the defect in the bone [9]. The pericranium is directly adherent to the underlying cerebral tissue forming a cerebromeningeal cicatrix. To identify the dura several burr holes are made at a distance from the cranial defect, and through them the dura is separated from the inner skull table toward the defect [9,16,23]. The pericranium is separated from the outer skull table and a wide craniotomy is made around the defect. Once the intact dura and dural defects are identified, the cerebral tissue adhering to the reactive periosteal tissue is exposed by removing the cerebromeningeal cicatrix tissue until normal white matter is exposed. The dural defect is closed using a pericranial graft [9,10,16,24]. The cranial defect is repaired with the autologous split skull grafts that were obtained at the time of craniotomy [9,16,23].

**Results**

In a five year period from 2005 to 2010, 10 patients underwent surgical repair for growing skull fractures by duroplasty using pericranium, and cranioplasty using autologous split thickness skull grafts.

60% the patients were females and 40% were males, with age range from 2-36 months with a mean age of 11 months. 50% of cases were less than 1 year of age.

All patients in this study presented with a scalp swelling (100%), two patients presented with intractable seizures (20%), two with contralateral weakness (20%), and one with squat due to right sixth cranial nerve palsy (10%). Nine out of ten patients (90%) presented with initial loss of consciousness following the initial head injury, and five patients (50%) had an initial Glasgow Coma Scale of 11 or less.

The mode of trauma was a fall from a height in 80% and road traffic accidents in 20% of cases. The time period from the initial trauma to the diagnosis of growing skull fracture ranged from 2 weeks to 1 year with 70% of cases diagnosed within 2 months from the initial trauma.
The fissure fracture involved the parietal bone alone in 6 cases (60%), the frontal bone alone in 1 case (10%), the fronto-parietal bones in 2 cases (20%), and the temporo-parietal bone in 1 case (10%). The dural defects seen intra-operatively ranged from 4-9cm and in all cases the dural defect extended some distance beyond the bony defect. A dural cyst herniating through the defect without herniating cerebral tissue was encountered in 4 cases (40%).

One case was complicated by postoperative hydrocephalus (10%) 4 days following surgery and was managed by a surgery for CSF diversion using a ventriculo-peritoneal shunt. One case had superficial wound infection (10%) which was managed by frequent dressings, intravenous and local antibiotics. No neurological deterioration or recurrence of cyst occurred in any in the patients of this study.

Postoperative skull X-Rays, CT scan of the brain were done to all patients in this study while MRI was done to 4 patients. The patients were followed in the outpatient clinic at regular intervals of 1 month with a mean follow-up period of 1 year.

Seizures were controlled in both cases presented with intractable seizures. Motor deficit markedly improved in two cases presented with right hemiparesis and right 6th nerve palsy and didn’t improve in 1 case which presented with hemiplegia from the time of the initial trauma.

Fig. (1): CT scan of the brain following head injury.

Fig. (2): Follow-up CT scan 2 months following initial trauma showing growing skull fracture.
Fig. (3): MRI of the brain for the same case showing herniated leptomeningeal cyst through the skull defect.

Fig. (4): Follow-up CT of the brain after surgical repair and cranioplasty.

**Discussion**

In this study there were 10 patients, 6 girls and 4 boys, with age range from 2-36 months (mean age 11 months), 50% of cases were less than 1 year of age. In Ersahin et al. [19] study the mean age was 12.4 months. In Greenberg [4] 50% of cases are under 1 year, and 90% are under 3 years of age. In Gupta et al. [5] study, 80% of patients were less than 5 years.

All patients in this study presented with a scalp swelling (100%), two patients presented with intractable seizures (20%), two with contralateral weakness (20%), and one with squint due to right sixth cranial nerve palsy (10%). Nine out of ten patients (90%) presented with initial loss of consciousness following the initial head injury, and five patients (50%) had an initial Glasgow Coma Scale of 11 or less. In Pezzotta et al. [11] study including 132 growing skull fractures, all patients presented with a scalp swelling, 46% with seizures, 38% with focal neurological deficit, and 21% with loss of consciousness. In the study by Scarfo et al. [24] all patients presented with a scalp swelling, 20% with seizures, and 24% with focal neurological deficit.

Fall from a height accounts for 80% of mode of trauma in this study while it was 88% in Ersahin et al. [19] study, and 90% in Gupta et al. [5] study.

In this study the fissure fracture involved the parietal bone (alone or in association with frontal
or temporal bones) in 90% of cases. In Gupta et al. [5] study this was in 56% of cases while in Pezzotta et al. [11] this was in 70% of cases.

In this study one patient (10%) had hydrocephalus postoperatively, in Des Champs et al. [2] study 2 patients 15%, in Ersahin et al. [9] 1 patient 6% had hydrocephalus and they were all managed by a ventriculoperitoneal shunt.

In this study all patients underwent surgical repair for growing skull fractures by duroplasty using pericranium, and cranioplasty using autologous split thickness skull grafts. Tomita [9] and Greenberg [4] recommend duroplasty & cranioplasty using autologous bone grafts for all patients. Kazuviko et al. [23] recommends autogenous bone for cranioplasty. In Ersahin et al. [19] study duroplasty was performed alone with no recurrence. Miranda et al. [18] recommended duroplasty alone. In Gupta et al. [5] study duroplasty alone was done for 8 patients with no recurrence; duroplasty and cranioplasty were done in 24 patients using acrylic, wire mesh, steel plates, or autologous bone.

In conclusion: All patients under the age of 3 years with linear skull fractures, especially those having an underlying brain pathology at the time of trauma should be closely monitored and followed-up at monthly intervals by plain X-Rays of the skull and brain CT scan for the development of growing skull fractures. Once diagnosed surgical intervention by duroplasty using pericranium, and cranioplasty using autologous split thickness skull grafts is recommended. Early intervention prevents progressive neurological sequelae and complications. Although difficult to obtain split thickness skull grafts in this young age, they give very good results without the risk of foreign body infection using synthetic materials or additional incisions to obtain bone from other parts of the body for cranioplasty.

References


