ORIGINAL ARTICLE

Early autologous cranioplasty after decompressive hemi-craniectomy for severe traumatic brain injury

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Abstract

Objective: To evaluate the outcome of early replacement of autologous bone flap for decompressive hemicraniectomy in severe traumatic brain injury patients.

Methods: The observational cross-sectional prospective study was conducted at the Neurosurgical Unit of the Combined Military Hospital, Rawalpindi, Pakistan, from July 2011, to June 2014, and comprised patients who underwent cranioplasty after decompressive hemicraniectomy for trauma. Patients over 20 years of age and of either gender were included. Cranioplasty was timed in all these patients using native bone flap preserved in the abdominal wall after decompressive craniectomy. Parameters recorded were mortality, wound infection, subdural collection, wound dehiscence, ventriculomegaly, bone resorption, cosmetic deformity and neurological outcome. SPSS 17 was used for data analysis.

Results: Of the 30 patients in the study, 28(93.3%) were males. The overall mean age was age 32.03±8.01 years (range: 20-48 years). Mean cranioplasty time was 66.2±11.50 days (range: 44-89 days). Major infection necessitating bone flap removal was found in 1(3.33%) patient, while minor scalp wound infections, treated with antibiotics and dressings were found in 2(6.66%). Cosmetic18 deformity was seen in 3(10%). Improved neurological outcome was noted in 21(70 %) patients; 6(20%) survived with a moderate to severe disability and 3(10%) remained in a vegetative state. No mortality was found after the procedure.

Conclusion: Early autologous bone replacement for decompressive hemicraniectomy in severe traumatic brain injury patients offered cost-effective, acceptable surgical and improve dneurological outcome.

Keywords: Decompressive hemicraniectomy, Autologous cranioplasty, Traumatic brain injury. (JPMA 65: 1325; 2015)

Introduction

Decompressive craniectomy (DC) is a widely accepted therapeutic option for refractory intra-cranial hypertension secondary to traumatic brain injury (TBI).[1] There are large calvarial defects after DC which needs to be covered in due time.[2] The large calvarial defects make these patients vulnerable to wide spectrum of complications like sinking flap syndrome and syndrome of the trephined.[3] All DC cases eventually require calvarial reconstruction and this procedure was traditionally performed after 3 -6 months due to brain swelling and risk of infection.[4] There is conflicting opinion regarding timing for cranioplasty even in literature. The purpose of cranioplasty is changed, now ranging from cosmetic, protection, restoration of normal intracranial physiology and improvement in neurological condition.[5] The calvarium is reconstructed with a wide choice of materials, each with its own merits and demerits in terms of cost-effectiveness, cosmetics, biocompatibility, implant strength and complication rate.[6]

Autologous cranioplasty (AC) is a procedure in which patient's own bone flap is stored. Bone is preserved either underneath the adjoining galea, subcutaneous pocket of anterior abdominal wall or cryopreserved, and then reutilised.[7]

The current study was planned to evaluate the efficacy of early cranioplasty (<12 weeks) and advantage of using native bone flap stored in the patients abdominal wall, especially in underdeveloped countries like Pakistan, and to simultaneously review literature regarding appropriate timing for cranioplasty after DC.

Patients and Methods

The prospective study was conducted in the Neurosurgical Department of Combined Military Hospital, Rawalpindi, Pakistan, from July, 2011, to June, 2014, and comprised patients who underwent AC after decompressive hemicraniectomy for trauma. Patients between the age of 20 and 50 years of either gender were included, while patients over 50 years of age or below 18 years, with penetrating head trauma, comminuted and compound fracture of the skull were excluded.

Incision was given over the previous scar. Scalp with underlying muscles were dissected out from dura .Edges of the surrounding bone were cleaned to let the flap fit. Bone

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flap was retrieved from the abdominal pouch and edges were freshened and holes were drilled. After repositioning the preserved bone, it was secured either with prolene or vicryl suture. Dissecting out scalp with underlying muscles from dura was the most difficult step in this procedure. Keeping these difficulties in mind, surgicel was laid over the entire area of exposed dura at the time of DC. This manoeuver helped prevention of dense adhesions between the dura and scalp/muscle layer. Dense adhesions predisposed to dural tears, which, if made during cranioplasty, were repaired in watertight fashion.

Data was recorded on a structured proforma. Parameters noted were age, gender, time of cranioplasty, complications related to the procedure like infection, subdural fluid collection, improved neurological outcome in terms of Glasgow outcome score (GOS), bone resorption, cosmetic deformity and mortality.

Data was analysed using SPSS 17. Relevant descriptive statistics like frequency, rate and percentage were computed for presentation of qualitative data. Quantitative variables like age, time etc. were presented as mean ± standard deviation.

Results

A total of 39 patients underwent the procedure. DC was performed in 33(84.62%) cases where computed tomography (CT) scan confirmed the presence of complex acute subdural haematoma (ASDH), and in 6(15.38%) with global diffuse oedema with evident contusions. Clinically, pre-op GCS was 6-8 in 26(66.67%) patients, and 4-5 in 13(33.33%).

