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Original Article

"Bone-mesh": Combined fractured bone and titanium mesh for primary reconstruction of compound skull fractures

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ABSTRACT

Problem considered: Skull fractures account for a large number of traumatic brain injuries and these injuries warrant urgent medical attention. Their variety in location, the magnitude of intra-cranial injuries, and a fairly cautious approach to reconstruct primarily have led to a lack in consensus in the management of these injuries. The long standing practice of removal of bone is giving way to single stage repair. The aim of the study was to analyze the benefits and adverse effects of primary reconstruction of skull using combination of the fractured fragments of bone and titanium mesh as the cranioplasty material.
Methods: Patients with compound fractures of skull, between the ages of 18–65years, were planned for primary reconstruction with fractured bone fragments and titanium mesh after dealing with the intra-cranial lesion. Patients were observed daily for clinical signs of infections and alternate day lab checks (WBC counts) were performed. Post-operative CT scans with 3-diamensional skull reconstruction was obtained before discharge and assessment of cosmetic results were done.
Results: Eleven male (mean age 32.63 ± 10.87 years) patients underwent primary reconstruction of compound skull fractures. The mean interval between injury and operation was 62.2 ± 21 h. The mean duration of surgery was 162.7 ± 32.3 min 9 had a Glasgow outcome Score (GOS) of 5, 1 had GOS 4, 1 had death, resulting from sepsis. Mean follow-up is 2.81 months and no complications could be observed within this period.
Conclusion: Primary reconstruction of compound fractures should be attempted in any possible case, even in ones with delayed presentation. When done with native bone fragments and titanium mesh provides cosmesis, protection, prevention of skin flap syndrome and better strength of construct. Although the rate of infection has been nil in our series, a larger series with longer follow-up is warranted before introducing into clinical practice.

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1. Introduction

Reconstruction of human skulls has been a need for both patients and surgeons alike since the advent of trephination, probably the oldest known surgical technique dating back to the Inca civilization around 3000 BC.[1] Skull fractures account for a large number of traumatic brain injuries, among these, compound skull fractures account for around 25%,[2] and these injuries warrant urgent medical attention. What has plagued the treatment of skull fractures is that their variety in location, the magnitude of intra-cranial injuries, and a fairly cautious approach to reconstruct primarily have led to a lack in consensus in the definitive management of these injuries. Compound fractures have been known to be associated with a myriad of underlying injuries ranging from hematomas, contusions to sagittal sinus injuries. Removal of fractured segments in a staged procedure is responsible for temporary cosmetic disfigurement, a potential for injury in the area of defect and a likelihood of a sunken scalp syndrome.

This dilemma in definitive management of compound skull fractures has evolved in the last few decades. For a long time prior to that it was standard and unquestioned practice to remove the bone fragments, debride the wound and leave a cranial defect to be repaired later.[3] The past few decades have seen the evolution of several materials for cranioplasty, ranging from autologous bone, methyl methacrylate, titanium mesh to computer aided ceramic synthetics. The dynamics and outcome of use of these materials alone or in combination to each other, primarily to reconstruct the compound skull fractures remains to be assessed.

2. Aim of the study

The aim of the study was to analyze prospectively the benefits and adverse effects of primary reconstruction of skull using combination of the fractured fragments of bone and titanium mesh as the cranioplasty material, and to detail the technique of fracture reconstruction with mesh and bone in our preliminary experience.

3. Materials and methods

Patients with compound, displaced (elevated, depressed or distracted) fractures of skull, with or without underlying injuries, between the ages of 18–65years, and having given informed consent for the procedure were included in the study. Those patients with clinical or radiological need for decompressive craniotomy or with gross visible wound contamination with foreign body were excluded. They were planned for primary reconstruction with fractured bone fragments and titanium mesh (Cranial Fixation System, Cranial Mesh), after dealing with the intra-cranial lesion. This study was conducted from January 2014 through May 2014. After initial resuscitation, and screening of concomitant injuries, a pre-operative computed tomography (CT) scan was obtained and evaluated, and planned for surgery.

3.1. *Technique*

Under general anesthesia, the patients underwent extension of the existing skin wound if necessary, followed by preliminary debridement of the wound both mechanically (trimming of wound margins and devitalized tissue) and using diluted hydrogen peroxide. Then the depressed and fractured bone fragments were removed with due care to prevent further injury to the brain. The extracted bone fragments were further treated with hydrogen peroxide and kept separately in a sterile container. Following this the intracranial pathology was dealt with and the dura was closed primarily or with pericranial patch or Synthetic Fabric Patch. In case of open air sinuses with violation of the mucosa, exenteration of mucosal lining was done and the sinus was packed with antibiotic soaked gel-foam and or pericranium. Only the larger fragments of bone were then used for reconstruction. Prior to fixation, these bone pieces were matched to the site from which they came, and the point for fixation of titanium mesh or mini-plates (Cranial Fixation System, Two hole straight plates) were marked, if required the mesh was fashioned and shaped according to the contour needed using the mesh cutter and mesh bender. After marking the exact points of fixation the bone fragments were again brought out and on a sterile trolley the exact construct comprising the bone and the titanium mesh were assembled using Miniscrews (Cranial Fixation System, Self Tapping Screw). This assembled unit of bone-mesh (Fig 1) was taken into the cranial defect for fixation. This reconstruction was followed by meticulous wound closure.

3.2. *Post-op and follow-up*

Post operatively the patients were managed in the intensive care unit or the Neurotrauma ward as was found necessary. Prophylactic anti-biotic was continued for 7–10 days post-operatively. Patients were observed daily for clinical signs of infections and alternate day lab checks (WBC counts) were performed. Post-operative CT scans with 3-diamensional skull

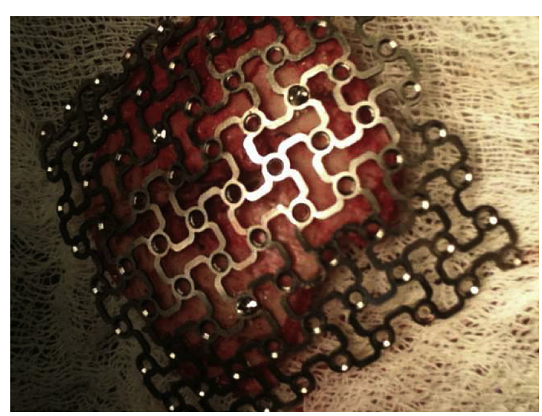

Fig. 1 – Intra-Operative picture showing Assembled Bone-Mesh Unit prior to cranial fixation, here the mesh forms a scaffold to solve the "puzzle" made by broken bone fragments.