



Decompressive Craniectomy - A narrative review and discussion



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ABSTRACT

There continues to be considerable amount of interest in decompressive craniectomy however its use is controversial. It is technically straightforward however it is not without significant complications and although there is currently unequivocal evidence available that it can be a life saving intervention, evidence that outcome is improved over and above standard medical therapy is less forthcoming. This narrative review considers the current role of decompressive craniectomy in the management of neurological emergencies and focuses on four specific questions, namely; (i) Is the decompressive craniectomy a life saving procedure? (ii) Does decompressive craniectomy improve outcome? (iii) Are there any risks associated with decompressive craniectomy? (iv) How do patients feel about their eventual outcome?

Finally the future directions for the use of decompressive craniectomy are explored.

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Introduction

There continues to be considerable amount of interest in the use of decompressive craniectomy in the management of a variety of neurological emergencies. The surgical procedure involves temporarily removing a large segment of the skull in order to provide extra space into which the injured or ischaemic brain can expand and it is technically straightforward. The rationale for decompressive surgery is that by reducing the intracranial pressure (ICP) life threatening herniation of the cerebellar tonsils is prevented and cerebral perfusion can be improved.^{1,2}

Over the past two decades there have been many reports attesting to the clinical efficacy of the procedure most commonly in the context of traumatic brain injury^{3–5} and stroke,^{6–8} but also more recently in the context of subarachnoid haemorrhage,^{9–11} severe intracranial infection,^{12–15} dural sinus thrombosis,^{16,17} and inflammatory conditions.^{18,19} (Table 1). However despite what would appear to be overwhelming support for ongoing use of the procedure there remain areas of controversy.

Given the central role that intensive care nurses have in the management of many of these patients, they are well placed to counsel family members in the often fraught and emotionally charged circumstances of an acute neurological emergency. It is also beneficial for all those involved in the management of

neurotrauma patients whether they are from a nursing, medical or surgical background, to be aware of the issues involved when considering potentially life saving but not necessarily restorative surgical intervention.

The aim of this narrative review is to critically appraise the evidence currently available regarding clinical efficacy so that appropriate guidance may be provided when considering four key questions, namely;

1. Is the decompressive craniectomy a life saving procedure?
2. Does decompressive craniectomy improve neurological outcome?
3. Are there any risks associated with decompressive craniectomy?
4. How do patients feel about their eventual outcome?

Thereafter the current role of decompressive craniectomy and future directions of research will be outlined.

Methodology and data synthesis

We aimed to include as much data as possible from studies that have reported the use of decompressive craniectomy in different neurological emergencies. A literature search was performed in the MEDLINE database (1966–June 2012). The following keywords were used: hemicraniectomy, decompressive craniectomy, or decompression and craniectomy together with stroke, ischaemia, middle cerebral infarct, traumatic brain injury, head injury, subarachnoid haemorrhage, infection, subdural empyema, sinus thrombosis, cerebrovenous thrombosis, encephalitis, or

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Table 1
Clinical indications for decompressive craniectomy.

Clinical indication for decompressive craniectomy
Malignant cerebral artery infarction
Traumatic brain injury
Subarachnoid haemorrhage
Cerebral venous thrombosis
Intracranial infection
• Encephalitis
• Meningitis
• Subdural empyema
• Toxoplasmosis
Demyelination disorders
Reyes syndrome
Acute hyperammonemia encephalopathy
Cerebral oedema from diabetic ketoacidosis

meningitis. Randomised controlled trials (RCTs) and cohort studies on benefits and risks of decompressive craniectomy in different types of neurological emergencies were included in the first instance. If these reports were not available, case series and reports were also analysed. Studies that were published only in abstract form, non English language studies, mixed pathologies were excluded.

Is decompressive surgery a life saving procedure?

In the context of ischaemic stroke there is now unequivocal evidence that decompressive hemicraniectomy is a life saving intervention. In the context of other neurological emergencies there is no such evidence available however, there is good evidence that surgical decompression can control intracranial hypertension which is strongly associated with mortality.

