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Original Article

Cranioplasty with Subcutaneously Preserved versus Cryopreserved Autologous bone flaps after Decompressive Craniectomy- A Comparative Study of 40 Cases

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Abstract

Background: *After decompressive craniectomy for acute brain swelling, bone flaps need to be stored in a sterile fashion until cranioplasty. We can preserve autologous bone flap as a freeze-preserved state or within abdominal subcutaneous tissue. The aim of this study is to compare the cryopreservation with subcutaneous abdominal preservation regarding the effectiveness and safety.*

Methods:*This is an interventional study. The clinical data of 40 patients underwent decompressive craniectomy and subsequent cranioplasty with autologous bone flaps in Neurosurgery Department of Shaheed Shiek Abu Naser Specialized Hospital and others private Medical Colleges in Khulna from Jan 2018 –December2019.20 patients under cranioplasty using autologous bone stored in ultra low freezer.. Another 20 patients cranioplasty with bone flap preserved in subcutaneous abdominal pocket. The analysis included the rate of complications, bone resorption, and reoperation to compare between SP group and CP group.*

Results: *The mean age was found 35.10(±13.34) years in subcutaneous preserved group and 39.90(±16.40) years in cryopreservation group with male predominance was observed in both groups.The rate of complications occurred in 4 (20%) in the SP group and3 (15%) in the CP group(P =0.677). The rate of bone resorption in SP group was 5.0% and CP group was15.0% (P=0.292). Reoperation in subcutaneous preservation group was 2(10.0%) and in cryopreservation group was 3(15%). The difference was not statistically significant between two groups (p = 0.633).*

Conclusion*: SP and CP both might be effective and safe methods for the storage of bone flaps for cranioplasty. There were no significant difference in complications, bone resorption , reoperation among two groups. However, identifying of the method that gives better results might depend on the individual surgeons preference and available equipment.*

Key words*: Bone flap, decompressive craniectomy, cranioplasty.*

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Introduction:

Decompressive craniectomy is a neurosurgical life-sav-ing procedure for treating medically refractory rasied in-tracranial pressure (ICP). It is performed commonly in severe traumatic brain injury (TBI), acute subdural hematoma, inracerebral haemorrahage (ICH) aneurysmal subarachnoid hemorrhage (ASAH) or malignant cerebral infarction, intraoperative brain swelling and encephalitis[1].The procedure was first introduced for MCA infarction in 1956[2].

There is always been controversy regarding the method of storage of bone whether to keep it in the

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subcutaneous pocket or tissue bank.[10] Various Preservation techniques including abdominal subcutaneous preservation, deep freezing, preservation in bactericidal solutions and sterilization.[3] Bone flaps removed during decompressive craniectomy are often preserved in a deep freezer, but the practice differs with regard to the freezing temperature used, ranging from "16 °C to "84 °C[7]. Storage of bone in abdominal subcutaneous pocket is safe, cheap, sterile, histocompatible and better cosmetic result[4].

Cranioplasty is usually done with autologus bone graft or synthetic materials Commonly performance of cranioplasty 3 months after craniectomy is recommended, and if the patient has a history of intracranial infection or open craniocerebral injury, the procedure can be delayed for at least 6 months after first surgery[5]. Patients own bone flap served as a cranioplasty material after deep freezing or preserving subcutaneously.Cranioplasty with subcutaneously preserved bone has less post operative infection, flap sequestration, or extrusion. It also provides excellent bony alignment, and a favorable cosmetic outcome

Material and Methods:

This was a prospective interventional study conducted in Neurosurgery Department of Shaheed Shiek Abu Naser Specialized Hospital and others private Medical Colleges in Khulna from Jan 2018 –December2019. Sampling method was purposive and sample size about 40 (SP group 20 and CP group 20) as inclusion and exclusion criteria.

Inclusion criteria: Decompressive craniectomy for acute brain swelling and Cryopreservation or subcutaneous abdominal preservation of removed bone flaps after decompressive craniectomy.

