



## ORIGINAL RESEARCH PAPER

## Neurosurgery

### DECOMPRESSIVE CRANIOTOMY IN HYPERTENSIVE BASAL GANGLIA HEMORRHAGE: A CONTEMPORARY REVIEW OF SURGICAL INDICATIONS, OUTCOMES, AND CONTROVERSIES

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#### ABSTRACT

Hypertensive intracerebral hemorrhage (ICH), particularly in the basal ganglia region, represents a devastating form of stroke with high morbidity and mortality. Decompressive craniotomy (DC) has been employed as a life-saving intervention in selected patients to relieve mass effect, reduce intracranial pressure (ICP), and prevent herniation. However, the optimal surgical approach, timing, and selection criteria remain debated. This review summarizes current evidence, surgical techniques, patient selection, and clinical outcomes of DC in hypertensive basal ganglia hemorrhage, aiming to inform clinical decision-making and highlight areas requiring further investigation.

#### INTRODUCTION

Hypertensive intracerebral hemorrhage (ICH) accounts for approximately 10–15% of all strokes and is a leading cause of neurological disability and death. The basal ganglia, supplied by small perforating arteries, are particularly vulnerable to hypertensive damage, often resulting in spontaneous deep ICH. Among various therapeutic options, decompressive craniotomy (DC) has emerged as a surgical method to mitigate raised intracranial pressure (ICP), control hematoma expansion, and prevent brain herniation.

While DC has been widely accepted for malignant middle cerebral artery infarctions, its role in hypertensive basal ganglia hemorrhage is less well-defined. Indications for surgery, timing, and extent of hematoma evacuation continue to evolve. This review explores the pathophysiology, rationale, current practices, and outcomes of decompressive craniotomy for hypertensive basal ganglia hemorrhage.

#### PATHOPHYSIOLOGY OF HYPERTENSIVE BASAL GANGLIA HEMORRHAGE

Chronic hypertension induces lipohyalinosis and fibrinoid necrosis of small vessels, particularly the lenticulostriate arteries, predisposing to rupture. Hemorrhage in the basal ganglia can result in mass effect, midline shift, ventricular compression, and transtentorial herniation, particularly with hematoma volumes >30 mL.

Increased ICP from expanding hematoma leads to decreased cerebral perfusion pressure (CPP), ischemia, and poor neurological outcomes. The rigid confines of the skull exacerbate this process, justifying surgical decompression in selected cases.

#### SURGICAL INDICATIONS FOR DECOMPRESSIVE CRANIOTOMY

Surgical intervention is typically considered in patients with:

- Hematoma volume >30–50 mL with significant mass effect
- Glasgow Coma Scale (GCS) score between 5 and 12
- Rapid neurological deterioration
- Signs of transtentorial herniation
- Midline shift >5 mm
- Failure of medical management

Patient age, pre-existing comorbidities, and baseline functional status also influence surgical candidacy.

#### SURGICAL TECHNIQUES

##### Decompressive craniotomy for basal ganglia

#### hemorrhage Typically Involves:

- Frontotemporal (pterional) craniotomy for optimal access to deep structures
- Microsurgical evacuation of the hematoma under neuronavigation or intraoperative ultrasound
- Dural opening with or without duraplasty
- Decompression with or without bone flap replacement (i.e., decompressive craniectomy)

Recent approaches favor minimally invasive techniques (endoscopic or stereotactic) in selected cases, although their role in large-volume hemorrhages is limited.

#### EVIDENCE AND CLINICAL OUTCOMES

##### 1. Stich Trials

The Surgical Trial in Intracerebral Hemorrhage (STICH and STICH II) questioned the benefit of early surgery in spontaneous supratentorial hemorrhage. However, subgroup analysis suggested potential benefit in superficial lobar hemorrhages and select deep ICH patients with mass effect.

##### 2. Retrospective and Cohort Studies

Several retrospective studies have shown improved survival and functional outcomes with DC in large-volume basal ganglia ICH, particularly when performed early (<24 hours). However, benefits are offset by risks such as rebleeding, infection, and poor functional recovery in severely disabled survivors.

##### 3. Meta-analyses

Recent meta-analyses suggest that DC may reduce mortality but is associated with a higher proportion of survivors with moderate to severe disability (modified Rankin Scale score >3).

#### CONTROVERSIES AND CONSIDERATIONS

- Timing: Early surgery (<6–24 hours) may improve outcomes but increases risk of rebleeding.
- Extent of Decompression: Wide decompression may relieve pressure but increase surgical morbidity.
- Functional Outcome vs Survival: Ethical considerations arise when increased survival leads to poor quality of life.
- Patient Selection: Prognostic scoring systems (e.g., ICH score) help identify candidates who may benefit from surgery.

#### FUTURE DIRECTIONS AND ONGOING RESEARCH

Ongoing randomized trials are investigating the role of early minimally invasive evacuation versus open decompression in

deep ICH. Advanced neuroimaging, machine learning prognostic models, and personalized surgical approaches may refine patient selection and optimize outcomes.

## CONCLUSION

Decompressive craniotomy remains a controversial but potentially life-saving intervention in selected patients with hypertensive basal ganglia hemorrhage. While evidence supports its role in reducing mortality in patients with large hematomas and impending herniation, functional outcomes vary widely. Careful patient selection, timely intervention, and post-operative neurocritical care are essential. Further high-quality trials are needed to define optimal strategies for this challenging neurosurgical emergency.

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