Risk Factors for Graft Infection After Cranioplasty in Patients with Large Hemicranial Bony Defects

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■ OBJECTIVE: **To identify infection incidence and related risk factors in patients who underwent cranioplasty (CP) after unilateral decompressive craniectomy (DC).**

■ METHODS: **CP after DC was performed in 45 patients from April 2011 through January 2012. The covariates studied were compared with occurrence versus nonoccurrence of infection. Univariate analysis was performed, followed by a multivariate analysis and development of independent logistic regression models with significance of 5%.**

■ RESULTS: **Wound infections were observed in 24% of cases. Patients treated with polymethyl methacrylate flaps had a 31% rate of infection compared with 12% in patients treated with autologous flaps, but the difference was not statistically significant ($P = 0.279$). Increased risk of infection was associated with performing CP during the same period of hospitalization as DC (45% vs. 8%; $P = 0.006$), recent systemic infection (53% vs. 10%; $P = 0.003$), a Glasgow Outcome Scale score lower than 4 (48% vs. none; $P < 0.001$), motor deficit (42% vs. 5%; $P = 0.011$), and lower levels of hemoglobin ($P < 0.001$). Another risk factor for infection was an interval between DC and CP of 29–84 days compared with >168 days ($P = 0.007$).**

■ CONCLUSIONS: **The incidence of wound infection was high. Risk factors included motor deficits, Glasgow Outcome Scale score <4, lower hemoglobin levels, recent systemic infections, interval between DC and CP of 29–84 days, and DC and CP performed during the same hospitalization. Performing CP during a different hospitalization may reduce the risk of graft infection because the hemoglobin level would be higher, and patients would be less dependent and free of recent infection.**

INTRODUCTION

Decompressive craniectomy (DC) is a surgical technique commonly used to treat refractory intracranial hypertension secondary to severe head trauma, extensive ischemia, cerebral venous sinus thrombosis, and subarachnoid hemorrhage (1, 6, 9, 10, 12, 13, 19). Although DC is effective in controlling intracranial hypertension, there are many consequences related to this procedure, which include the syndrome of the trephined (11) and the need to correct a large bony defect in surviving patients.

Cranioplasty (CP) is needed to protect the brain, reestablish esthetic appearance, and improve symptoms of the syndrome of the trephined. Some studies also report cognitive amelioration and motor deficit recovery as well as increased cerebral blood flow and brain metabolism (7, 8, 21, 26). Although CP is considered a low-complexity surgery compared with other neurosurgery procedures, it has a high incidence of postoperative complications, which can be 40.8% (3). Of these complications, wound infection is the most frequent with an incidence rate of up to 31.8% (25). The objective of the present study was to identify the risk factors of wound infection in 45 patients who underwent unilateral hemicranial CP performed by one team with standardized surgical technique.

MATERIALS AND METHODS

After receiving approval by the Committee of Ethics in Research, this retrospective study was performed at the Hospital João XXIII

Key words
- Cranioplasty
- Decompressive craniectomy
- Infection
- Risk factors

Abbreviations and Acronyms
CI: Confidence interval
CP: Cranioplasty
DC: Decompressive craniectomy
GOS: Glasgow Outcome Scale
Hb: Hemoglobin

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in Belo Horizonte, Brazil. Data were collected from forms filled out on the day of surgery containing information related to the clinical condition of patients and intraoperative findings as well as from a retrospective review of medical records and during outpatient consultations.

The study initially included 62 patients who had undergone CP to correct large bony defects resulting from unilateral DC. There were 17 patients excluded, leaving 45 patients for the study. There were 3 patients excluded because they underwent reoperation for an extradural hematoma, and the flap was removed before the wound infection could be assessed. There were 8 patients excluded because they did not have a 90-day follow-up period. However, 2 patients who returned with wound infection during this period of time remained in the study. There were 5 patients excluded because relevant data for the research, mainly data related to technique, could not be obtained (the patients were not operated on by the main author (RSR) of this article). A 2-year-old boy was excluded owing to his age and immature skull because comparing results with older patients (minimum 9 years old) could produce inaccurate data.

Infection in the operative wound was defined as follows: presence of fluid draining from the surgical site, even in the absence of inflammatory signs or positive cultures; cases of wound dehiscence with flap exposure; and detection of an extra-axial collection under the CP flap with progressive increase in size and mass effect, symptomatic or asymptomatic, seen on a computed tomography scan. In all these cases, the patients underwent reoperation for removal of the graft.

