Cranioplasty in Children with Split Rib Graft

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Introduction

Defect of the cranial vault results from trauma, decompression craniotomies and ablative tumour resection. These patients suffer from the feeling of insecurity as the brain tissue is prone to trauma in exposed regions. Cranioplasty not only provides mechanical protection to the cerebrum but also improves cosmesis. Unexpected neurological recovery due to change in cerebral haemodynamics has been reported by Richaud et al [1]. The goal of a cranioplasty procedure is to achieve a lifelong, stable, structural reconstruction of the cranium covered by a healthy skin and scalp flap [2,3]. The successful clinical outcome relies upon the following factors:

1. The selection of an implant to reproduce the rigid framework of the skull.
2. Preparation of the recipient bed to optimize implant stability and vascularity.

In children use of alloplastic materials are disadvantageous as they are biologically inert and fail to keep up with the dynamic contouring of the developing skull. The autogenous bone graft, with its ability to become incorporated as living tissue and good reparative capabilities is the material of choice for cranioplasty. Various sources of autogenous bone grafts are calvarium, ilium and rib. Autogenous split calvarial graft is material of choice for being the bone of same origin, volume available, same operating site and favourable contour. In children below nine years of age harvesting a split calvarial graft is difficult due to poor differentiation of the diploic bone. Harvesting of iliac crest is also contraindicated below nine years, as it interferes with growth. Hence rib graft is the only viable option in children. We present a case of post traumatic cranial defect in a three year old child treated at our institution with split rib graft.

Case Report

A three year old male child was referred to our department for management of a post traumatic skull defect. The child had sustained injury six months back due to accidental fall on head and developed sub dural hematoma over the left side. He underwent emergency decompression of the left parietal area. Postoperatively he was placed on tab sodium dilantin 100 mg once daily.

On clinical examination, the child was active and vital parameters were within normal limits (Fig. 1). The physical growth was adequate but speech was impaired. The defect over the left parietal bone was about 5 cm in diameter with visible and palpable pulsation. While coughing the pulsatile soft tissue used to bulge out through the defect. Pre-operative investigations were carried out including radiographs and computed tomography with 3D volumetric reconstruction study, which confirmed the clinical findings. Radiologically the defect in maximum diameter measured 4.7 cm anteroposteriorly and 4.2 cm mediolaterally. The laboratory findings were within normal limits. Following preanaesthetic assessment the case was taken up for cranioplasty under general anaesthesia. In the preoperative preparation head shaving was carried out.

The incision was placed 3 cm from the defect on the healthy bone conforming to the basic flap design (Fig. 2). Subgaleal dissection was carried out, 1 cm from the defect. Sub periosteal dissection was carried out with colorado electrocautery needle. Care was taken to avoid any dural tear or button holing of the flap. The defect was exposed and graft bed was prepared (Fig. 3). Chest preparation was done to harvest the rib graft. Through right sub mammary incision the 5th and 6th rib of 5.5 cm length were harvested. The chest wound was filled with normal saline to rule out any pleural tear. Hemostasis was achieved and the wound was closed in multiple layers.

The width of the harvested ribs was about 11mm and thickness 4 mm. The ribs were split through its thickness using micro saw into two halves and spread like an open book. Two ribs were converted into four pieces which were

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Fig. 1 : Preoperative profile.

Fig. 2 : Marking of the Incision.

Fig. 3 : Exposure of the defect.

Fig. 4 : Split rib graft.

Fig. 5 : Fixation of the graft with micro screws.

Fig. 6 : Post-operative profile.

adequate to cover the defect (Fig 4). The graft was placed over the defect with ends overlapping the parietal bone. The elasticity of the graft permitted moulding under finger pressure to conform to the contour of the skull. Each graft was stabilized with titanium micro screw one on each end to the underlying parietal bone (Fig. 5). Haemostasis was achieved and suction drain was placed. The wound was closed in layers and pressure dressing applied. Postoperatively, the patient was on injectable antibiotics for four days. Suction drain was removed on the second and sutures on 8th day postoperatively. He has been followed up postoperatively at first, third and six months with no complications (Fig. 6). Radiographic evaluation at six months has shown good take up of the graft (Figs. 7, 8).

Discussion

Various types of autologous grafts and alloplastic materials are used to restore the continuity of calvarial bone. For the developing paediatric cranial vault, the use of synthetic materials is not ideal because they lack growth potential hence fail to adapt with the developing neurocranium. Infection, dislodgement, migration, thermal sensitivity and implant exposure also have been reported [4,5]. Autogenous bone is better suited for grafting in paediatric patients because it meets the goals of cranioplasty while potentially allowing ongoing growth [6]. Various sources of autogenous grafts are calvarium, ilium and rib. Split calvarial graft is the material of choice, as it is anatomically, structurally and functionally similar

Fig. 7 : Post-operative radiograph.

Fig. 8 : Six months post-operative CT Scan.

to the lost tissue. However, due to poor differentiation of the diploic bone in young children harvesting of split calvarial graft is difficult. Similarly iliac graft is also contraindicated in children due to growth interference. Hence rib graft is the material of choice.

Brout in 1917 [7] was the first to use split rib graft for reconstruction of cranial defect. This method was subsequently popularized by Longacre et al [8] observed incorporation of the grafts with calvarial bone and progressive growth with maintenance of the cranial contour. Histological study confirmed neovascularization, osteoclastic activity and subsequent bone formation. Normal appearing bridging bone was apparent by six months.

The advantages of rib graft are availability,

regeneration and minimal blood loss. Splitting the rib graft improves elasticity, hence easily conforming to the calvarial contour. One micro screw at each end is adequate to stabilize the graft in position. Hence the requirement of metallic implant was minimal. The regenerated rib can also be reutilized. Some of the drawbacks include longer operating time, extensive resorption, contour deformities and requirement of multiple ribs for large defects in staged reconstruction [9].

On six months post operative evaluation, clinically there is no difference between the grafted area and the adjacent healthy bone. The CT with 3D volumetric reconstruction revealed complete take up of the graft. Hence in children split rib grafts are suitable as they maintain their contour well, incorporate easily into the adjacent bone and maintain the shape of the calvarium [10].

Conflicts of Interest

None identified

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