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ORIGINAL ARTICLE

Cranioplasty-Autologous Bone graft Vs Titanium Mesh

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ABSTRACT

Background: Cranioplasty (CP) is a neurosurgical procedure performed after decompressive craniectomy using autologous bone graft or various artificial materials.
Aim: To find differences in complications between patients who underwent CP using an autologous bone flap versus a titanium mesh as well as to identify significant risk factors for post-CP complications
Study Design: Comparative cross-sectional study.
Methodology: A total of 46 patients were included in this study, out of which 37 were males (80.4%) and 9 were females (19.6%). All patients underwent cranioplasty using titanium mesh or autologous bone graft.
Results: Comparison of outcome between autologous graft and titanium implant was done. In 45.7% patients, autologous bone graft was used while titanium implant was used in 54.7%. 23.9% patients had developed different types of complications in both groups, out of which 81.9% were from autologous group and 18.1% belonged to titanium graft group. Surgical site infection was noted in 18.1% of patients (equally) in both groups. Craniopalsty infection was noted in 45.4% patients who underwent autologous graft. Hematoma was encountered in 2 patients; both with autologous bone graft and none in patients who had titanium mesh cranioplasty. Removal of autologous bone graft was done in one patient whileremoval was not done in the other arm of study. Bone resorption was seen in five patients, all of which had autologous bone graft. Learning curve is that this technique be followed by neurosurgeons for better outcome.
Practical implicatio Titanium mesh cranioplasty is a technique to be followed by junior neurosurgeons for learning and good outcome, decrease duration of hospital stay and preservation of precious resources of hospital.
Conclusion: Cranioplasty in which titanium mesh is used is superior to autologous bone grafting as it has lessercomplications.
Keywords: Autologous graft, bone resorption, cranioplasty, hematoma, infection, titanium mesh.

INTRODUCTION

In Pakistan neurotrauma is one of the leading causes of death and disability[1]. Cranioplasty is surgical repair of skull defect that is left behind after a previous surgery or injury. This procedure is done after treatment and stabilization of the primary pathology such as cerebral edema following traumatic brain injury, brain tumor or infracts that lead to craniectomy. Cranioplasty is done later to protect underlying brain parenchyma and give better cosmetic appearance or to avoid atmospheric pressure influence on cranial fluid dynamics such as syndrome of trephine. Materials used for cranioplasty is separated into 2 categories; autologous bone or synthetic replacements. Inautologous bone graftpatient's ownresectedskull bone is used which is cost effective and is a physiologic alternative as compared to synthetic materials[2].

Cranioplasty is usually done 2-3 months after craniectomy, so preservation of the bone flap must be considered beforehand. Autologous bone flap is stored either by cryopreservation, where the bone flap is placed in a dedicated freezer under a pre-planned protocol or by placing bone flap in a subcutanous compartment in abdominal cavity. Several synthetic materials are available for cranioplasty such as titanium mesh, polymethyl methacrylate, hydroxyapatite cement, and polyetheretherketone (PEEK). Presently, no individual material provides all desired characteristics. Therefore neurosurgeons select an option that is beneficial and has decreasedcomplications[19]. Titanium mesh is easily available and provides a strong, malleable material that can be shaped intraoperatively[3].Theadvantages of titanium is that it is biocompatible, carries a low risk of infection and also facilitates cosmetic restoration[3].

This study was aimed to compare the complication rates in cranioplasty using autologous bone graft versus titanium mesh implants. It also signifies which method of cranioplasty was beneficial having least complications and cost effective.

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METHODOS

This was a comparative cross-sectional study conducted in CMH Peshawar between 1st January 2019 and 30th June 2022. Population: Patients above 18 years of age who underwent autologous bone / titanium cranioplasty after craniotomy in our hospital were included. A total of 46 patients were included out of which 37 were males and 9 were females.

Data collection procedure: After institutional review board approval, patients were counselled and well-informed, written consent for enrollment was taken from each patient. Their previous clinical data was collected with related demographic information and relevant operative characteristics such as cranial defect size, Glasgow Coma Scale score (preoperative and postoperative) were collected. Acute surgical complications such as hospital-acquired infection or surgical site infection, hematoma, deep vein thrombosis, cerebrospinal fluid leak, pulmonary embolism, bone resorption, readmissions, reoperations, cranioplasty flap removal, cranioplasty flap infection, duration of stay in neurosurgical ward and discharge were noted.

Development of instrument; Decompressive craniectomies were performed in patients of severe head injuries with significant mid line shift due to hematoma, blooming contusions or stroke showing clinical deterioration due to increased intracranial pressure despite adjuvant medical management. In patients with unilateral fronto-temporal, parietal craniectomy and durotomy or duroplasty using dural substitute bone flap was dissected and placed in subcutaneous abdominal fat.The sharp edges of bone flap were nibbled and placed with the convex surface outwards in subcutaneous abdominal compartment. The material used for CP is according to surgeon's preference and time lapse between DC and CP. In this study, we used a titanium mesh plate in cases who had more than 3-months interval. Before performing CP, sterilized clipper was used to remove patient's hair.The previous skin scar was re-opened and dissection was done in fibrous tissue between

the artificial dura and galea for placement of the titanium mesh or autologous bone graft. In case of using bone flap, flapwas washed with normal saline solution and povidone-iodine. Flap was placed and fixedwith multiple sutures in its original position using low profile titanium plates and screws. The skin was then closed using vicryl and prolene sutures.

Data Analysis; The frequency or percentage for categorical variables as well as mean and standard deviation for continuous variables, were used to present data.Analyses was done using SPSS version 21.0 (IBM Corp., Armonk, NY, USA).