The intraoperative prophylactic antibiotic was cefazolin (for outpatients) or meropenem plus vancomycin (for patients operated on during the same hospitalization as the DC) as a single dose. Whenever possible, the skull reconstruction was done with the bone flap stored in abdominal subcutaneous tissue. Polymethyl methacrylate was used in the other cases. There was no frontal sinus exposure during any CP. The flap was fixed to the skull by monofilament thread. A suction drain was positioned in the extradural space and removed on the first postoperative day. The patients were discharged as soon as possible. All patients included in this study had at least 1 assessment after the surgery. The last assessment during the follow-up period was not always in person. Some patients, or their legal representatives, were contacted by telephone. For the patients who died, the date of death was considered the last day of follow-up.

Statistical Analysis

Data analysis was carried out in R software, version 2.15.0 (http://cran.r-project.org/bin/windows/base/old/2.15.0), and Epi Info, version 6.04 (https://wwwn.cdc.gov/epiinfo/html/ei6_downloads.htm). The level of significance was set at 5%. The results were acquired by measuring the frequencies and percentages of the categorical characteristics, by measuring central tendency (mean and median), and by measuring dispersion (standard deviation) to quantitative. In the univariate analysis, the comparison between infection and the characteristics in the quantitative form was made by Student *t* test, when the supposition of normality was satisfied. Otherwise, the Mann-Whitney test was used. The supposition of normality was verified using the Shapiro-Wilk test to normality and the Levene test to homoscedasticity. In cases with 2 categories, the F (analysis of variance) or Kruskal-Wallis nonparametric test was used. Comparisons between 2 characteristics in categorical form were made from contingency tables (2 categories in each variable), and χ^2 test with Yates correction was applied to proportion comparison. Pearson χ^2 test was used when ≥ 3 categories were analyzed. In the presence of an expected frequency <5, Fisher test was conducted. With regard to multivariate analysis, 5 independent logistic regression models were developed for the response variables, with penalized likelihood estimator because there are cases of null frequency. In the initial model, all the variables with *P* values < 0.25 were included in the univariate analysis. All the variables with higher *P* values were removed, resulting in variables with statistical ($P \leq 0.05$) and clinical significance.

RESULTS

Of 45 patients, 37 (82%) were male. The average age was 31.9 years (range, 9–71 years). Wound infections were detected in 11 cases (24%). The interval between the CP and flap removal because of infection ranged from 26 to 195 days (mean 88.5 days and median 82 days). The postoperative care period ranged from 63 to 797 days, and only 25% of the patients had a follow-up period <511.5 days. In 4 patients, the follow-up period was <200 days; 3 of these patients presented with infection and underwent reoperation (follow-up times 63, 88, and 130 days), and 1 did not have an infection (follow-up time 143 days).

Table 1 shows the comparison of wound infection and discharge after DC, recent systemic infection (defined by the use of antibiotics in the 30 days before CP), flap over temporal muscle, sinking flap, cerebrospinal fluid drainage or dural lesions during the surgery, and presence of tracheostomy at the time of the CP. *P* values <0.25 were noted with the following variables: discharge after DC, recent systemic infection, and intraoperative cerebrospinal fluid drainage. These were indicated in the multivariate model.

Table 2 shows the comparison between wound infection and the indication for DC, the material used to cover the cranial defect and incision type, the side of the surgery, the preoperative Glasgow Outcome Scale (GOS) score, the presence of motor deficit and malnutrition, the number of days between the DC and the CP, and the number of days between CP and discharge. The variables indicated in the multivariate model were incision type, preoperative GOS scale, motor deficit, interval between the DC and the CP, and interval between CP and discharge because they achieved a *P* value < 0.25.

Table 3 shows the comparison between wound infection and hemoglobin (Hb), hematocrit, leukocytes, platelets, clotting times, and serum albumin. Hb, hematocrit, leukocytes, and platelets were used in the multivariate model because they achieved a *P* value < 0.25. Data on serum albumin levels were unavailable in 19 of 45 patients. After the univariate analysis had been performed, multivariate analyses were carried out, and 5 independent models of logistic regression with significance levels of 5% were designed (Table 4).

DISCUSSION

In this case series, which included 45 patients who had undergone CP after unilateral DC, the wound infection rate was 24% (11