However, 9(23%) patients were excluded from the study either because they did not meet the inclusion criteria or the outcome was death. Of the 30(77%) patients who comprised the study population, 28(93.3%) were male and 2(6.6%) were females, with an overall mean age of 32.03±8.01 years. Cranioplasty was performed within 12 weeks, with the mean duration of 66.2±11.50 days. Major wound infection mandating the revision cranioplasty was found in 1(3.33%) patient, whereas minor wound infection was found in 2(6.66%).Cosmetic deformity, subdural fluid collection, ventriculomegaly was found in 3(10%), 2(6.66%) and 1(3.33%) respectively.

The early outcome (3-month) revealed most of the patients had an improved neurological function after cranioplasty; 21(70%) were good (independent patients), 6(20%) survived with a moderate to severe disability, and 3(10%) remained in a vegetative state. No mortality was found after this procedure (Table).

It is worth mentioning that most of the complications associated with decompressive hemi-craniectomy were

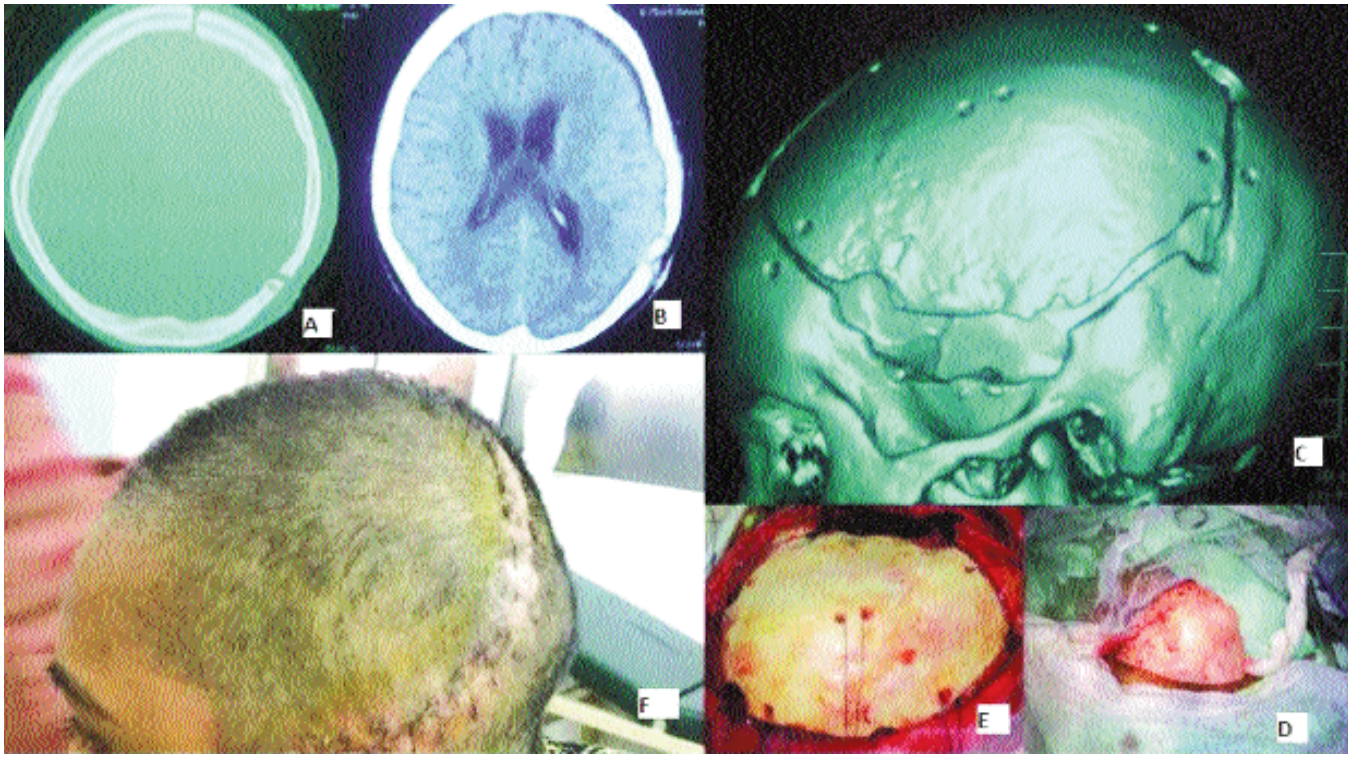

Figure: Cranioplasty (A) Bone window (B) Small subdural hygroma (C) 3D reconstruction (D) Bone flap retrieval from abdomen (E) Bone flap replacement (F) Cosmetic outcome.

Table: Demographics, outcomes and complications.

