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A Simple Technique for Bone Storage after Decompressive Craniectomy in Children

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Established Facts

- Storage in an abdominal subcutaneous pocket, between the abdominal fat and the muscle, and cryopreservation of the bone flap are the two popular methods of autologous bone storage.

Novel Insights

- We present a simple method of bone storage in a small child with severe head injury after decompressive craniectomy. The bone was split transversally, and both parts were stored under the galea for later replacement.

Key Words
Bone flap storage · Autologous cranioplasty · Decompressive craniectomy

Abstract
Cranial vault reconstruction in the pediatric population is a specialized procedure, which requires additional considerations. Generally, inherent difficulties of bone storage and cranioplasty are neglected in the literature. We present a simple method of bone storage and autologous cranioplasty in a small child with severe head injury. The child underwent surgical treatment with decompressive craniectomy. A bone flap was transversally divided into two pieces and stored under the galea. Bone storage and reconstruction of the cranial vault with our surgical technique is a safe, easy and cost-effective choice excluding the surgical trauma to obtain a new subcutanous pocket for bone storage in pediatric decompressive craniectomy patients.

Introduction

Skull repair in little children requires additional considerations because of the dynamic nature of the pediatric skull and the potential long-term survival of the patient [1]. Different types of allografts and autografts can be used in attempts to restore the cranial vault following craniectomy. However, autologous bone grafts are univer-

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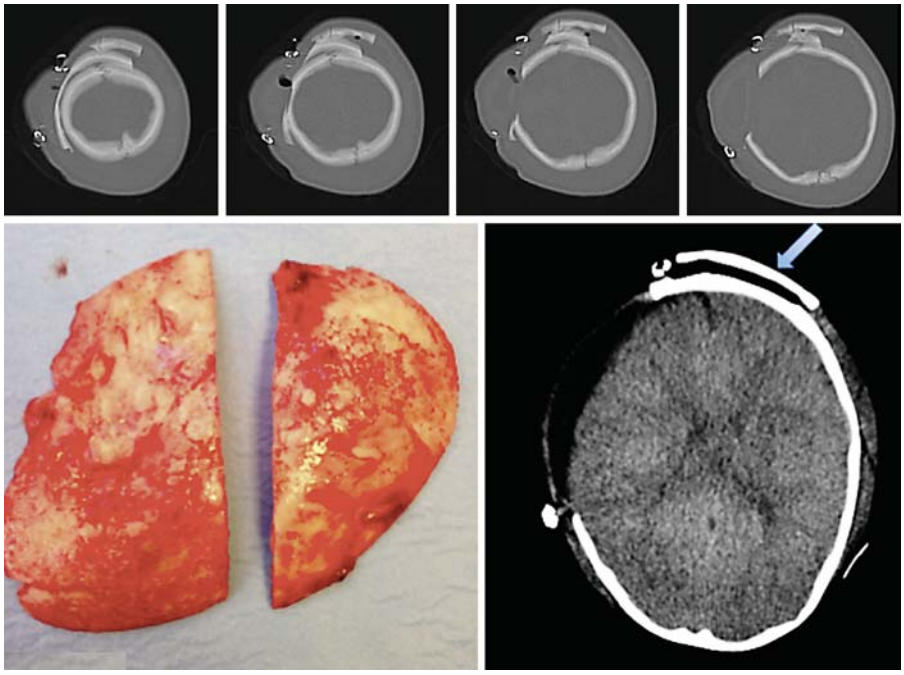

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Fig. 1. The bone flaps were placed under the scalp in the left frontoparietal region and vertex, away from the craniectomy line after being divided transversally into two parts. Postoperative cranial CT images showing the bone flaps on the cranium.

sally accepted as the preferred option in pediatric patients because of their integration with the growing skull, their capacity to osseointegrate and to grow with the pediatric skeleton [2].

We present a simple method of bone storage and autologous cranioplasty in a small child with severe head injury after decompressive craniectomy.

Case Report

A 12-month-old boy was admitted to the pediatric emergency department with severe head trauma of 2 h. Computed tomography showed diffuse edema and contusion on the right hemisphere. No additional pathology was observed. The patient was treated using the 2012 Pediatric Head Injury Guidelines, which state 'decompressive craniectomies with duraplasty, leaving the bone flap out, may be considered for pediatric patients with traumatic brain injury who are showing early signs of neurologic deterioration or herniation or are developing intracranial hypertension refractory to medical management during the early stages of treatment' [3].

The child underwent surgical treatment with decompressive craniectomy with duraplasty. A bone flap was stored under the galea after being divided transversally into two parts. The patient underwent autologous cranioplasty for cranial vault reconstruction 6 weeks later, as soon as the intracranial hypertension regressed. The postoperative course was uneventful. No complications were noticed at the end of the 1-year follow-up. He was followed with periodical outpatient visits and clinical examinations. Follow-up cranial CT scans and clinical examinations did not show a spontaneous resorption or sinkage of the cranioplasty flap. The patient has no definite neurological deficit and developmental/mental deficiency compared to coevals.

Surgical Technique of Craniectomy

We performed a wide unilateral craniectomy in our case, on the side ipsilateral to the lesion. A reverse question mark-shaped incision was used, followed by removal of bone in the frontal, temporal and parietal regions, extending the craniectomy to the floor of the middle fossa. The dura mater was opened widely, and an onlay dural substitute allograft was used in our case to provide coverage of the cerebral hemisphere. A bone flap was placed under the scalp after being divided transversally into two parts. The contralateral frontoparietal subgaleal space was dissected, and two pieces of bone fragments were placed within this space with a proper fit of the concave side onto the underlying cranial vault. One of these two bone fragments was placed over the left frontoparietal area, with the other fragment placed at the vertex lying adjacent to each other (fig. 1). A minimal aperture of the anterior fontanel was observed intraoperatively; this did not constrain us while dissecting the subgaleal space and placing the bone flap. The galea and subsequently the skin were sutured in two layers, with vicryl and stapler sutures. We did not experience any difficulty in approximating incision lines due to increased tension. The patient was administered intravenous prophylactic cefazoline sodium preoperatively and 3 days postoperatively. The wound healed well, and the staples were removed on the 10th postoperative day.

