

# Outcome Assessment in Craniosynostosis: a Prospective, Statistical Analysis of Reoperation Rates

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## SUMMARY

A prospective statistical study of reoperation rates were reviewed in the treatment of 167 consecutive children with nonsyndromic and syndromic craniosynostosis over a six year period at Scottish Rite Children's Medical Center in Atlanta, Georgia. Reoperation equal to or exceeding the magnitude of the original procedure occurred in 7% of cases. Multivariable statistical analysis revealed several factors associated with reoperation. Females and children with syndromic synostoses were more likely to require reoperation. Age at initial surgery, length of operation, and estimated blood loss did not predict a higher reoperation rate.

## INTRODUCTION

The rate of reoperation is an important outcome variable in the surgical treatment of craniosynostosis. Although quantitative changes of craniofacial remodeling are critical to understanding operative results, the decision to reoperate on a particular child is determined primarily from subjective measures of outcome, most commonly aesthetic appearance. Longitudinal studies of reoperation rates from a variety of centers are beginning to appear in the literature [1-5]. Herein, a prospective, six year study of reoperation rates in the treatment of 167

children with nonsyndromic and syndromic craniosynostosis is presented. Preoperative, operative and postoperative variables are analyzed to determine if clinical factors associated with reoperation can be identified.

## MATERIALS AND METHODS

From January 1989 to January 1995, 167 patients with craniosynostosis were surgically managed at the Center for Craniofacial Surgery at Scottish Rite Children's Medical Center in Atlanta, Georgia. All children were seen by a multidisciplinary group and operated on by a team of craniofacial and neurosurgeons. Our protocols for management of non-syndromic and syndromic cases are shown in Tables 1 and 2. Sixty-one children were females and 106 were males, whose ages at the initial operation ranged from 2 weeks to 6 years (mean= 1 year).

**Table 1:** Treatment of Nonsyndromic Synostosis.

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Sagittal synostosis (< 7 weeks, mild to moderate deformity) - Strip craniectomy

Sagittal synostosis (>7 weeks, severe deformity) - Total cranial vault reconstruction at presentation.

Unicoronal, bicoronal, metopic synostosis - Fronto-orbital remodeling, floating forehead at 4-6 months of age.

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**Table 2:** Treatment of Syndromic Craniosynostosis.

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Fronto-orbital advancement, cranial reshaping at 4-6 months of age, earlier if increased ICP present.

\* Redo Fronto-orbital advancement, cranial reshaping as required at approximately 2 years of age.

Monoblock or LeFort III with or without bipartition at 4-7 years of age.

Orthognathic surgery at adolescence (post-growth period).

\* Reoperations evaluated in this study include this procedure.

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Patients treated with lambdoid disorders were excluded from the study. There were 12 children with bicoronal synostosis (7.2%) 39 with metopic (23.4%) 18 with unicoronal (10.8%) 46 with sagittal synostosis who had strip craniectomies (27.5%); 31 with sagittal



synostosis undergoing total cranial vault reconstruction (18.6%); 9 with multiple synostoses (5.4%) and 12 with syndromic synostoses (7.2%). Only the neurosurgeon was involved if a strip craniectomy was carried out, but for the remaining patients 4 combinations of teams conducted the operation. The length of operation (total anesthesia time) in minutes ranged from 81 to 570 (mean= 245 minutes). The mean estimated blood loss was 203 ml. Twenty-three percent of patients required no transfusion, 16% required less than 100 ml and 61 % required more than 100 ml. Thirty-four percent of patients were sent to the intensive care unit after surgery, while 67% were transferred to the floor. Mean length of hospital stay was 4.67 days.

Reoperation was defined as total if the reoperation equaled or exceeded the magnitude of the original procedure and partial if it did not. Partial reoperations were almost always for recontouring with or without hardware removal.

Hardware removal was recorded as a separate partial reoperation.

### Statistical Analysis [6]

Crude statistical analysis of reoperation rates following primary repair of craniosynostosis was carried out using Fisher's Exact

Tests or Generalized Fisher's Exact Tests because of the relatively small number of reoperations (7%).

Interval variables such as operating times in minutes or length of hospital stay were analyzed with T-tests. In some cases the Wilcoxon Rank Sum tests appeared more valid given the skewed distributions of the interval variables.

Options for multiple logistic regression analysis of total reoperation rates using some of the variables that appeared significant on crude, univariate analysis were limited in this study. The rule of thumb is that the total number of variables in the logistic regression should be no greater than the smaller of 10% of the number of reoperations (n=12) or non-reoperations (n=149). This suggests that multivariable analysis is not possible. We can stretch this criterion a bit, however, in order to identify important relationships among the variables, but the results must be interpreted cautiously.

### RESULTS

Twelve of the 167 patients required a total reoperation for a reoperation rate of 7% (Fig. 1). The mean length of follow-up was 2.8 years with a range of 3 months to 6 years. When compared individually, there was no statisti-

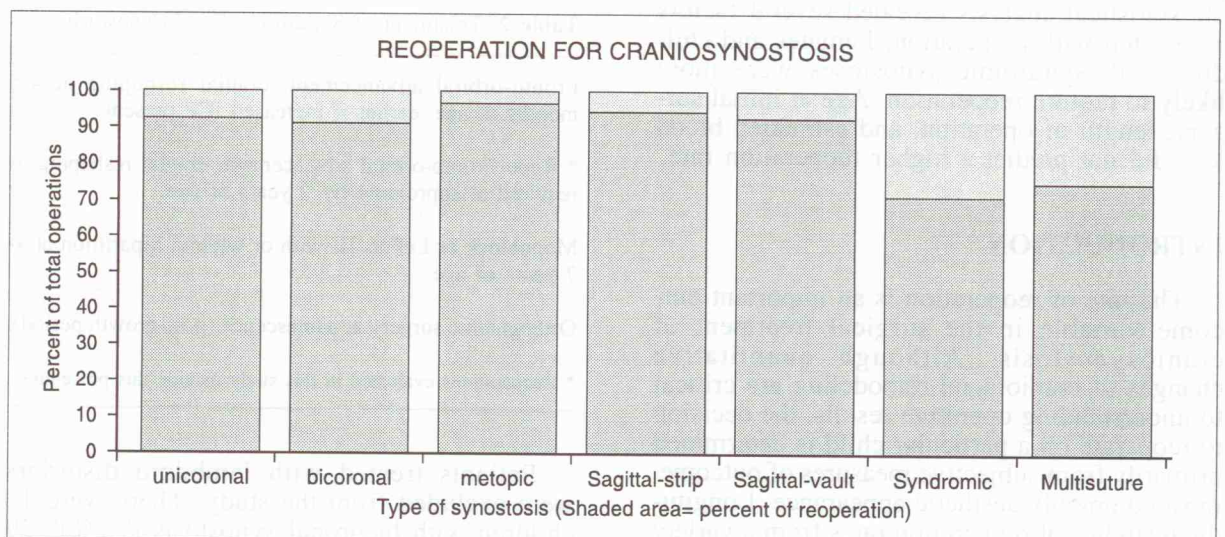


Fig. 1: Reoperation for Craniosynostosis.

