THE TECHNIQUE OF TANTALUM PLATING OF SKULL DEFECTS


The Neurosurgical and Oral Surgical Sections of the Walter Reed General Hospital, Washington, D.C.

(Received for publication August 4, 1944)

The repair of skull defects caused by war wounds or incidental to casual illness among service personnel has become a major responsibility of the military neurosurgeon. A scholarly review of the problem of skull defect repair was presented in 1939 by Grant and Norcross. Since that time, emphasis has been directed toward the use of inert metals or plastics in this procedure and the reports of Geib, Peyton and Hall, Beck, Pudenz, Fulcher and Gurdjian have described the relative clinical merits of vitalium, tantalum and plexiglass (methyl methacrylate).

The strength, malleability and inertness of tantalum in tissue have recommended its use in skull defect repair. Following the experimental demonstration of these qualities by Pudenz, the first tantalum plating of a skull defect in the Walter Reed General Hospital was done by Lt. Col. R. Glen Spurling on 28 September 1942.* This report is concerned with the operative techniques that have evolved during the repair of 42 various skull defects. A later report will include case records in detail.

In the first six cases of this series, small, relatively simple plates were inserted in the skull defects without further fixation. They were preformed by methods to be described and altered to fit at the operating table or formed at the operating table from sheets of .015-inch tantalum plate. After the defect had been exposed, its edges were smoothed and a ledge, several millimeters wide and somewhat deeper than the thickness of the plate, was chiselled out of the outer table of the skull. The fitted tantalum plate was laid upon this ledge without further support.

In the sixth case of this series, following the resection of a cholesteatoma of the occipital bone overlying the torcular Herophili, a tantalum plate was inserted at the primary operation with this simple technique. Fourteen days following operation, while the patient was ambulatory, roentgenography of the skull showed that the plate had slipped from its original position.

In six other cases of this group, fixation of the plate was secured by wiring the plate through drill holes in the plate and skull with #30 tantalum wire. This proved to be a very adequate method of adjusting less complicated plates to relatively even contours such as those represented by the parietal bone. In such instances, the plate was hammered out at the operating table.

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* The authors wish to acknowledge and emphasize the pioneering efforts made by Lt. Col. Spurling, former Chief of the Neurosurgical Section, in the development of the techniques described in this paper.

† These six cases were operated upon at the Ashford General Hospital, West Virginia.
and if greater convexity than might be secured by hammering was desired, it was gained by resecting a small, narrow triangle from the plate (Fig. 1).

Such methods for the formation and fixation of the tantalum plate are not easily applicable to the restoration of more complicated contours such as may be present in skull defects involving the frontal bones, including the supraorbital ridges. In the remaining 30 cases of this series, the following techniques for forming and fixing the plates were devised and have been found adequate.

**THE TECHNIQUE OF PRIMARY REPAIR**

a) *Preparation of the Plate.* The margin of the skull defect is outlined on the scalp with an indelible pencil after removal of the long hair. The scalp and hair are lubricated with vaseline. Dental compound is softened in warm water and molded into the defect and upon the surrounding scalp contours until hard. The outline and depth of the skull defect will be noted as an elevated mass on this primary impression. A model is then poured with dental stone or ordinary plaster. The marking of the indelible pencil will persist on this cast. The depressed area within the cast is filled with wax and contoured to fit the adjacent skull outlines. It is well to overemphasize the convexity of the wax fill to compensate for thin, scarred scalp tissue and for subsequent inlay of the plate. A mold is made with any of the molding sands and a die poured with zinc.* The die is painted with a solution of talc and alcohol. A soft clay, such as moldine, is adapted about the circumference of the die to act as a matrix for the counter die of poured lead. The required size of .015-inch tantalum plate is roughly fashioned with at least a one-centimeter greater diameter than assumed necessary since the defect may be enlarged at operation. The plate is swedged between die and counter die with a hand or hydraulic press. After the initial press, the edges of the plate are smoothed with carborundum and it is polished with an abrasive disc. A single hole, 2 mm. in diameter, is bored in the proposed dependent portion of the plate for drainage purposes and the plate is reswedged. The materials and apparatus required for the formation of such a plate are available in any dental laboratory. Before operation, the plate is cleansed in laboratory cleansing fluid, washed in running water and sterilized in an autoclave.

