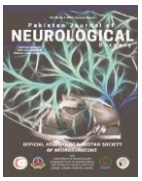

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Original Article (BRAIN)

The outcome of Titanium Mesh Cranioplasty

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ABSTRACT

Objective: The purpose of this study was to report on the result and complications of titanium mesh cranioplasty in patients with trauma.

Materials and Methods: The patients who underwent craniectomy previously for acute subdural hematomas (20 cases) or depressed fractures (40 cases) following RTA (road traffic accidents) were included in the study. Titanium mesh was placed on the skull defect 3 – 6 months later in the private hospitals of Quetta. The resulting complications were reported.

Results: There were 50 male and 10 female patients. The majority (66.66%) of patients were from the age group 15 – 40 years. The majority of patients (83.33%) did not develop any complications. 8.3% of patients had wound infections, 3.3%had mesh exposures, 1.6% developed loosening screws and 1.6% had mesh indentation due to external pressure.

Conclusion: This study concludes that there are few patients (< 20%) who develop complications after cranioplasty. The study's findings will assist neurosurgeons in the clinical decision-making process.

Keywords: Titanium Mesh Cranioplasty, Acute Subdural Hematoma, Road Traffic Accident, Depressed Fractures.

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INTRODUCTION

The present study was conducted to report the outcome and complications reported from titanium mesh cranioplasty. The trauma cases were enrolled in the current study, were initially operated in the public hospitals, and then later on titanium mesh cranioplasty was done in private hospitals of Quetta. Contact and acceleration-deceleration injuries have already been classed as closed head injuries. Acute subdural hematoma (ASDH) is a common acceleration-deceleration injury. Davceva et al.[1] demonstrated that not all traffic accidents, but some, are more likely to

result in DAI and that ASDH is not a common trait for all types of falls.[1] According to the findings, ASDH is more likely to occur in situations of simple falls, assaults, motorcycle accidents, and cycling, whereas DAI is more common in vehicle traffic accidents and cases of falling from a significant height.[1] Titanium mesh is used in cranioplasties to repair the neurocranium. Though typically well-tolerated, erosion of the overlying soft tissue with implant exposure is a complication that has a negative impact on patient outcomes.[2]

In neurosurgical clinics, adequate and sustained covering of cranial contour and continuity abnormalities of any cause is a typical difficulty. Cranioplasty is a well-known treatment in contemporary neurosurgery that involves the repair of a skull vault defect with the implantation of an item. The primary justifications for cranioplasty are brain protection and aesthetic considerations. Furthermore, cranioplasty has been demonstrated to reduce the incidence of epilepsy. Repairing cranial abnormalities alleviates psychological problems and improves social function. Sinking brain and scalp syndrome is an uncommon illness associated with a neurological disability after traumatic brain edema decompressive craniotomy. Cranioplasty can prevent the recurrence of head trauma, achieve the plastic effect, protect the patient from cerebral seizures, relieve trephine syndrome (headaches, dizziness, intolerance to vibration and noise, irritability, fatigability, loss of motivation and concentration, depression, and anxiety), increase brain blood flow, improve brain energy metabolism, promote brain tissue resumption, and treat encephalocele.[3]

A study reported on the mechanical load-bearing capability and design benefits of custom-made implants produced from a thin, pure-titanium sheet (CranioTop) for covering complicated cranial deformities. The stability of three different shaped and sized thin titanium sheet implants was examined in nine test series employing vertical, uniaxial compression with three different compression stamps to study the behavior of these implants in relation to punctiform and planar forces. An additional benefit is a large reduction in the effort necessary to prepare the region of the bone margins when compared to other existing cranioplasty procedures.[4]

Decompressive craniectomy is a common treatment for medically intractable intracranial hypertension. There was currently little research comparing the complications of titanium cranioplasty to non-titanium cranioplasty. A systematic review evaluated the problems associated with titanium cranioplasty and compared it to nontitanium materials. Overall complications rate, hematoma rate, and inaccurate fitting rate were all significantly lower with titanium cranioplasty. It did, however, reveal that titanium cranioplasty can significantly increase implant exposure rate.[5] Zhu et al.[5] validated the benefits of titanium cranioplasty in minimizing problems such as hemorrhage and inaccurate fitting, and they also recommended that doctors should pay more attention to postoperative implant exposure.

MATERIALS AND METHODS

An observational study was conducted for two years in the Neurosurgery departments of private hospitals in Quetta. A total of 60 patients with trauma were included.

Inclusion Criteria

The patients who underwent craniectomy previously for acute subdural hematomas (20 cases) or depressed fractures (40 cases) following RTA (road traffic accident) were included in the study. Titanium mesh was placed on the skull defect 3 – 6 months later in the private hospitals (Yaseen Hospital, Sultan Tareen Hospital, and Akram Hospital) of Quetta.

Exclusion Criteria

We excluded the tumor patients who had intracranial infections after a road traffic accident. Patients below 10 years of age and above 60 years were excluded.