Exclusion criteria Vegetative or disable patients after decompressive craniectomy, chronic discharging sinus or infected case and unwilling to give consent

The clinical data of 40 patients underwent decompressive craniectomy and subsequent cranioplasty with autologous bone flaps. 20 patients under cranioplasty using autologous bone stored in ultra low freezer . Another 20 patients cranioplasty with bone flap preserved in subcutaneous abdominal pocket. The analysis included the rate of complications, bone resorption,and reoperation to compare between SP group and CP group.The data were collected by using a preformed data sheet and all other needed data was collected from history sheet and investigation papers. Data were processed and analyzed by SPSS (Statistical Package for Social Science) version 22.0 software package. Test statistics were used to analyze the data were Chi-square test, Student "t" test (unpaired) The level of significance was 0.05. *P* value <0.05 was considered significant. The summarized data was present in the table.

Results:

Table-I

Distribution of patients according to age in groups (n=40)

Age(years)	Group		*p* value
	SP Group n (%)	CP Group n (%)	
d"20	2 (10.0)	2 (10.0)	0.673
21 – 30	7 (35.0)	3 (15.0)	
31 – 40	6 (30.0)	9 (45.0)	
41 – 50	2 (10.0)	2 (10.0)	
>50	3 (15.0)	4 (20.0)	
Total	20 (100.0)	20 (100.0)	
Mean ± SD	35.10±13.34	38.85±15.25	0.413
Range (Min-Max)	18-60	16-65	

Table-I The mean age was found 35.10(±13.34) years in subcutaneous preserved group and 39.90(±16.40) years in cryopreservation group.

Table-II

Distribution of patients according to gender in groups (n=40)

Gender	Group		*p* value
	SP Group n (%)	CP Group n (%)	
Male	15 (75.0)	14 (70.0)	0.723
Female	5 (25.0)	6 (30.0)	
Total	20 (100.0)	20 (100.0)	

Among the 40 patients in the study,male predominance was observed in both groups.

Table-III

Distribution of patients according to causes in groups (n=40)

Causes	Group		*p* value
	SP Group n (%)	CP Group n (%)	
TBI	14 (70.0)	13 (65.0)	0.888
Spontaneous ASDH	4 (20.0)	4 (20.0)	
Spontaneous ICH	2 (10.0)	3 (15.0)	
Total	20 (100.0)	20 (100.0)	

Table III: TBI was the most common cause of decompressive craniectomy in both groups. There were no statistically significant difference between two groups (p = 0.888).

Table-IV

GCS during decompressive craniectomy and cranioplasty in groups (n=40)

GCS	Group		*p* value
	SP Group Mean±SD (Min – Max)	CP Group Mean±SD (Min – Max)	
During decompressive cranioectomy	9.85±2.05 (7-13)	9.84±1.74 (8-13)	0.990
During cranioplasty	14.73±0.45 (14-15)	14.72±0.46 (14-15)	0.956

Table IV showed that the mean GCS in subcutaneous preservation group was 9.85(±2.05) at admission and 14.73(±0.45) during cranioplasty, on the other hand in cryopreservation group, it was 9.84(±1.74) during decompressive craniectomy and 14.73(±0.45) at cranioplasty. The difference of GCS between two groups were not statistically significant (p = 0.990).

Table-V

Distribution of patients according to complications in groups (n=40)

Complications	Group		*p* value
	SP Group n (%)	CP Group n (%)	
Yes	4 (20.0)	3 (15.0)	0.677
No	16 (80.0)	17 (85.0)	
Total	20 (100.0)	20 (100.0)	

Table -V shows the total complications between two groups. It was observed that the complications were 4(20%) and 3(15%) in SP group and CP group respectively. The difference of complications between SP and CP groups were not statistically significant (p = 0.677).

Table-VI

Post operative radiological evaluation of patients according to bone resorption in groups (n=40)

Bone resorption	Group		*p* value
	SP Group n (%)	CP Group n (%)	
Yes	1 (5.0)	3 (15.0)	0.292
No	19 (95.0)	17 (85.0)	
Total	20 (100.0)	20 (100.0)	

Table VI shows that bone resorption in subcutaneous preservation group was 1(5.0%) and in cryopreservation group was 3(15%). This difference were not statistically significant between two groups (p = 0.292).

Table-VII

Distribution of patients according to reoperation in groups (n=40)

Reoperation	Group		*p* value
	SP Group n (%)	CP Group n (%)	
Yes	2 (10.0)	3 (15.0)	0.633
No	18 (90.0)	17 (75.0)	
Total	20 (100.0)	20 (100.0)	

Chi square test was done to measure the level of significance

Table VII shows reoperation in subcutaneous preservation group was 2(10.0%) and in cryopreservation group was 3(15%). This difference were not statistically significant (p = 0.633).

