



CHANGES IN CALVARIAL BONE PLACED IN ABDOMEN AFTER DECOMPRESSIVE CRANIECTOMY: A PROSPECTIVE CLINICAL STUDY

Neurosurgery

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ABSTRACT

Background: Cranioplasty is done after therapeutic decompressive craniectomy (DC) to protect brain and for cosmetic purpose. The autologous bone is kept in the subcutaneous plane in anterior abdominal wall.

Methods: It was a Prospective study with a total 50 patients were included after inclusion and exclusion criteria were met between 2016 to 2018. Gross and microscopic changes in the bone were noted.

Results: Men constituted 78% of the study group. There is statistically significant reduction in length ($p=0.025$), width ($p=0.021$), thickness ($p=0.012$) and weight ($p=0.04$) measured in patients who underwent cranioplasty 3 months after initial surgery compared to patients who underwent cranioplasty on or < 3 months of initial surgery. Only 6% of patients showed necrotic changes.

Conclusion: There is significant reduction in length, width, thickness and weight of bone measured in patients who underwent cranioplasty 3 months after initial surgery compared to less than 3 months of initial DC.

KEYWORDS

Decompressive craniectomy, cranioplasty, traumatic brain injury

INTRODUCTION

Traumatic Brain injury (TBI) is a heterogeneous disease with varying clinical and radiological presentation. TBI is associated with significant morbidity and mortality.

Decompressive craniectomy is surgical procedure in which the part of the skull bone removed and surgically expanding the dural sac to allow the brain to swell without raising the intra cranial pressure (ICP) [1,2]. This technique has been reported to be beneficial in a number of conditions, like traumatic brain injury, hemispheric ischemia stroke and ICP associated with aneurysmal subarachnoid hemorrhage, brain tumor.[3-6] Cranioplasty is defined as the restoration of a defect in the cranial bone or correction of a deformity of the bone. Reconstruction of the cranial vault is often needed for protective and cosmetic reasons. The goals are to protect the brain and restore the normal contour with as few complications as possible. Other controversial goals are eliminating headache, apprehension, avoiding cerebral palsy, decreasing vibration, motion intolerance, overcoming fatigue, insecurity and post-traumatic epilepsy.^[7]

An enormous range of materials has been employed for the repair of cranial defects. These may be an autografts, xenograft and sometime using material other than the bone.

In autograft part of the skull bone removed and is placed in subcutaneous plane of anterior abdominal wall & then repositioned back in its original place in skull after brain edema subsides & increased ICP settles down.[6] Storing the bone flap in the abdominal wall until it was required for the cranioplasty was first described by Kreider (1920)[8]. There are only very few studies which were done to see histopathological changes in the skull bone before cranioplasty.^[9,10]

Our study had been done to assess the gross and microscopic changes in the calvarial bone retrieved from abdomen after 3 months and compared to patients who underwent cranioplasty on or before 3 months of initial DC.

MATERIAL AND METHODS

The study was conducted in the department of Neurosurgery and National Institute of Pathology at VMMC & Safdarjung hospital, New Delhi. It was a Prospective clinical non randomized study with a total 50 patients were included after inclusion and exclusion criteria were met between 2016 to 2018. Inclusion criteria: Acute TBI patients admitted in the department and those planned for surgery. Criteria for

decompressive craniectomy will depend upon pre operative imaging, Glasgow Coma Scale & intra operative findings. Any patient with hemispheric ischaemia stroke, aneurysmal bleed, subarachnoid haemorrhage, brain tumour with increased ICP refractory to medical management.

Exclusion criteria:

- Patients with skin lesion or any infection over anterior abdomen.
- Osteomyelitis of the skull bone placed in abdomen.
- Skull bone involvement due to other disease.
- GCS score 3.
- Patient with hemodynamic instability who are unfit for surgery.
- Decompressive craniectomy within 2 weeks or more than 2 years.
- Refusal to participate in the study.

After taking consent, a complete history, clinical examination, routine and special investigation (if required) were done. Gross appearance of bone like maximum length, maximum width, thickness measured with Vernier calliper and weight measured with weight measuring scale were noted. Microscopic appearance like normal bone histology, atypical changes complete or focal necrosis were noted. Two groups were made changes before and at 3 months and after 3 months of removal from abdomen. This study was approved by the Institutional ethical committee of V.M.M.C & Safdarjung hospital. All information was kept confidential.

Statistical Analysis: The data analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0. Qualitative variables were correlated using Chi-Square test. A p value of <0.05 was considered statistically significant.

RESULTS: The study group consisted of 50 subjects who were subjected to decompressive craniectomy and later cranioplasty. Out of total 50 patients 58% were < 40 years and remaining >40 years of age with range 6-65 years and mean \pm SD 39.1 \pm 12.68. Men constituted 78% of the study group. Head injury (64%) was the most common indication for decompressive craniectomy. RTA (Road traffic accident) was most common mode of injury accounting 59.53% of total patients. Among women the most common mode of injury was fall from bike (sitting behind without helmet). Trauma patients more commonly needed decompressive craniectomy as compared to tumour and cerebrovascular diseases. 32 (64%) patients had trauma, 11 (22%) had tumour and 7 (14%) had cerebrovascular diseases. Severe trauma (GCS 3 to 8) patients formed the major bulk in the group constituting 24 (48%) followed by 14 (28%), 12 (24%), were in moderate (GCS 9

to 12) and mild(13-15) trauma patients respectively. See table 1.

