

# Complications and neurologic improvement associated with timing of cranioplasty: A systematic review and meta-analysis

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## BACKGROUND

Cranioplasty after decompressive craniectomy is a common neurosurgical procedure, yet the optimal timing of cranioplasty has not been well established.

## OBJECTIVE

To investigate whether the timing of cranioplasty is associated with differences in complications and neurologic outcome.

## METHODS

We performed a systematic review and meta-analysis using MEDLINE, Scopus, and the Cochrane databases for studies reporting timing of cranioplasty after decompressive craniectomy and either complications or standard quantitative neurologic assessments. For timing, we considered “early” cranioplasty to be within 90 days from craniectomy and beyond that to be “late”. For complications, extracted data included overall complications, infections, reoperations, intracranial hemorrhage, extra-axial fluid collections, hydrocephalus, seizures, and bone resorption. Odds Ratios (OR) and 95% Confidence Intervals (CI) were calculated for each category. For neurologic assessments, extracted data included mean and standard deviation. To normalize and compare measures, the Standard Mean Difference (SMD) was calculated. The Mantel-Haenszel method was used to pool effect measures.

## RESULTS

For complications, twenty-five articles met inclusion criteria for a total of 3,126 patients (1,421 early vs 1,705 late). All were retrospective observational studies. Early cranioplasty had significantly higher odds of hydrocephalus than late cranioplasty (OR 2.38, CI 1.25-4.52,  $p=0.008$ ). There was no difference in odds of overall complications, infections, reoperations, intracranial hemorrhage, extra-axial fluid collections, seizures, or bone resorption. Subgroup analysis of trauma patients revealed a decreased odds of extra-axial fluid collection (OR 0.30,  $p=0.02$ ) and an increased odds of hydrocephalus (OR 4.99,  $p=0.05$ ).

For neurologic outcomes, eight articles met inclusion criteria for a total of 528 patients (248 early vs 303 late). All included studies were retrospective observational data. Neurologic measures reported were Barthel Index, Karnofsky Performance Scale, Functional Independence Measure, Glasgow Coma Scale, and Glasgow Outcome Score. Combining early and late procedures, cranioplasty was associated with significant neurologic improvement (SMD 0.56,  $p=0.01$ ). Looking at timing, early cranioplasty was associated with greater post-cranioplasty scores (SMD 0.58,  $p=0.04$ ) and greater neurologic improvement (SMD 2.90,  $p=0.02$ ) compared to late cranioplasty. These results are limited by significant heterogeneity within and between subgroups.

## CONCLUSION

Early cranioplasty within 90 days after decompressive craniectomy is associated with an increased odds of hydrocephalus than with later cranioplasty, but no difference in odds of developing other complications. Earlier cranioplasty in the trauma population may also be associated reduced extra-axial fluid collections.

Although there is no consensus on neurologic measure and there is significant heterogeneity among results, cranioplasty appears to improve neurologic function and earlier cranioplasty may be associated with greater neurologic improvement.