ORIGINAL RESEARCH PAPER

Neurosurgery

DECOMPRESSIVE CRANIOTOMY FOR TRAUMATIC SUBDURAL HEMATOMA: A CONTEMPORARY REVIEW OF INDICATIONS, TECHNIQUES, AND OUTCOMES

KEY WORDS: Decompressive Craniotomy, Head injury, Traumatic Subdural Hematoma

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ABSTRACT

Traumatic brain injury (TBI) remains a leading cause of morbidity and mortality worldwide, often complicated by the development of acute subdural hematoma (ASDH). While conventional craniotomy with hematoma evacuation is the mainstay of surgical management, decompressive craniotomy (DC) has emerged as a critical intervention in select patients with elevated intracranial pressure (ICP) and refractory cerebral edema. This review outlines the role of DC in TBI-associated subdural hematoma, including indications, surgical techniques, evidence-based outcomes, and ongoing controversies. It emphasizes patient selection, intraoperative decision-making, and the need for further randomized controlled trials to optimize management protocols.

1. INTRODUCTION

Acute subdural hematoma (ASDH) is a frequent and severe manifestation of traumatic brain injury (TBI), often resulting from high-impact acceleration-deceleration injuries that cause tearing of bridging veins. In cases with significant mass effect, midline shift, or intracranial hypertension, prompt surgical evacuation is life-saving. While craniotomy with hematoma removal is standard, decompressive craniotomy—leaving the bone flap off—may be required in patients with diffuse swelling, elevated ICP, or anticipated secondary brain injury.

2. Pathophysiology of TBI-Associated Subdural Hematoma

TBI-induced ASDH is characterized by rapid accumulation of blood in the subdural space, leading to increased ICP, cerebral ischemia, and global brain dysfunction. Secondary injury mechanisms such as inflammation, oxidative stress, and cytotoxic edema further compound the initial insult. DC addresses these pathophysiological processes by relieving pressure, improving cerebral perfusion pressure (CPP), and preventing herniation.

3. Indications for Decompressive Craniotomy in TBI-SDH

DC is typically reserved for patients with:

- ASDH with significant cerebral swelling and impending herniation
- Refractory ICP > 20–25 mmHg despite maximal medical therapy
- Intraoperative brain bulging during standard craniotomy
- GCS ≤ 8 with CT findings of midline shift >5 mm or hematoma >10 mm
- Bilateral fixed pupils (controversial and poor prognosis, but not always exclusionary)

Recent trauma guidelines suggest that early surgical decompression may be considered in patients under 60 years of age with favorable premorbid status and salvageable brain tissue.

4. Surgical Techniques and Intraoperative Considerations

Decompressive Craniotomy (DC) typically involves:

- Large fronto-temporo-parietal bone flap (>12 cm)
- Wide dural opening with or without expansile duraplasty
- Hematoma evacuation and hemostasis
- Avoidance of aggressive retraction or injury to viable cortex
- Placement of an ICP monitor or subdural drain

The size and location of the bone flap are critical; inadequate decompression may lead to persistent ICP elevation and poor outcomes.

5. Clinical Outcomes and Prognostic Factors

The clinical outcomes of DC for TBI-related ASDH are highly variable:

- Survival: DC has been shown to reduce mortality in several observational studies and case series.
- Functional outcome: Recovery is often limited by the extent of primary brain injury. Younger age, higher admission GCS, and absence of brainstem compression are associated with better Glasgow Outcome Scale (GOS) scores.
- Timing: Early DC (within 6 hours of injury) may be associated with better outcomes compared to delayed intervention.

However, randomized trials like DECRA and RESCUEicp (focused on diffuse TBI rather than focal hematomas) have highlighted the risk of survival with severe disability following DC.

6. Complications and Risks

Common complications include:

- External cerebral herniation
- Subdural hygroma
- Hydrocephalus
- Cranioplasty-related infections or seizures
- Poor neurological recovery despite radiological decompression

Ethical concerns also arise regarding the quality of life post-DC in patients with severe neurological impairment.

7. Current Evidence and Guidelines

- Brain Trauma Foundation (BTF): Recommends DC for refractory intracranial hypertension but urges caution for prophylactic use.
- RESCUE-ASDH Trial (in progress): Specifically evaluates DC versus craniotomy for TBI-associated ASDH.
- Systematic reviews support DC in selected patients but call for individualized decisions based on radiology, clinical trajectory, and intraoperative findings.

8. Future Directions

- High-quality RCTs specifically evaluating DC in TBI-SDH are essential.
- Predictive modeling using clinical, radiological, and molecular biomarkers may enhance patient selection.

- Advances in neurocritical care and neurorehabilitation can improve outcomes following aggressive surgical intervention.

9. Conclusion

Decompressive craniotomy remains a valuable surgical option for traumatic subdural hematoma in the context of TBI, particularly in patients with malignant cerebral edema and refractory ICP. However, the decision to perform DC must balance potential survival benefits with the risk of poor neurological outcome. Individualized, multidisciplinary management supported by emerging trial data is essential for optimizing patient care.

10. REFERENCES

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