Table 1: Changes in length, width, thickness and weight of bone for cranioplasty done before 3 months and after 3 months

N=50	3months	>3 months	P value
Percentage change in length (cm)	N=32	N=18	0.025
Mean ± SD	6.41 ± 1.8	-8.59 ± 4.04	
Median	-6.3	-7.7	
Min-Max	10.24 to -3.53	-22.35 to 5	
Inter quartile Range	-7.692 to -5.144	-9.859 to -6.154	
Percentage change in width(cm)			0.021
Mean ± SD	-6.36±2	-7.78 ± 2.07	
Median	-6	-7.28	
Min-Max	-10.29 to -2.86	-12 to -4.9	
Inter quartile Range	-8.000 to -4.974	-10.000 to -6.000	
Percentage change in thickness(mm)			0.012
Mean ± SD	-9.15 ± 5.27	-11.54 ± 4.72	
Median	-8	-10.26	
Min-Max	-30 to -3.23	-25 to -6.67	
Inter quartile Range	-9.545 to -6.905	-13.793 to -7.692	
Percentage change in weight (gm)			0.04
Mean ± SD	-15.1 ± 4.49	-18.15 ± 5.57	
Median	-13.91	-15.95	
Min-Max	-27.66 to -7.61	-31.92 to -11.96	
Inter quartile Range	-18.559 to -12.036	-20.513 to -13.830	

DISCUSSION

Decompressive craniectomy (DC) has been used as an effective treatment for raised ICP for several years. [11] Many randomized trials were conducted in order to ascertain whether DC can improve clinical outcomes and to better define its role in the treatment algorithms for patients with severe TBI. [2,5,6,12]

However, in decompressive craniectomy three main procedures performed for TBI are hemicraniectomy (large unilateral fronto-temporoparietal flap), bilateral hemicraniectomy, and bifrontal DC (bone flap extending from the floor of the anterior cranial fossa anteriorly to the coronal suture posteriorly and to the middle cranial fossa floor bilaterally). Various studies showed this removed bone may be then preserved in alcohol, formalin and cryopreserved. To maintain sterility boiling and autoclaving methods had been employed without much interfering with osteogenic potential of the bone. [13-15]

Storing the bone flap in the abdominal wall until it was required for the cranioplasty was first described by Kreider in 1920.[8] But this necessitates another operation and produces an unsightly scar and there is little evidence for better osteogenic potential of the bone. It is known that bone removed from its blood supply and replaced in fresh tissue dies, with the exception of a layer of superficial cells less than a millimetre in depth. Nevertheless, this method has its contemporary proponents. [16]

The present study was conducted to assess gross and microscopic changes in calvarial bone placed in abdomen after decompressive craniectomy done in patients admitted in Neurosurgery department. There are many studies which shows the effectiveness of DC, but there are no clear guidelines about timing of cranioplasty, the risk-benefit, cost-benefit and lack of standard comparisons between studies especially assessing the gross and microscopic changes.

Fifty patients were included after the inclusion and exclusion criteria. Out of which 32 patients were operated for cranioplasty before or on 3 months of decompressive craniectomy. Eighteen patients underwent cranioplasty after 3 months of initial surgical procedure. A total of 3 patients who had osteomyelitis of bone flap were excluded from study. Men (39) were more commonly involved than women(11) and the

results were similar to other studies. [17] Head injury (64%) was the most common indication for decompressive craniectomy. RTA (Road traffic accident) was most common mode of injury accounting 59.53% of total patients. Among women the most common mode of injury was fall from bike.

48% patients had severe head injury where as 28%, 24% patients had moderate and mild head trauma respectively. This is comparable to general distribution of patients according to severity of TBI [18]. In gross examination of bone it was found that there was statistical significant reduction of bone length 6.41% in patients who under went cranioplasty on or before 3 months compared to 8.59% reduction in other group of patients who underwent cranioplasty after 3 months(p=0.025).

There was significant reduction of bone width 6.36% vs 7.78% in patients who underwent cranioplasty on or before 3 months compared other group of patients who underwent cranioplasty after 3 months (p=0.021). It was found that there was significant reduction in bone thickness 9.15% vs 11.54% in patients who under went cranioplasty on or before 3 months compared to patients who underwent cranioplasty after 3 months (p=0.012).

There was statistical significant reduction of bone weight 15.1% vs 18.15% in patients who underwent cranioplasty on or before 3 months compared to patients who underwent cranioplasty after 3 months (p=0.04). Our results are similar to other studies which also showed reduction in volume of the bone. [19]

On microscopic examination, only 6% patients had shown some mild degenerative changes and necrotic foci. These patients underwent cranioplasty 3 months after initial decompressive craniectomy. Remaining 94% patients had shown normal bone histology with normal lamellar structure. Our finding are comparable to study by Singla N et al[9] who also found that in microscopic examination presence of osteocytes in 86 %, osteoblastic activity in 38 % and angiogenesis in 14 % of bone respectively. But it was not significant correlation. Subcutaneously preserved bone remains viable and retains its osteogenic potential and is simple, cost-effective option with negligible infection rate. [9]

CONCLUSION:

There is statistical significant reduction in length, width, thickness and weight measured in patients who underwent cranioplasty 3 months after initial surgery compared to patients who underwent cranioplasty on or before 3 months of initial surgery. Degenerative changes and focal necrosis on microscopic examination is more common in patients who underwent cranioplasty 3 months after initial decompressive craniectomy. So preservation of bone in the abdominal wall keeps the bone viable and a good cost effective alternative with minimum reduction in size of the bone if it is done within 3 months of DC.

LIMITATION OF THE STUDY: In our study sample size was small, so study with large sample size should be done to make more conclusive results.

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There are no conflicts of interest.

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