Cranioplasty: Is Surgical Education Safe?

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BACKGROUND: **Patient safety aspects and the residents' role in spine surgery within a structured training program have recently been investigated. The current work deals with residency training safety aspects for cranioplasty (CP), a standard neurosurgical cranial procedure.**

METHODS: **Retrospective 2-center study comparing consecutive patients undergoing CP by a supervised neurosurgery resident (teaching cases) with a consecutive series of patients operated on by a board-certified faculty neurosurgeon (nonteaching cases). The primary end point was occurrence of a postoperative complication. Secondary end points were severity (Ibañez degree) of postoperative complications, surgical site infections requiring CP removal and patients' clinical outcome measured with the modified Rankin Scale.**

RESULTS: **A total of 240 CPs (137 teaching [57.1%] and 103 nonteaching [42.9%] cases) were analyzed. The mean teaching case operation time was longer (129.2 vs. 115.8 minutes; $P < 0.001$), and there was no difference in the estimated blood loss (mean 243.3 vs. 223.1 mL; $P = 0.444$). Supervised residents were as likely as board-certified faculty neurosurgeons to have a postoperative complication (odds ratio [OR], 0.77; 95% confidence interval [CI], 0.42–1.39; $P = 0.385$) and the severity was comparable (Pearson $\chi^2 = 7.62$; $P = 0.106$). Teaching cases were as likely as nonteaching cases to experience a surgical site infection requiring CP removal (OR, 1.66; 95% CI, 0.69–4.04; $P = 0.261$). Also, the likelihood for postoperative improvement on the modified Rankin Scale was similar for patients in both groups (OR, 1.11; 95% CI, 0.62–2.00; $P = 0.719$).**

CONCLUSIONS: **A relatively simple cranial procedure, such as CP, can be safely performed by a supervised neurosurgery resident without increasing complications or compromising patients' outcomes.**

INTRODUCTION

In times of work-hour restrictions in residency, high-quality neurosurgical education in Europe is a concern of paramount importance.[1] Although regulating the neurosurgical training program is one solution,[1] surgical education should begin as early as possible without putting patients at risk and should be complemented by surgical training simulators and cadaver courses. In the context of a previously reported structured training program used at the Department of Neurosurgery of the Cantonal Hospital St. Gallen, surgical resident education proved to be safe for several spinal procedures such as lumbar microdiscectomy and decompression as well as anterior cervical discectomy.[2-5] Whether these findings also hold true for cranial surgery remains unanswered.

Key words
- Complication
- Cranioplasty
- Functional Outcome
- Resident Training
- Risk
- Safety
- Surgical Education

Abbreviations and Acronyms
BCFN: Board-certified faculty neurosurgeon
CP: Cranioplasty
EBL: Estimated blood loss
F-U: Follow-up
HUG: University Hospital Geneva
KSSG: Cantonal Hospital St. Gallen
mRS: Modified Rankin Scale
PEEK: Polyetheretherketone
PGY: Postgraduate year
PMMA: Polymethylmethacrylate
SSI: Surgical site infections

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Cranioplasty (CP) is a reconstructive procedure, most commonly performed in patients after decompressive hemicraniectomy for increased intracranial pressure secondary to ischemic or hemorrhagic stroke or traumatic brain injury.[6] Less frequently, CP is performed after infectious or wound healing complications after bone flap reinsertion after cranial surgery. On the one hand, CP is a relatively straightforward procedure commonly performed early in neurosurgery residency training. On the other hand, CP is one of the cranial procedures associated with considerably high rates of overall complications, which are reported to be up to 31.32%.[7]

The present study tested the hypothesis that complication rates and postoperative outcome of supervised residents and experienced board-certified faculty neurosurgeons (BCFNs) are similar in CP surgery.

METHODS

Study Design and Patient Identification

This was a retrospective 2-center study of consecutive patients scheduled for CP in the time interval January 2010 to August 2015 at Cantonal Hospital St. Gallen (KSSG) and between January 2008 and August 2013 at the University Hospital Geneva (HUG). Patient charts were reviewed and all patients with complete relevant clinical and radiologic data were included. All cases were dichotomized into teaching cases (patients operated on by a neurosurgery resident in postgraduate year [PGY] 2 to PGY-6) and nonteaching cases (patients operated on by a BCFN).[2-5] At KSSG and HUG, residents fulfill the requirements to perform their first CP after 18 months of training, at the time when they also begin to perform cranial approaches. Group assignment was mostly influenced by the surgeon's level of experience at the initial surgery: patients who previously underwent removal of their bone flap by a resident or BCFN were usually reassigned to the same surgeon to pursue continued patient care.

