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Tools and techniques

Impacts of pressure bonding fixation on a bone flap depression and resorption in patients with craniotomy

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ABSTRACT

Fixation of bone flaps after craniotomy is a routine part of every neurosurgical procedure. Common problems encountered are bone flap depression and resorption. Authors performed the pressure-bonding bone flap fixation (PBFF) using absorbable craniofix (AC) and hydroxyapatite wedge (HW). The aim of the present study is to evaluate the efficacy of PBFF to prevent a bone flap depression and resorption in patients treated with craniotomy. Four-hundred fifty-four patients underwent craniotomies. Authors collected the following data: age, sex, type of craniotomy, what kind of surgery, whether bypass surgery was performed, whether surgery was the initial, whether AC and the HW were used, bone flap depression and resorption at 6-month after the craniotomy. PBFF was defined as a bone flap fixation using both AC and HW to impress a bone flap to forehead. The mean age was 62 ± 13 years and 404 (89%) patients were women. PBFF was performed in 71 patients (16%), either AC or HW was used in 141 (31%), only AC was used in 116 (25%), and only HW was used in 25 (5.5%). At 6-month after the surgery, a bone flap depression was seen in 38 patients (8.4%), and a bone flap resorption was seen in 66 (15%). Multivariate analysis showed that only a PBBF showed a negative correlation with bone flap depression ($p = 0.044$) and resorption ($p = 0.011$). The results of the present study showed that PBFF reduced a bone flap depression and resorption and provided excellent postoperative cosmetic results.

1. Introduction

Fixation of bone flaps after craniotomy is a routine part of every neurosurgical procedure. Historically, bone flap fixation after craniotomy was performed with steel wires, which were subsequently abandoned and replaced by silk or nylon sutures following the introduction of computed tomography (CT) scans due to the extensive metal artifacts. From a mechanical point of view, soft sutures could not provide a stable attachment of the bone flap to the cranium as there are no locking connections and only a weak connection by friction [1]. The most common problem encountered is bone flap depression [2]. In addition, bone resorption is also a known complication after craniotomy [3].

In collaboration with Lerch [4], Aesculap (Aesculap AG, Tuttlingen, Germany) developed a new fixation clamp made of absorbable polyester (Craniofix Absorbable®). The absorbable craniofix (AC) consists of two synthetic halfshells constricted by non-resorbable sutures. The sutures are pre-manufactured in a chain-block and have to be pulled to seal the clamp. The procedure does not demand any additional tools. Recently, authors developed a small wedge, which was composed of hydroxyapatite (hydroxyapatite wedge, HW) [HOYA Technosurgical Corporation, Inc., Tokyo Japan], to fill the gap between bone flap and the cranium. A bone flap could be crimped to the cranium by inserting HWs into the gap. Authors performed pressure-bonding bone flap fixation (PBFF) using ACs and HWs.

The aim of the present study is to evaluate the efficacy of PBFF to prevent a bone flap depression and resorption in patients treated with craniotomy.

2. Methods

Between June 2013 and June 2015, 565 patients underwent frontotemporal, bifrontal, or other craniotomy at the Department of Neurosurgery at Teishinkai Hospital. Patients with open head

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injuries, other additional risk of wound infection, suboccipital craniotomy were not included. Among them, 111 patients were excluded: fifty-one were still not be performed CT scan at 6-month after surgery, fourty five were move to rehabilitation hospital or other neurosurgical hospital to be follow-up, and fifteen were performed only magnetic resonance imaging after surgery. Finally, 454 participated in the present study. The study protocol was approved by the institutional ethics committee.

Authors collected the following data: age, sex, type of craniotomy, what kind of surgery, whether bypass surgery was performed, whether surgery was the initial, whether AC and/or HW were used, bone flap depression and resorption at 6-month after the craniotomy.

2.1. Surgical technique

The patients underwent surgery either in skull clamp fixation or on a horse-shoe headrest. Each patient received perioperative antibiotics with 1 g Cefamezin i.v. Usually, only 1 or 2 burr holes were made and the burr holes were connected by the use of an electrical motor driven osteotome (most often Primado [NSK Nakanishi, Inc., Tochigi, Japan] or Midas Rex [Medtronic, Inc., Minneapolis, MN]). The bone flap was wrapped and immersed in saline at room temperature during the surgical procedure. Bone wax was used sparingly and only to control specific sites of active bleeding. Dural tenting sutures were used to control specific sites of epidural bleeding and never for prophylaxis. Since July 2014 authors used AC and since December 2014 they used HWs. Before these periods, they used titanium plate to fix a bone and/or they used nylon suture to fix anterior edge of bone flap with bone piece wedging into posterior gap between a bone flap and skull. After the intracranial procedure, the dura was closed by 5-0 Pronova® sutures and the bone flaps were returned to its correct anatomical position and fixed exclusively with AC (Fig. 1). The bottom clamp of the AC has to be positioned inferior to the edge of the trepanation, thereafter the bone flap is inserted. The upper clamp is then drawn down by pulling the prepared suture in the manner of a chain block. The traction torque is predefined by the disruption of the handle at a predetermined breaking point. One or two additional knots can be made to lock the AC. Subsequently HWs and bone dust were inserted into the gap between a bone flap and cranium (Fig. 1). To achieve rigid immobilization of the flap, a thin-bladed instrument, such as a freer elevator, is used to pry the kerf open and allow the HWs to be tightly wedged into the gap. Occasionally the HWs were driven into place with a small mallet or other surgical tool. In most cases, a bone flap was impressed to forehead, and AC and HWs were used behind the hairline because of esthetic concerns. PBFF was defined as a bone flap fixation using both ACs and HWs.