Variables		N=30	%	p-value
Gender	Male	28	93.33%	0.666
	Female	2	6.66%	
Age	Mean	32.03±8.01		0.398
	Range	20-48		
Time of cranioplasty	Mean	66.2±11.50		
	Range	44-89		
Bone graft	Replaced	30	100%	
	Died before replaced	9		
Bone resorption		NIL	0.00%	
Major infection	Revision cranioplasty	1	3.33%	0.223
Minor wound infection	Daily dressing	2	6.66%	0.779
Cosmetic deformity		3	10%	0.427
Subdural fluid collection		2	6.66%	0.048
Ventriculomegaly		1	3.33%	0.486
Improved neurological outcome		21	70%	0.077
Moderate to Severe disability		6	20%	0.109
Vegetative state		3	10%	0.109
Mortality with cranioplasty		NIL		

relieved after the cranioplasty with improvement in neurological function and CT scan image (Figure).

Discussion

Decompressive craniectomy and durotomy is an option used to relieve the intractable intracranial hypertension and brain tissue shifts after severe TBI.[1,2] Large calvarial defects>160cm^2 after DC make these patients vulnerable to wide spectrum of complications, like sinking flap syndrome and syndrome of the trephined, and further mandates calvarial reconstruction.[4,8]

A study reported a syndrome characterised by persistent headache, dizziness, fatiguebility, cognitive and functional decline, irritability, epilepsy and psychiatric symptoms observed in patients with large cranial defects which they named as syndrome of the trephined.[8] Another study coined the term "syndrome of the sunken skin flap" to describe the neurological symptoms due to a large craniectomy defect. All these symptoms are well-known indications for cranioplasty.[9]

It is believed that venous return is impaired due to the atmospheric pressure acting on the large calvarial defect that disturbs cerebral blood flow, cerebral metabolism, cerebral vascular reserve capacity and cerebrospinal fluid (CSF) hydrodynamics.These effects are rectified after cranioplasty[10-12] and early cranioplasty has potential benefits for cerebral perfusion.[13]

Cranioplasty in not performed only for cosmetic reasons, but also for its therapeutic effects.

There is conflicting opinion regarding timing for cranioplasty. Traditionally it is believed that a shorter time from craniectomy to cranioplasty is associated with poor outcome.[14,15] There is upcoming evidence that DC will be a part of neurosurgical practice and subsequently cranioplasties. There are no comprehensive guidelines available regarding the technique and timing of the procedure. Current practices regarding cranioplasties are subjective and are based either on the surgeon's preferences or institutional policies.[16]

We reviewed available literature regarding appropriate time for cranioplasty after DC. In most recent literature, studies support early cranioplasty over delayed cranioplasty. Some concluded that early cranioplasty (<12 weeks) had a better functional outcome and complication rates were not different between early and late cranioplasty groups.[17,18] Others have also emphasised on early cranioplasty after DC to alleviate complications from craniectomy.[19] One study reported that early cranioplasty reduces operative time by facilitating soft tissue dissection before massive scar formation without causing additional complications like blood loss, infection, subdural hygroma, and brain parenchymal damage.[20]

Calvariumis reconstructed with a wide range of materials, each with its own advantages and disadvantages in terms of cost, cosmetic appearance, biocompatibility, implant strength and risks of complications related to a large foreign body remains.[21] AC is a procedure where the patient's own bone flap is stored and reutilised. There are

certain methods with expensive and sophisticated equipment for the storage of bone flap.[22] Considering our resource-constraints, we used patient's abdominal wall for the storage of the bone flap. The mechanical, immunologic and technical-grafting properties of autologous bone, together with its superior aesthetic and psychological effects, probably make it the best material for calvarial reconstruction.[23] In addition, the complication rate was similar to published data on cranioplasty using artificial prosthetic materials.[24]

Cranial reconstruction after DC has been shown to be associated with a relatively high complication rate (16.4%-34%) compared with standard neurosurgical procedures (2%-5%).[25] In this study, interim outcomes were comparable with literature.[26] Infection rates of minor (6.66%), major (3.33%), subdural collection (6.66%), and secondary hydrocephalus (3.33%) were also comparable with a study.[27] No deaths or intracranial infection after the procedure were found in this study which, again, was comparable.[26] Bone resorption was not found in any patient, as this is a well-known complication in <18 years.[28] One study suggested that early cranioplasty in patients having undergone unilateral DC may shorten intervention time, thus preventing re-hospitalisation and would lower the overall cost of care.[27] This holds well in our settings where most of the patients are soldiers who don't leave the hospital till they are fit to join their duty.

Hence, early cranioplasty with autologous bone flap preserved in the abdominal pouch improved rehabilitation without exposing the patients to late complications like syndrome of the trephined, and relatively low morbidity.

Timing of reconstruction should not be bound by a chronological number of three months, rather the neurological status of the patient, brain swelling and the complications associated with the large calvarial defects should help in deciding the plan for cranioplasty.

The limitations of our study included its small sample size, and lack of long-term follow-up. A prospective, randomised, controlled study with extended follow-up duration is needed to fully investigate the promises and constraints of early AC in Pakistani setting.

Conclusion

With appropriate selection of patients, early autologous bone flap replacement (<12 weeks) for decompressive hemicraniectomy in severe TBI patients offered cost-effective and acceptable surgical outcome and prevented late complications of DC.

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