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Mini Review

Re-consideration of the Role of Decompressive Craniectomy in the Treatment of Severe Traumatic Brain Injury

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Abstract

Decompressive Craniectomy (DC) has been widely used in the treatment of Traumatic Brain Injury (TBI). However, there is still a lack of class I evidence for the routine use of DC in TBI. DC is controversial for its long-term effectiveness and complications. In the authors' opinions, DC is a second-tier treatment for severe TBI. DC can effectively decrease Intracranial Pressure (ICP), but lower ICP cannot guarantee a better functional outcome. To save lives and prevent complications, therapeutic DC is advocated.

Keywords: Traumatic brain injury; Decompressive craniectomy; Outcome; Complication; Intracranial hypertension

Abbreviations

TBI: Traumatic Brain Injury; DC: Decompressive Craniectomy; ICP: Intracranial Pressure; GCS: Glasgow Coma Scale

Introduction

The treatment of Traumatic Brain Injury (TBI) is still faced with many noteworthy challenges. As estimated by the World Health Organization, TBI will be the leading cause of death and disability in 2020 [1]. Decompressive Craniectomy (DC) has been used in neurosurgery for a long time, especially in severe TBI patients with refractory intracranial hypertension [2-8]. DC is effective in decreasing ICP, but there are still some complications or severe sequelae [4,5,9-11]. Furthermore some studies show that DC not only decreases ICP but also reduces mortality [6,8]. Recently, a retrospective study showed that DC is associated with unfavorable outcomes and disabilities according to long-term evaluation [12]. At present, there is very little class I evidence for the routine use of DC in TBI. DC is controversial. In this article, the authors briefly review the major opinions on DC and present their opinions and experience.

Classification of DC

It is well known that DC can be divided into two types: prophylactic DC and therapeutic DC. Prophylactic DC is performed to prevent intracranial hypertension when the operator feels that ICP is going to increase post-surgery.

Therapeutic DC is generally performed to control high ICP refractory to maximal medical therapy. DC is performed when first- or second-line therapeutic measures have failed to control ICP [13]. In many centers, measures to control ICP include intubation, normocarbic ventilation, sedation, moderate head-up posture, cerebral spinal fluid drainage, mannitol, mild hypothermia, and so on. Therapeutic DC is advocated because DC may cause some complications. Early prophylactic DC does not seem to significantly improve outcome in patients with refractory intracranial hypertension compared with medical treatment [14]. DC is a second-tier method to control ICP.

A widely acceptable indication for DC is still lacking. When first-tier measures fail to control ICP, DC should be considered for the treatment of intracranial hypertension. However, it is difficult to catch the right timing for DC. If it is performed too late, the patient's outcome may be made worse or even be fatal. On the contrary, if DC is performed too early perhaps means prophylactic DC. Therapeutic DC means precise treatment and less unnecessary damage to patients.

Dispute on DC

A main controversy is whether DC could provide a better outcome with sufficient quality of life to overcome the complications caused by DC. Some studies suggest DC is advantageous for the treatment of TBI. For example, Jiang et al. showed that DC not only saves lives but also improves neurological outcomes [6]. Howard et al. noted that the majority of survivors after DC had a good functional outcome [4]. However, in 2011 the "DECRA" trial showed that the outcome of patients with DC was poorer than the outcome of those without DC [15]. Kurland et al. reviewed the available literature and found three major types of complications (1) hemorrhagic, (2) infectious/inflammatory, and (3) disturbances of the CSF compartment. Overall, 10% of patients undergoing DC may suffer a complication necessitating additional medical and/or neurosurgical intervention [16]. After DC, the survivors should undergo a second procedure with cranioplasty. Chaturvedi et al. found that the mortality rate was 1.35% and overall complication rate was 31% in 74 patients who underwent cranioplasty after DC [17]. Doubts about the benefits of DC are influenced by its complications. Is DC a failure in TBI or even harmful to patients?

When we evaluate the role of DC in TBI, we should implement a uniform standard. In terms of ICP, DC has a positive role because of the removal of a large bone fragment. For example, after undergoing DC, a TBI patient may be alive but in a vegetative state. So with regard to saving a life, DC can decrease mortality and have a positive role in the treatment of TBI, without DC, the patient may die. However,

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with regard to functional outcome and quality of life, DC is associated with more unfavorable outcomes. Until now, there has only been one randomized control trial that has shown the benefits of DC in children [18].

As far as we know, the pathophysiology of TBI is very complicated and many factors may affect the outcome. The prognosis of TBI patients is closely associated with Glasgow Coma Scale (GCS), pupils reaction, types of injury, ICP, hypoglycemia, hypoxia, hyperthermia, and so on. However, we are still lacking a widely acceptable indication for DC. In some centers, DC is performed when encephalocele occurs during surgery or ICP is out of control after maximal medical treatment. Little research has divided patients into subgroups with similar GCS and injury types. Perhaps this is the reason why there are different conclusions on DC at present. DC can effectively decrease ICP, but lower ICP does not guarantee a better functional outcome. More studies are needed to evaluate the role of DC in TBI treatment.

Authors' Experience

For life preservation and prevention of complications, therapeutic DC is advocated in our hospital. Basic treatments are performed in accordance with the guidelines for the management of severe head injuries [19]. Surgical indications follow the guidelines for surgical management of TBI [20-22]. For patients admitted with severe TBI without surgical indications, DC should be performed if ICP is persistently higher than 25 mmHg with Cerebral Perfusion Pressure (CPP) ≤50 mmHg after maximal medical treatment. For patients with mass intracranial lesions, after the space-occupying lesion has been removed, the bone flap is removed if brain tissue is stiff without apparent pulsation and swollen above the inner plate of the skull. On the contrary, the skull flap is repositioned when brain parenchyma pulsation is normal and there is no brain swelling, and the edge of the brain parenchyma is lower than the internal lamina of the skull. We suggest intra-operative brain swelling can be the indication for DC in severe TBI patients. We retrospectively analyzed a small number of sample cases and found that only 20% of patients with severe TBI achieved favorable outcomes after DC [23]. We also reviewed 284 patients with severe TBI who underwent craniotomy for mass lesion evacuation: there were 41 (14.4 %) patients who underwent salvage DC for delayed intracranial hypertension and, overall, 32% of patients had favorable outcomes [24].

At present, we perform a prospective randomized evaluation of therapeutic DC in severe TBI with mass lesions (PRECIS; ISRCTN20139421, http://www.controlled-trials.com/ISRCTN20139421). We focus on severe TBI patients with massive lesions, who are Marshall Classification VI, presence of high- or mix-density lesion ≥ 25 ml (contusion, intraparenchymal, and subdural hematoma).One size cannot fit all. We try to investigate whether DC may be of benefit to certain types of TBI patients. As a coin has two sides, DC has great advantages as well as adverse effects in the treatment of TBI. In this paper, we have simply reviewed the major opinions on DC and presented our opinions and experience.

Conclusion

DC is a lifesaving procedure but its benefit to functional outcome is not assured. DC is a second-tier treatment for severe TBI. The use of DC in TBI is under dispute. Further studies are needed to evaluate the role of DC in the treatment of TBI.

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