Discussion:

This study was carried out with an aim to compare subcutaneous abdominal preservation with cryopreservation using autologous bone flap after decompressive craniectomy. Present study findings are discussed here and simultaneously compared with previously published relevant international studies.

A total of 40 patient were included in this study. They were divided into two groups (SP group and CP group). The mean age was found 35.10(±13.34) years in SP group and 39.90(±16.40) years in CP group. The age difference was not statistically significant (p = 0.413). A male predominance was observed in both groups.

Decompressive craniectomy is life- saving procedure in Neurosurgery. Among the 40 patients in the study it was observed that the majority of the causes of decompressive craniectomy in SP group was 14(70%) and in CP group was 13(65%). There were no statistically significant difference between these two groups (p = 0.888). Cheng et al[5]. 2014 showed that majority of decompressive craniectomy was done in subcutaneous preservation group due to TBI 6(75%) and 9(75%) in cryopreservation group. Similar findings were observed in the study of Bhaskar et al.[6] 2011 in subcutaneous preservation group 27(50.94%) and in cryopreservation group 4(7.54%).

GCS score is an important predictor of outcome. It was observed that the mean GCS in subcutaneous preservation group was 9.85(±2.05) at admission and 14.73(±0.45) during cranioplasty, on the other hand in cryopreservation group, it was 9.84(±1.74) during decompressive craniectomy and 14.73(±0.45) at cranioplasty. The difference of GCS between two groups was not statistically significant (p = 0.990). Basheer et al.[1], 2010 found simillar GCS in their study which were 8.1±3.0 at the time of decompressive craniectomy and 14.1±0.6 at time of cranioplasty.

The current study revealed that the overall incidence of complication in the CP group was lower comparing the SP group (15.0% vs 20.0%). However, this difference was not statistically significant (p=0.677). Compared with the study of Cheng et al.[5] 2014 it was observed that complications of cranioplasty in CP group (11.11%) and SP group (18.18%) which was very close to this study. Inamasu et al. (7) 2010 found the complications of cranioplasty in SP group (10.23%) and CP group (16.1%) and Basheer et al. [(1)] 2010 showed SP group (21.4%) and CP group (22.2%).

Bone flap resorption is the most common complication of cranioplasty after decompressive craniectimy. Incidenec of bone flap resorption vary from 3% to 12%[8]. However, there are few existing reports that have compared the SP and CP procedures in the term of the incidence of bone flap resorption. The present study showed that bone resorption in subcutaneous preservation group was 1(5.0%) and in cryopreservation group was 3(15%).

The rate of bone resorption was higher in CP group but the difference was not statistically significant (p = 0.292). Similar findings were also observed in the study of Cheng et al.[5] 2014. Storing the bone flap in the deep freezer might cause bone cell death. One hypothesize that dead bone flaps might cause foreign body reactions following cranioplasty. Active osteoclasts might destroy the dead bone which would cause bone resorption and a decrease the flap thickness. In contrast, the SP storage method might keep the bone cell alive. Future studies were warranted to elucidate the precise mechanisms of bone resorption that occurred in these settings.

All the patients who had developed wound dehiscence, sunken bone flap, epidural abscess , bone resorption usually required reoperation. In all of them autologous bone had to be removed and a second surgery had to be done using synthetic materials. The present study shows reoperation in subcutaneous preservation group was 2(10.0%) and cryopreservation group in 3(15%). This difference were not statistically significant (p value 0.633). In Häuptli and Segantini (1980) study[9] showed the incidence of reoperation in SP group 3(7%) and in CP group 23(16%) which was very close to this study. Comparing with the Basheer et al.,[(1)] 2010 study 12(14.3%) in SP group and 2(11.1%) in CP group.

Limitation of the study was very small sample size. So the study findings are not generalizable in large scale. It was a single centre study. The rate of bony fusion and bone resorption which are concerns with delayed follow up for better outcome.

Conclusion:

Cranioplasty is one of the common operation performed in Neurosurgery. SP and CP both might be effective and safe methods for the storage of bone flaps for cranioplasty. There was no significant difference in complications, bone resorption , reopertion among two groups. However, identifying of the method that gives better results might depend on the individual surgeons preference and available equipment.

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