b) *Operative Fixation of the Plate.* With appropriate consideration of vascular supply and scarring of the scalp, the area of the skull defect is exposed, frequently by means of the standard craniotomy incision. The pericranium is incised one centimeter about the border of the defect and this portion is removed. Indicated bone resection, cerebral scar resection, dural repair, removal of excess tissue or other measures are carried out. With the "lineator" (Fig. 2), the border of the proposed ledge in the outer table is cut circumferentially one-half centimeter from the skull defect. The ledge is formed to a depth slightly exceeding the thickness of the tantalum plate with a Stout #3 dental chisel (Fig. 2). The preformed tantalum plate is adapted to fit the diameter of the ledge by cutting with heavy scissors. With the plate held in place by digital pressure, seats for the tantalum points, much like glazier points, are made with the "perforator" (Fig. 3). The points, usually four to six in number and made of .020-inch tantalum, are tapped into place with the "wedge director" (Fig. 2), completing fixation of the plate.

Since many of the skull wounds have been infected subsequent to the acute injury, sulfanilamide powder is dusted beneath and above the plate and sulfadiazine is given orally for ten days following repair. The craniotomy wound is closed with the customary two layers of interrupted fine silk or nylon sutures without drainage. The repair is carried out in uncomplicated cases under local anesthesia and patients are allowed up within 24 hours.

c) *Illustrative Cases.*

* Studies are now being carried out for these purposes with hydromite, generously provided by the U. S. Gypsum Company.
Case 1. Primary repair of uncomplicated skull defect with preformed tantalum plate.

E.D., aet. 31, sustained an extensive, compound depressed fracture of the right frontal and parietal bones with dural and cerebral laceration on 19 July 1943, when a 155-mm. howitzer exploded in action. Primary and secondary debridements were followed by infection and the development of a cerebral fungus. On 3 April 1944, a preformed tantalum plate was inserted. Pre- and post-operative roentgenograms show the extent of the bony defect, the plate and the technique of fixation by tantalum points (Fig. 3).
Case 2. Secondary repair of deforming frontal defect by preformed tantalum plate.

W.H., aet. 22, developed an acute frontal sinusitis followed by osteomyelitis of the left frontal bone for which an extensive sequestrectomy and bilateral exenteration of the frontal sinuses were performed. Four months after the initial procedure, on 28 January 1944, a complicated, preformed tantalum plate was inserted. The extent, contour, and fixation of the plate may be seen in the pre- and post-operative roentgenograms (Fig. 4).
THE TECHNIQUE OF SECONDARY REPAIR

a) The debridement of bone in acute injuries of the skull, or the removal of a skull tumor or sacrifice of a bone plate following craniotomy may suggest the necessity for a secondary repair of the resultant skull defect. This repair may be facilitated by preliminary preparation of the operative field. After the indicated procedure is completed, the edge of the resulting skull defect is ledged as described previously. An impression of the ledge and the extent of the defect is made with autoclaved dental compound and the tantalum plate is prepared in the usual manner. Prior to closure of the primary wound, a sheet of tantalum foil is placed over the defect, extending well beyond the borders of the circumferential ledge. Experience has indicated that this is an important step in the technique since at the secondary operation for repair, the skull defect and adjacent bone will be found to be uninvolved in scar tissue and not adherent to the overlying scalp. Fixation of the tantalum plate may proceed without further dissection.

b) Illustrative Case.

Case 3. Primary debridement of extensive injury to frontal bones with secondary repair of skull defect.

E.W.D., aet. 20, was injured on 27 July 1943, when fragments from a dynamite blast struck the right frontal region of the head. On 11 August the comminuted fragments of the medial halves of both supraorbital ridges, the anterior and posterior plates of both frontal sinuses and the adjacent frontal bone were removed. After preparation of a ledge around the defect, an impression was made with sterile dental compound. Tantalum foil was placed over the defect including its edges for a width of one centimeter. On 14 September the primary coronal suture line was reopened and the scalp flap retracted rostrally. In the area where the foil had been placed, there were two glistening, white opposing surfaces with complete prevention of adhesions between the scalp, and the dura and bone. The tantalum plate fitted perfectly and was fixed in position without further alteration.

SUMMARY

The rehabilitation for further duty of Army personnel with skull defects is an ever increasing responsibility of the Army neurosurgeon. Simply contoured tantalum plates may be formed by hammering and fixed in place with tantalum wire. For the formation and fixation of more complicated plates, preformed molding and inlay fixation with tantalum points are indicated and have provided an adequate restoration of skull contour. The various techniques are described and illustrated.

REFERENCES