A COMPARISON OF POLYETHYLENE AND TANTALUM FOR CRANIOPLASTY
A PRELIMINARY REPORT


Neurosurgical Section, Surgical Service, Valley Forge Army Hospital, Phoenixville, Pennsylvania

(Received for publication November 21, 1951)

Animal experimentation in 1947 by Ingraham, Alexander and Matson\textsuperscript{5} with polyethylene in contact with the brain and its coverings showed the plastic to be innocuous to the tissue studied.

Busch\textsuperscript{2} reported in 1949 the successful use of polyethylene plate for cranioplasty in 8 patients.

Alexander and Dillard\textsuperscript{1} used polyethylene for cranioplasty and in 1950 described its advantages over other materials, citing experimental and clinical data from their own investigations and reviewing the literature concerning the properties of polyethylene and the tissue-response to this material. Polyethylene cranioplasty was reported in 5 patients. The report emphasized that polyethylene is firm, resilient, radiolucent, easy to fashion at the operating table and innocuous to tissues. Its cost is about 1/50 that of tantalum.

As is widely known, tantalum has been used successfully during recent years in large numbers of cranioplasties.\textsuperscript{3,4,6,7}

The present study is of the immediate results of cranioplasty in a group of 24 patients with skull defects following war injuries. Polyethylene was used in 12 patients. Tantalum was used in an equal number of patients. The same operating team performed surgery on both groups.

CLINICAL MATERIAL

All 24 patients were overseas casualties from the Korean Area. Twenty-two had open craniocerebral missile injuries. Two had closed head injuries with depressed skull fractures. All had had craniectomies at overseas hospitals.

Operative notes made at overseas hospitals indicated that in instances in which the dura was not penetrated by the missile, opening of the dura was carried out to determine if subdural hematoma was present.

Removal of reasonably accessible bone fragments and metallic foreign bodies had been accomplished overseas.

As a result of preparation at overseas hospitals, the edges of the skull

---

* Associate Professor of Neurosurgery, Graduate School of Medicine, University of Pennsylvania, Philadelphia.
defects were universally rather smooth and dural defects, where present, had been covered with galeal, epidermal or fascia lata grafts. The average skull defect was 6 cm. in diameter. This study did not include cranioplasty over a previously injured frontal sinus or repair of any supraorbital skull defects.

Five of the patients had had major infections with cerebral abscess or infection in the scalp flap. None had had osteomyelitis of the skull.

In the cases where cerebral abscess or infection in the scalp flap had been present, the average length of time between injury and cranioplasty was 10 months. In those cases where there had not been infection, the average length of time between injury and cranioplasty was 6 months.

All patients had been ambulatory for at least 4 months and were without exception well-nourished young adults in good general physical condition.

OPERATIVE METHODS

**Polyethylene.** The polyethylene plate,* 3 mm. in thickness, was sterilized by scrubbing for 10 minutes with soap (Septisol) followed by immersion for 24 hours in 1:1,000 aqueous Zephiran solution.

The cranial defect was exposed and the pericranium incised circumferentially 1 cm. from its margin. The pericranium was then resected centrally together with any excessive scar tissue overlying the dura. A ledge then was formed in the bone edge by using a hammer and gouge, or dental drill with burr, to remove the outer table of the skull to a width of 1 cm. about the entire circumference of the defect (Fig. 1).

A rough pattern of the defect was prepared with cloth, x-ray film or aluminum foil. The polyethylene plate was fashioned roughly from this pattern by using tin shears, or a linoleum-cutting knife, and the desired contour was obtained by manual molding during immersion in hot water.

When the desired contour was obtained, it was set by immersing the plate in cold water for 1 minute. The edges of the plate then were shaved and beveled with a linoleum-cutting knife and scalpel to obtain a smooth, tight fit in the defect with the surface of the plate flush with the outer surface of the skull.

Multiple perforations, approximately 3 mm. in diameter, to permit the escape of any accumulation of fluid or blood under the plate, were drilled in the polyethylene. These perforations also permit granulation tissue to protrude and ultimately be-

* Obtained from Plastics Department, du Pont de Nemours & Co. (Inc.), Arlington, New Jersey.
come scar tissue. It is expected that the plate thus will become more firmly secured following the initial stabilization with No. 2 silk passed through small drill-holes at the edge of the defect and at the edge of the plate (Fig. 2).

*Tantalum.* A perforated tantalum plate, 0.015-inch thick, was cut to size, following a cloth pattern obtained from the skull defect. This was hammered into shape on a skull-shaped anvil of bronze. When laid over the defect, with an overlap of about 0.5 cm. beyond the edge of the defect, it was held in place with 0.018-inch stainless steel wire which linked the perforations with drill-holes at the edge of the defect. The ends of the wire were twisted and inserted into the drill-holes (Fig. 3).

![Figs. 2 and 3. (Left) Perforated polyethylene plate secured in place with No. 2 silk. (Right) Tantalum plate secured in place with 0.018-inch stainless steel wire.](image)

**GENERAL ROUTINES**

General anesthesia with endotracheal intubation was used for all but 2 patients who had local procaine anesthesia.

When very thin temporal bone was found at an edge of a defect, tantalum was chosen because of difficulties in countersinking polyethylene in such instances.

Penicillin was given postoperatively for 10–15 days. Dilantin and phenobarbital were given prophylactically after operation for about 3 weeks.

All patients were allowed to be ambulatory on the 1st or 2nd postoperative day.

Patients were observed for an average period of 4 months following cranioplasty.

**RESULTS**

The average operating time for polyethylene and tantalum was approximately the same.
All wounds healed without infection. X-rays after operation showed no osteomyelitis. A moderate amount of subgaleal fluid accumulated in 3 patients after tantalum cranioplasty and in no patient after polyethylene cranioplasty. This minor complication was transient, and aspiration of the scalp was not carried out in any case.

One tantalum plate was removed because of the development of headache and status epilepticus within 3 weeks after cranioplasty. Subsequent observation of this patient indicated that he had a severe personality disturbance and had volitional control of his seizures.

No other patient developed headache after cranioplasty. Headache, when present before operation, was not significantly altered after cranioplasty. Likewise, visual disturbance, speech difficulty, convulsive seizures, weakness of the extremities and intellectual impairment—when present before operation—were unchanged after operation.

Moderate intolerance to exposure to hot sun was offered as a complaint by 8 patients with tantalum plates. No patient with a polyethylene plate had this complaint.

**SUMMARY**

1. Polyethylene was used for cranioplasty in 12 patients and tantalum in an equal number. The results are compared.
2. Preliminary evaluation of the patients studied indicated confirmation of the previously described qualities of polyethylene as a substance useful in cranioplasty.
3. The advantage of being able to tolerate exposure to hot sun was emphasized by the patients with polyethylene plates.
4. Tantalum was selected when thin bone edges were encountered because of the difficulty in countersinking polyethylene in such instances.
5. One tantalum plate had to be removed because of headache and seizures after cranioplasty. Causal relationship between operation and the complication is questionable.
6. Moderate subgaleal fluid accumulation occurred after tantalum cranioplasty in 3 instances and after polyethylene in no instance.
7. Otherwise, both substances were well tolerated without complication.

**REFERENCES**