Operative Management of Non-Syndromic Sagittal Craniosynostosis: A Head-to-Head Meta-Analysis of Outcomes Comparing Three Techniques

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Background

The treatment of sagittal craniosynostosis is currently evolving. Total vault remodeling (CVR) has been effective for correcting shape and expanding intracranial volume. However, treatment paradigms have shifted, emphasizing less-invasive procedures, including spring-mediated cranioplasty and strip suturectomy. This study aimed to compare outcomes for CVR, spring-mediated cranioplasty, and strip suturectomy via systematic meta-analysis.

Methods

A literature search was conducted identifying all articles involving operative management of non-syndromic sagittal craniosynostosis. Comparison of 2 operative techniques was required for inclusion, and methodological quality was assessed via ASPS Levels of Evidence scale. Three techniques were considered: CVR, strip suturectomy, and spring-mediated cranioplasty. Meta-analysis was conducted for change in cephalic index (CI), reported as weighted mean difference (WMD). Pooled subgroup comparisons were performed for operative time, length of stay, blood loss, and total cost.

Results

13 studies were included, all providing level 3 evidence. All studies involved CVR (n=187), 8 involved strip suturectomy (n=299), and 7 involved spring-mediated cranioplasty (n=158)(Figure 1). Average age for CVR was 8.4 months, compared to 4 months for suturectomy and 5 months for spring-cranioplasty; all groups were male-predominant. Head-to-head comparison of change in CI demonstrated a greater, yet statistically insignificant change for CVR versus spring cranioplasty, WMD=0.94 [-0.23-2.11] ($p=0.12$, $I^2=55\%$)(Figure2). In contrast, CVR showed a statistically greater change in CI versus strip suturectomy, WMD=1.47 [0.47-2.48] ($p=0.004$, $I^2=66\%$). Post-operative cephalic index was correlated with follow-up for each technique, demonstrating that as follow-up increased, CI increased in the strip and spring cranioplasty groups and decreased in CVR groups. Subgroup analysis showed longer operative time for CVR versus suturectomy/spring-cranioplasty (170.2 vs 97.2 min), higher blood loss (237.7 vs 47.3 mL), longer length of stay (5.13 vs 2.96 days), and higher total costs ($35,280 vs $13,147), all with p values<0.0001.

Conclusions

This study, the first meta-analysis comparing 3 primary operations for correcting sagittal craniosynostosis, demonstrates no difference in CI for CVR versus spring cranioplasty and a small but statistically greater improvement in CI favoring CVR to strip suturectomy. Longer follow-up time was associated with decreasing CI for the CVR group and increasing CI for less invasive modalities, and secondary outcomes favored the less invasive procedures. While definitive conclusions cannot be made, it appears that less invasive procedures are as efficacious as CVR but offer more favorable safety profiles.

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