Data Collection

Patients were included with their informed consent after receiving approval from the hospital ethical committee. Those who met the requirements for inclusion were chosen. A pre-designed proforma was used to record the data. The data was processed in SPSS version 26.0.

Surgical Procedure

The procedure was carried out in the supine posture under a general anesthetic. At the onset of anesthesia, a broad-spectrum antibacterial drug was administered intravenously, followed by one dosage every 12 hours for the next 72 hours. Hair clippers were used to remove the patient's hair. There was no skin injury. The skin was completely cleaned and disinfected. An Opsite (iodine-impregnated incision drape) was draped over the exposed skin, with care given to cover all surfaces. Previous incisions created during the craniectomy procedure were reopened with a knife and sharp dissection, exposing the bony defect in the subperiosteal plane. The temporalis muscle was frequently dissected from the dura and reflected laterally after the scalp flap was reflected. It was left connected to the dura in situations where it was highly adherent, and the cranioplasty was put on top of both tissues. It was really important not to open the dura. Once the dural plane was dissected and all the margins of the craniolacunia were revealed, a large amount of saline was utilized to wash the debris away and hemostasis was achieved. Only clean gloves were used to handle the prosthesis. The prosthesis was placed at this moment. It was important to adjust precurved mesh as much as feasible by cutting or manipulating it to change the curvature. Titanium screws were used to secure the prosthesis. Sutures for central dural tenting were frequently inserted. A wound suction drainage device was implanted beneath the skin. The following day, a CT scan was acquired, and the wound drain was withdrawn if there was no postoperative collection.[6]

RESULTS

Gender Distribution

A total of 60 patients were included in the study. There were 50 male and 10 female patients.

Age Distribution

There were 5 (8.3%) patients of age between 10 – 15 years, 40 (66.66%) patients of age between 16 – 40 years, and 15 (25%) patients of age between 41 – 60 years.

Outcome

The majority of patients [n = 50 (83.33%)] did not develop any complications. Five (8.3%) patients had wound infections, two (3.3%) had mesh exposures, one (1.6%) developed loosening screws and one (1.6%) had mesh indentation due to external pressure.

DISCUSSION

Titanium mesh provides a long-lasting repair for isolated bone abnormalities. However, the results are much poorer in high-risk individuals with soft-tissue defects. In these circumstances, free tissue transfers for soft-tissue covering are more likely to be effective, particularly when a myocutaneous or fasciocutaneous free flap is used. Kwiecien et al,[7] showed that this popular material has a significant complication risk, especially when paired with a locoregional scalp flap or free muscle flap. As a result, titanium mesh should be

utilized with caution in certain situations. We reported the complications of titanium mesh cranioplasty in patients with trauma. The variables that lead to periprocedural problems after cranioplasty, including patient- and surgery-specific factors, must be extensively evaluated. The vast majority of our patients (83.33 percent) experienced no problems. Five (8.3%) patients suffered wound infections, two (3.3%) developed mesh exposures, one (1.6%) developed loosening screws, and one (1.6%) developed mesh indentation owing to external pressure. The goal of a prior study was to identify risk variables that predispose individuals to cranioplasty complications and mortality. Zanaty et al,[8] performed a retrospective study of all patients who received cranioplasty after craniectomy for stroke, subarachnoid hemorrhage, epidural hematoma, subdural hematoma, and trauma at their hospital. The following factors were investigated: age, gender, race, diabetes status, hypertensive status, cigarette usage, cause for craniectomy, the urgency of craniectomy, graft material, and cranioplasty site. Reoperation for hematoma, post-cranioplasty hydrocephalus, post-cranioplasty seizures, and cranioplasty graft infection were among the cranioplasty complications.[8] The total complication rate was found to be 31.32 percent. The death rate was 3.16 percent. In a multivariate analysis, hypertension, increasing age, and hemorrhagic stroke were all predictors of overall problems.[8]

According to the available information, fresh bone grafts and titanium mesh had the lowest rates of surgical-site infection, surgical-site incidence, and graft failure. Banked bone flaps experienced the most surgical-site problems and transplant failures.[9] Acquired cranial abnormalities provide a reconstructive challenge in patients who have lost calvarial bone owing to trauma, illness, neoplasia, congenital deformities, or other causes. They assessed the postoperative rates of infection, local problems, and allograft failures in adult patients after cranioplasty reconstruction using titanium mesh, polymethyl methacrylate, polyether ether ketone, and Norian implants.[10] Titanium mesh is used in cranioplasties to repair the neurocranium. Though typically well-tolerated, erosion of the underlying soft tissue with implant exposure is a complication that has a negative impact on patient outcomes. Previous research looked at potential risk factors for titanium mesh exposure. Maqbool et al,[2] included patients who had undergone titanium mesh cranioplasty. The most recent postoperative computed tomography scans were evaluated to identify the thickness of soft tissue around the implant as well as the presence of significant extradural dead space deep into it. Implant exposure occurred in 7 patients (14%) while threatening exposure was reported in 1 patient, for a total of 8 complications (16 %). Titanium mesh exposure was increased by preoperative irradiation, free flap covering, and soft tissue atrophy[2]. Andrabi et al,[3] reported that complications were observed in 15.25 percent of the patients, and wound infection/dehiscence accounted for 6.78 percent. A major complication following cranioplasty was a postoperative hematoma. Other problems included 2.54 percent of seizures, 1.69 percent of bone resorption, and 0.85 percent of the sunken bone plate. Nineteen of the 36 patients who developed issues had to be reoperated on. Men had a higher rate of complications (16.06 percent) than females (11.63%).