Starting burr holes are obscured by filling them with Apaceram [HOYA Technosurgical Corporation, Inc., Tokyo Japan]. After bone flap fixation, the wound is closed in layers. The subgaleal space was drained with bulb suction through a flat perforated tube; the drain was removed approximately 24 to 48 h later.

2.2. Outcome

All patients underwent a postoperative CT scan of the head with 3D reconstruction just after surgery to detect any surgical complications, visualizing the bone flap position as well. All surviving patients underwent CT at 6 months after surgery to evaluate bone flap depression (using CT algorithm measurement [on bony windows calculating the difference of alignment between inner and outer cortical bone of both skull and flap along the craniotomy]) and resorption (erosion of the bone flap and/or the cranium using always the same bony windows setting [level 600, width 4 095]).

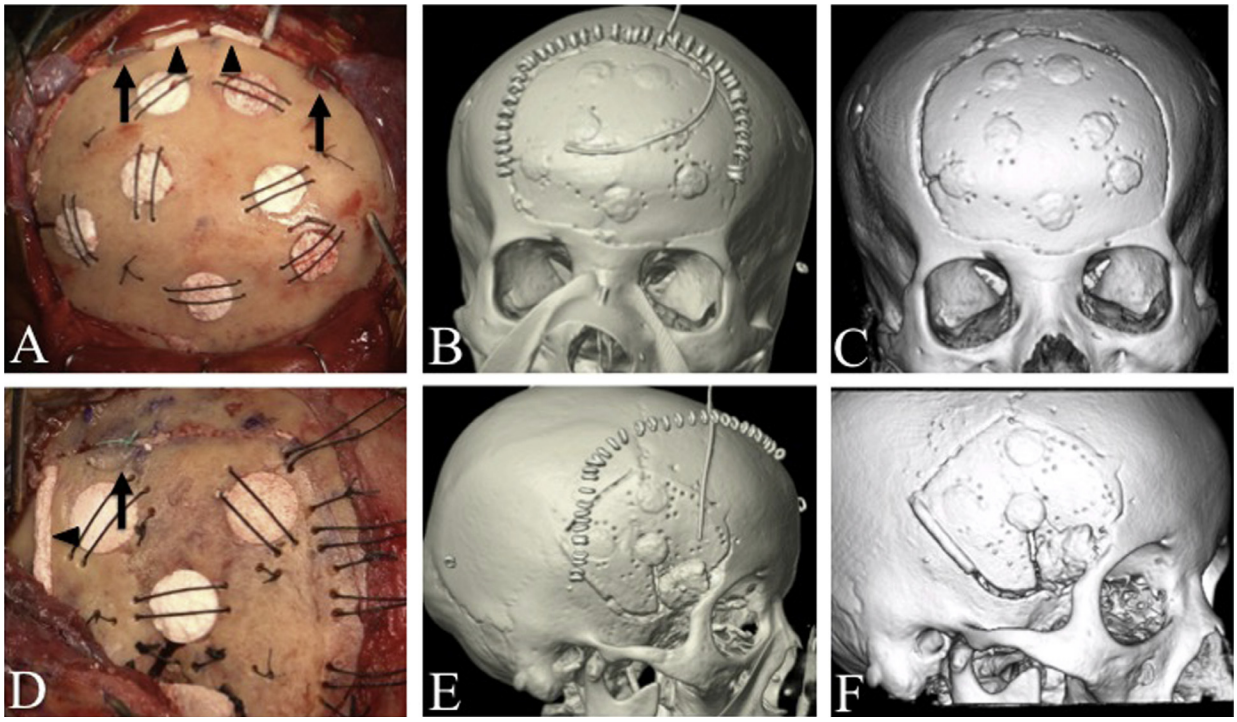

Fig. 1. PBFF in bifrontal and frontotemporal craniotomy. Black arrows indicate AC and black arrow heads indicate HW in bifrontal craniotomy (A). 3D CT scan of bone image showed that a bone flap is in a good anatomic position (B), and bone flap depression and resorption were not observed at 6-month (C). Black arrows indicate AC and black arrow heads indicate HW in right frontotemporal craniotomy (D). 3D CT scan of bone image showed that a bone flap is in a good anatomic position (E), and bone flap depression and resorption were not observed at 6-month (F). Abbreviation: AC, absorbable craniofix; HW, hydroxyapatite wedge; PBFF, pressure-bonding bone flap fixation.