Patients or their next of kin were informed of their surgeon's training level. Every teaching case was supervised by a BCFN, who was usually scrubbed in and could intervene when the resident experienced difficulties (eg, dissection of scar tissue, hemostasis, or in case of intraoperative complications such as brain swelling and problems with fitting the flap). The study protocol respected crossovers as previously handled.[2-5] Teaching cases were operations that were (almost) completely performed by the trainee. For the analysis, the operation was declared a nonteaching case whenever key parts of the procedure such as the surgical approach (interface dissection), handling complications (brain swelling, bleeding), ventricle tapping (if necessary), or constructing the CP were performed by the BCFN. Informed consent was obtained from all individual participants included in the study.

Sample Size Calculation

No literature data were available on cranial complication rates comparing residents and BCFNs. An estimated complication rate of 20% in teaching cases and 15% in nonteaching cases with a standard deviation of 10% was used for sample size calculation, which showed that 64 patients per group were needed to detect a difference with a power of 80% and α set at 0.05.

Preoperative Factors

Besides patients' baseline characteristics and details on comorbidities, the cause and side of the bone defect, time to CP from bone flap removal, number of previous cranial surgeries since the bone flap removal as well as the modified Rankin Scale (mRS) before CP were determined. Computed tomography measurements of the diameter of the craniectomy site were taken as shown in Figure 1 to compare the size of the bone defect.

Surgical Technique and Management

Timing of CP was not standardized and depended on the clinical and radiologic evolution of the patient after craniectomy. Timing for CP in teaching cases was decided by both the resident and his/her supervising BCFN. Surgery was performed under general anesthesia in the supine or lateral decubitus position. Usually, cefamandole 1–2g (KSSG)/cefazolin 2 g (HUG) (Mandokef/Kefzol [Teva Pharma AG, Basel, Switzerland]) was administered for standard perioperative antibiotic prophylaxis. A lumbar drain was inserted in case of insufficient subsidence of the skin flap with evidence of ventricular enlargement. The scar was reincised and extended when necessary. The myocutaneous flap was dissected free from the underlying dura or patch. Once the bone edges and central tack-up sutures were prepared, a frozen and autoclaved autologous bone, a polymethylmethacrylate (PMMA) (Palacos [Heraeus, Yverdon-les-Bains, Switzerland]) or polyetheretherketone (PEEK) (Peek-Synthes [Synthes, Oberdorf, Switzerland]) plastic was inserted and the temporal muscle reattached. The choice of material was largely influenced by the cause of bone flap removal. An extracranial drain without suction was inserted at the discretion of the surgeon and the wound was closed in the usual fashion.

Data Collection

Operation time in minutes, estimated blood loss (EBL), and type of graft material were recorded. Complications up to postoperative day 30 were recorded and classified according to Ibañez et al.[8]: grade I complications were any non–life-threatening deviations from the normal postoperative course; grade II complications were those requiring invasive (surgical) treatment (eg, surgical site infection [SSI], epidural hematoma); grade III complications refer to life-threatening complications requiring management in an intensive care unit (eg, large epidural hematoma, intracerebral hemorrhage); and grade IV complications result in death. SSI and delayed SSI >30 days postoperative requiring redo surgery were recorded separately. The mRS at the last known follow-up (F-U) was used to determine the postoperative outcome.

Statistical Methods and Study End Points

Important baseline (Table 1) and surgical parameters (Table 2) between the study groups were compared using Pearson χ^2 tests for categorical and rank-sum tests for ordinal variables. The same applies to the comparison of operation time, EBL, and complication rates (Tables 2 and 3). The primary end point was the occurrence of a postoperative complication. The secondary end point was patients' clinical outcome at the last F-U. Because we noted a relatively high rate of infectious complications, a further analysis pertaining to SSI was performed. The primary