Cranioplasty is a technically easy treatment used to fix skull abnormalities, enhance functional results, and restore cosmesis following a craniectomy. Several materials have been utilized to repair skull abnormalities. Surgeons must be aware of these possible risks and select the proper material for each patient.[11] Adults and children with acceptable donor locations and minor to moderate anomalies continue to benefit the most from autologous bone transplants. Advances in alloplastic materials and bespoke implant production will have a significant impact

on cranioplasty approaches in the next years.[12] Titanium plates for cranioplasty are considered safe for human implantation, and they are one of the most often utilized biomaterials in Japan for calvarial fixation or reconstruction. Infection rates associated with titanium plates in different neurosurgeries for which it has been used are around 5%, with removal required in 1% of all cases. Mikami et al,[13] presented their experiences with patients who had titanium implant exposure. Clinical features and our management options are discussed, together with a review of the relevant literature. This case series emphasized the need for long-term follow-up following titanium cranioplasties and the necessity for neurosurgeons to effectively inform patients and caregivers about the long-term effects. In general, Mikami et al,[13] do not consider long-term consequences while performing craniotomy or cranioplasty treatments during first surgeries, such as skin incision design, temporal artery preservation, skin flap relaxing to minimize atrophy, and so on. Plastic surgeons should be involved in the early considerations and multidisciplinary care of cranioplasties on a more regular basis.[13]

Infection was the most prevalent consequence, and the total removal rate was 8.4 percent. The location and length of postoperative hospital stay had a significant connection. There was no link found between location and problems, removal rates, or infections. There was no correlation between age and overall problems, postoperative hospitalization, or infections. There was a non-significant trend in the removal of cranioplasty in elderly individuals. The size of the titanium cranioplasty predicted the duration of stay after surgery. However, the size of the titanium cranioplasty does not indicate problems or the rate of removal. Furthermore, there was no link between the time since the main procedure and difficulties. In the elderly, there was a non-significant trend toward higher rates of titanium cranioplasty removal. Although no predictors of problems were discovered, they are prevalent and patients should be informed accordingly.[14] Williams et al,[14] demonstrated that custom-made patient-specific titanium cranioplasties outperform other published approaches and remain a proven and established choice for full-thickness calvarial defect repair of all sizes. A variety of procedures are available for full-thickness calvarial defect restoration, and the best substrate for cranioplasty is yet unknown. 149 individuals experienced the implantation of 151 custom-made titanium cranioplasties using the same procedure for 9 years. Clinical records were searched for information on patient demographics, the rationale for cranioplasty, and the location and extent of the defect. In all instances, patients were followed for an average of 1 year and 2 months. Early problems demanding intervention occurred in 7% of patients, and included seroma, hematoma, and persistent bleeding in one patient, prompting implant removal. One patient died three days after surgery as a result of a hemorrhagic stroke. Late self-limiting problems such as seroma occurred in 19% of patients, although severe failure necessitating implant removal occurred in just 4% of instances. In all cases, infection was the root cause of failure Williams et al.[14]

CONCLUSION & RECOMMENDATION

This study concludes that there are few patients (less than 20%) who develop complications after cranioplasty. Titanium mesh cranioplasty is gaining popularity because it avoids cosmetic deformity, minimizes the vulnerability of sensitive brain areas, and lowers the risks and costs associated with subsequent procedures. The study's findings will assist neurosurgeons in the clinical decision-making process. Controlling a patient's risk factors and detecting problems early may assist practitioners in avoiding the comprehensive list of issues. Longer-term randomized studies are needed to confirm the

correlations discovered in this investigation. It would be exciting to study the cost-effect and functional results of cranioplasty materials with the creation of innovative synthetic materials.

LIMITATION

A sample size of 100 is insufficient to draw a more profound conclusion and more research in this regard is needed.

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Additional Information

Disclosures: Authors report no conflict of interest.
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Human Subjects: Consent was obtained by all patients/participants in this study.
Conflicts of Interest:
In compliance with the ICMJE uniform disclosure form, all authors declare the following:
Financial Relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.
Other Relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

AUTHORS CONTRIBUTIONS

Sr.#	Author's Full Name	Intellectual Contribution to Paper in Terms of:
1.	Mahmood Khan Kibzai	1. Study design and methodology.
2.	Muhammad Shoaib Kibzai	2. Paper writing, referencing, and data calculations.
3.	Muhammad Haroon	3. Data collection and calculations.
4.	Zeenat-un-Nisa	4. Analysis of data and interpretation of results etc.