Surgical Technique of Cranioplasty

A detailed written informed consent was obtained from the parents after explaining the possible adverse effects of the cranioplasty. The procedure was performed under general anesthesia.

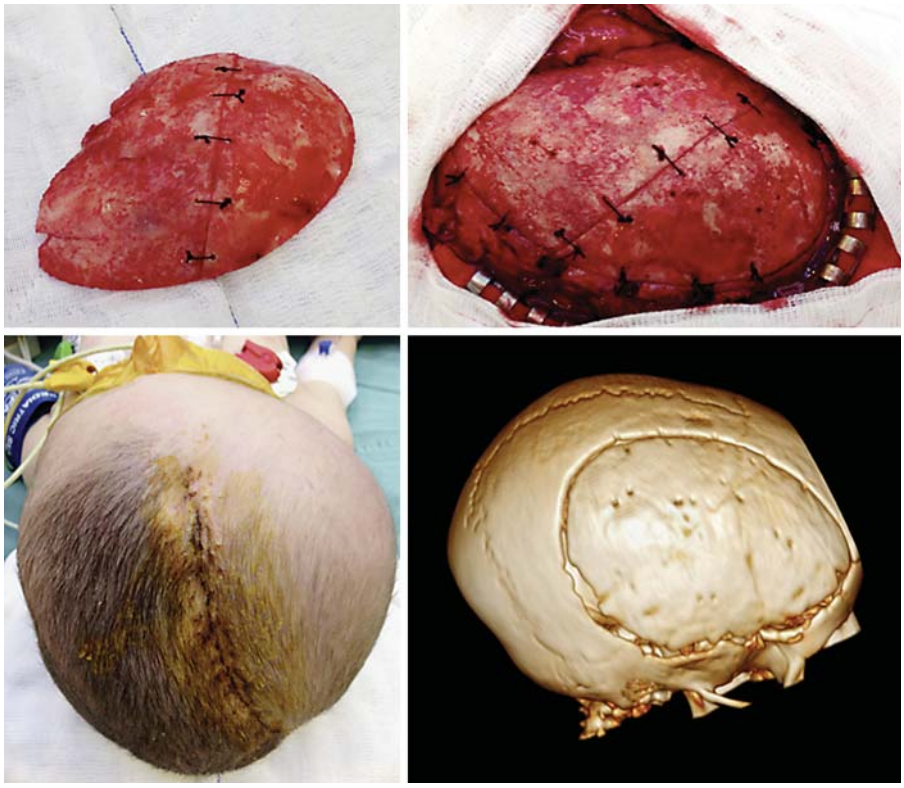

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Fig. 2. Two pieces of bone were attached to each other by 3-0 silk sutures, followed by fixation to the skull with 3-0 silk sutures. Postoperative cranial 3-dimensional CT image showing bone flap replacement.

The patient's existing decompressive craniectomy incision was used to expose the area required for cranioplasty so that the suture line would not lie on the implant. The scalp was separated from the dura and the onlying dural substitute with gentle dissection. The transversally split and embedded autologous bone flap under the galea was exposed and taken out. We did not experience any difficulty during this procedure. The split bone flaps were in good condition. It was easy to dissect the flaps from both subgaleal tissue and the underlying healthy cranial vault. We did not observe any adhesion, vascularization or displacement. Two pieces of bone were attached to each other by 3-0 silk sutures, followed by fixation to the skull with 3-0 silk sutures (fig. 2). The scalp was unfolded and sutured in two layers, initially the galea and subsequently the skin with vicryl and stapler sutures.

Discussion

Autologous bone flaps need to be stored until the cranioplasty can be performed. Storage in an abdominal subcutaneous pocket, between the abdominal fat and the muscle, and cryopreservation of the bone flap are the two popular methods of autologous bone storage. The choice of method is usually based on the surgeon's preference, and only a few previously published papers have discussed whether one method is superior to the other [4].

Prospective randomized trials evaluating the efficacies and safeties of these two methods have not been conducted. Moreover, the literature contains no evaluation of pediatric cranioplasty after subcutaneous storage of the bone flap. It is therefore impossible to assess the risk of bone resorption, infection or any other adverse event associated with this storage method [5].

In our pediatric practice, we routinely store the bone flaps in our bone bank. The freezer in the bone bank was not functioning at the time of the decompressive craniectomy in our patient, so we had to use another method for bone storage. Abdominal subcutaneous pocket storage was not feasible in our patient since the abdominal surface area was too small; therefore, we preferred to store the bone under the galea. Subgaleal storage is a method which we have previously used in adults especially for small cranial defects. However, because it was difficult to store a big bone flap in the pediatric subgaleal space, we preferred to split the bone flap transversely into two pieces before storage. We did not experience any problem, in either placing the bone flap subgaleally or closing the skin.

The average head circumference/abdominal circumference ratio of a 1-year-old baby is around 1 [6]. This

may suggest that the abdominal space has no superiority to already dissected subgaleal space in terms of storage.

In conclusion, the use of original autologous bone with our surgical technique is a safe, easy and cost-effective alternative after pediatric decompressive craniotomies, also excluding the further trauma to obtain a new subcutaneous pocket for bone storage. This method can be a safe alternative to store the bone flaps after large cranial defects.

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Disclosure Statement

We certify that there is no actual or potential conflict of interest in relation to this article.

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