Decompressive craniectomy in the context of ischaemic stroke – mortality

The term “malignant” middle cerebral artery infarction refers to the life threatening cerebral oedema that develops in 1–10% of patients who have a supratentorial infarct and the prognosis for these patients is poor with a mortality rate in the region of 80%.²⁰ Throughout the 1980s and 1990s a number of clinical studies reported a reduction in mortality following decompressive hemicraniectomy, however there remained considerable controversy regarding patient selection, surgical timing and long term outcome.^{21,22} In order to address some of these issues three European randomised controlled trials were independently conducted. The trials compared decompressive hemicraniectomy with standard medical therapy for patients under 60 years of age who developed clinical deterioration following middle cerebral artery infarction.^{23–25} Two of these trials interrupted recruitment early in 2006. The DECIMAL trial was interrupted because of slow recruitment and a significant difference in mortality between the treatment groups favouring surgery.²³ The DESTINY trial was interrupted because a predefined sequential analysis showed a significant benefit of surgery on mortality.²⁴ The HAMLET trial was stopped because it was thought that it would be highly unlikely that a statistically significant difference would be seen for the primary neurological outcome measure which was defined as good (modified Rankin Score [mRS] 0–3) or poor (mRS 4–6).²⁵ What the trials independently and unequivocally demonstrated was that survival was improved in those patients who were randomised to receive decompressive surgery. Thereafter a pooled analysis of the 93 patients involved in all three trials demonstrated a reduction in mortality from 78% for those patients treated medically to 29% for those patients who had surgical decompression.²⁶

Decompressive craniectomy for other neurological emergencies – mortality

In the context of traumatic brain injury the evidence available for the role of decompressive craniectomy as a life saving procedure is not quite as unequivocal however it is nevertheless fairly convincing. There is a strong association between outcome and ICP and there have been numerous studies demonstrating successful control of intracranial hypertension following surgical decompression.^{3–5}

In the context of other neurological emergencies the evidence is less robust and although many reports emphasis the life saving nature of the intervention and the favourable outcomes that are achieved considerable caution must be exercised when interpreting this data. Most studies have either been small cohort studies, case series or case reports and there is often a strong publication bias to report cases with a positive outcome.^{9,12–15} However, notwithstanding these limitations, there would appear to be a sufficient evidence to support the use of decompressive surgery as a life saving intervention once medical therapy fails to control refractory intracranial hypertension (e.g. >25 mmHg for a prolonged period of time) or a patient clinically deteriorates with new-onset unequal pupils in association with intracranial hypertension. What remains to be established is whether the final clinical neurological outcome is improved.

Does the surgery improve neurological outcome

For many years the debate regarding outcome has centred on the concern that whilst decompressive craniectomy may reduce mortality it may leave survivors with an unacceptable level of neurological disability.^{21,27} In the light of these concerns the conclusions from the pooled analysis of the three European stroke trials were initially welcomed because the authors reported that not only did decompressive craniectomy reduce mortality but also that there was an increase in the number of patients who survived with a favourable outcome from 75% for those patients treated surgically compared to 24% for those patients who were treated medically.²⁶ These findings would appear to provide unequivocal support for the ongoing use of the procedure for patients less than 60 years of age (as per the trial enrolment criteria), however closer examination of the basic data did not really support this position.

Decompressive craniectomy in the context of ischaemic stroke – neurological outcome

Traditionally in the stroke literature, outcome is assessed using the modified Rankin score and favourable outcome has always been defined as a mRS of 0–3 and unfavourable outcome is an mRS of 4 or 5 (Table 2). Although the use of the mRS has some limitations,

Table 2
The modified Rankin Scale.

Score	Description
6	Dead
5	Severe disability; bedridden, incontinent and requiring constant nursing care and attention
4	Moderately severe disability; unable to walk without assistance and unable to attend to own bodily needs without assistance
3	Moderate disability; requiring some help, but able to walk without assistance
2	Slight disability; unable to carry out all previous activities, but able to look after own affairs without assistance
1	No significant disability despite symptoms; able to carry out all usual duties and activities
0	No symptoms at all

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