EXPERIMENTAL OBSERVATIONS ON THE USE OF STAINLESS STEEL FOR CRANIOPLASTY
A COMPARISON WITH TANTALUM*

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During the past war many articles4,5,6,7,8,10,11 were published on the use of tantalum for cranioplasty. To date the results have been satisfactory. However, the writers believed that it might be worth while to investigate the use of stainless steel in animal and human cranioplasties since the material has been used successfully for many years in various parts of the body. It is easily shaped and cut at the operating table, and its present cost is 1/290th of tantalum.

The use of stainless steel as suture material was first introduced by Babcock (1933), who showed that it evokes minimal tissue reaction as compared with catgut sutures.1

The authors, as well as others, have found stainless steel wire very satisfactory for closure of laminectomies. Orthopedic surgeons have used it for bone plates and screws.

We can find no reference in literature concerning histological studies following the use of stainless steel plates in cranioplasties. Boldrey2 has used stainless steel wire mesh for the closure of small cranial defects. He placed a layer over the external table of the skull. No evidence of irritation of the meninges or brain was found, and fibrous and bony connective tissue practically welded the two wire-mesh layers into one firm plate. Chao, Humphreys and Penfield (1940)3 investigated the reaction following the use of stainless steel plates (as well as other metallic substances), in the subdural space for the prevention of meninogocerebral adhesions. These authors make no mention of its use for cranioplasties.

The present communication deals with repair of cranial defects in dogs, using perforated, stainless steel plates.†

The studies were carried out on three dogs, which were sacrificed at the end of six weeks, three months, and six months respectively.

Dog #1. Under intravenous nembutal a right parietofrontal craniotomy was performed. The dura was left open and the bone defect was repaired by an overlying stainless steel plate, 8 × 5 cm. The temporal muscle was sutured over the plate with stainless steel wire sutures, and the skin closed. Wound healing was normal. After 6 weeks the animal was sacrificed. There was no fluid above or below the plate. After reflection of the temporal muscle

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† Analysis and thickness: The stainless steel plate was 0.015 inches in thickness. The stainless steel used had the following composition: carbon, .08-.20%; manganese, 1.25% maximum; silicon, .75% maximum; sulfur and phosphorus, .09% maximum; chromium, 18-20%; and nickel, 8-10%.

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the plate was found to be completely encapsulated by a thickened, smooth, glistening hyaline membrane.

Microscopic. Sections of this membrane did not reveal the presence of any inflammatory reaction. The membrane resembled a thickened dura. No photomicrographs were available for reproduction.

Dog #2. A bilateral trephine opening was made over both parietal areas. The dura was opened on the right and a small, perforated, stainless steel plate, 1 ½ cm. square, was placed beneath it in the subdural space and the dura closed with stainless steel wire. The muscle was closed with stainless steel wire. The dura was not opened on the left. A perforated stainless steel plate was anchored to the bone over the trephine opening by stainless steel wire. Healing was excellent and at no time were any collections of fluid noticed beneath the muscle or scalp. Three months later the animal was sacrificed by intravenous nembutal.

Fig. 1 (left). Dog #2. The temporal muscle is reflected, showing the stainless steel plate surrounded by a thin, transparent capsule.

Fig. 2 (right). Dog #2. The outer capsular layer is reflected, exposing the underlying, shiny, stainless steel plate. No fluid was found above or below the plate.

Autopsy. Left trephine (plate sutured to external table around trephine opening). There was no serous collection beneath the scalp or temporal muscle. The undersurface of the muscle was adherent to a very thin, transparent capsule which covered the outer surface of the plate (Fig. 1). The capsule, approximately 1 mm. in thickness, was incised and reflected from the underlying shiny plate. The undersurface of this membrane was glistening (Fig. 2) and no fluid was found between it and the plate. The plate was completely encapsulated, and bands of firm tissue penetrating the perforations in it firmly united the outer and inner layer of the capsule. A section of this capsule, and overlying muscle, showed no inflammatory reaction (Fig. 3A). The plate was firmly anchored to the bone and upon elevation its undersurface was just as clean and shiny as the outer surface. There was no fluid beneath the plate. The bony defect was completely covered by glistening white tissue, the outermost layer of which was apparently the inner layer of capsule surrounding the plate. Sections of this tissue showed the absence of inflammatory reaction (Fig. 3B). The inner layer of the capsule was composed of a thickened layer of fibrous tissue consisting of numerous fibroblasts. The nuclei of the fibroblasts were arranged parallel to the surface of the capsule. The dura was flat, of normal color, and, although thickened, showed no inflammatory reaction (Fig. 3C). The bony edges of the trephine openings were smooth and showed no abnormal reaction.

Right trephine (subdural insertion of plate). The temporal muscle was reflected, exposing the dura. The dura was reflected laterally and a capsule was found adherent to its undersurface. The capsule was approximately 1 mm. thick and its undersurface was smooth and glistening, where it had been applied to the outer surface of the plate. Firm tissue had grown