RESULTS

Comparing the outcome of autologous graft verses titanium implant,a total of 46 patients were selected out of which 80.4% were males and 19.6% were females.In 45.7% patients, autologous bone graft was used while titanium implant was used in 54.7% patients.Complications occurred in 23.9% of patients in both groups out of which 81.9% were from autologous group and 18.1% were from titanium graft group. Surgical site infection was noted in 18.1% equally in both groups, craniopalsty infection occurred in 45.4% of patients who underwent autologous graft. Hematoma was encountered in 2 patients (both with autologous bone graft) and none in patients who had titanium mesh cranioplasty. Removal of autologous bone graft was done in 1 patient and none in patients in the other arm of study. Bone resorption was seen in 5 patients, all of which had autologous bone graft.

Table- I. Gender distribution

Gender	Frequency	%age
Male	37	80.4
Female	9	19.6
Total	46	100.0

Table- II. Frequency of autologous and titanium implant used.

Valid	Frequency	%age	Valid%	Cumulative%
Autologous bone graft.	21	45.7	45.7	45.7
Titanium Implant.	25	54.3	54.3	100.0
Total	46	100.0	100.0	

Table- III. Indications

Valid	Frequency	%age	Valid%	Cumulative%
Traumatic brain injury	37	80.4	80.4	80.4
Stroke	7	15.2	15.2	95.7
Hemorrhage	1	2.2	2.2	97.8
Epidural abscess	1	2.2	2.2	100.0
Total	46	100.0	100.0	

Fig. 1: Titanium implant being placed.

Table- IV. Post Op. Complication

Valid	Frequency	%age	Valid%	Cumulative%
No complication	31	67.4	67.4	67.4
Surigical site infeciton	2	4.3	4.3	71.7
Cranioplasty infection	5	10.9	10.9	82.6
Hematoma	2	4.3	4.3	87.0
Cranioplasty removal	1	2.2	2.2	89.1
Bone Resorption	5	10.9	10.9	100.0
Total	46	100.0	100.0	

Table-V. Post op complications

Post op complications	11	9	2
Surgical site infection (wound)	2	1	1
Cranioplasty infection	5	4	1
Hematoma	2	2	0
Cranioplasty removal	1	1	0
Bone resorption	5	5	0

DISCUSSION

This was a randomized prospective controlled study which compared autologous cranioplasty with titanium implant. Titanium mesh plates are another choice instead of autologous bone flap, having additional benefits of being biologically inert and haslesser tissue reaction, especially if bone defect is large[4]. One of the hypothesis upon which this study was done is that the complications resulting from titanium mesh cranioplasty protectsbrain tissue by preventing skull bone resorption which could lead to reoperation and raise cost of treatment more than titanium plates[5].

In our study bone resorption was encountered in 10.9 % of cases which is almost similar inrange of few other studies showing resorption rate ranging from 5% to 17%. In a study done by Ali Alkhaibary et.al., incidence ranges from 7.2% to 50%, with a higher ratenoted in the pediatric age group[6]. Surgical site infection was seen in 4 cases of autologous and 1 case of titanium implant patients which comes to 8.6% and 2.17% respectively. According to the study done by Conen Annaa et al., infections in implant was seen in 3–15% cases i-e, 0.3–12% in craniotomies and 1–24.4% for craniectomies[7,8].

In our study cranioplasty removal was done in 1 patient (2.2%) who underwent autologous bone graft reconstruction due to infection.Another study including 12 patients showed post autologous craniotomy infection and resection craniectomy was done. In 10 patients (83%) who had titanium cranioplasty infection that was successfully treated after the administration of intravenous and oral antibiotics[9].

In another study, debridement and bone flap retention was shown to be effective in 91% of patients along with intravenous (range 2–6 weeks) and oral (range 0–6 weeks) antibiotic treatment. These small studies confirm that implant retention or immediate exchange are alternatives to removal. Hematoma was encountered in 4.3% of cases; all seen in patients who underwent autologous bone graft. In a study done by Kadrl Lillemäe et. al., the incidence of hematoma in cranioplasty was 3.6%[10]. Overall, the results of the current study favours the use of titanium mesh moiré than autologous bone while considering cranial reconstruction following decompressive craniectomy. However, there are a number of issues that require considerationbefore this position can be embraced[11,12]. In many cases, the autologous cranioplasty provides an very good restorative contour with evidence of bone fusion on radiological investigations, on the anterior aspect of the reconstruction[13,14]. In some studies, post CP complications were found regardless oftype of material used and rate of complications was higher[15]. Few studies show thattherate of complications using an autologous bone flap was around 58.3% as compared to55%using 3D titanium mesh[16,17,18]. In our study, there was increase prevalence of complications in patients who underwentautologous bone flap as compared to titanium mesh. Therefore, learning curve is that titanium mesh cranioplasty is a technique to be followed by junior neurosurgeons for learning and good outcome, decrease duration of hospital stay and preservation of precious resources of hospital.

CONCLUSION

Cranioplasty in which titanium mesh is used is superior to autologous bone grafting as it has lessercomplications. Moreover,the overall cost of treatment may be reduced by using

titanium implant for cranioplasty resulting in reduced burden on medical resources.

Conflict of interest: The authors have no conflict of interest of any kind i\n any capacity

Limitation of study: This study had some contraints. First of all, the study was comprising of date from 1 hospital (Tertiary Care). Moreover, the input of patients was dependant on the incidence of neurotrauma happening in that region. There was also a difficulty in acquiring consent of the patient in some cases due to varying GCS scores (attendants were taken on board in such cases).

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