Subacute Surgery in Neurointensive Care

57

Terje Sundstrøm, Eirik Helseth, and Knut Gustav Wester

Recommendations

Level I

Decompressive craniectomy can reduce intracranial pressure (ICP) and mortality in severe traumatic brain injury (TBI) with or without surgical lesions, but it does not improve the rate of patients surviving with a favourable outcome.

Level II

There are insufficient data to support a Level II recommendation for this topic.

Level III

Decompressive craniectomy is an option to treat neurologic deterioration, herniation or intracranial hypertension refractory to medical management in children.

Decompressive craniectomies should be large and include duraplasty.

Post-operative complications can be avoided by meticulous surgical technique and adequate choice of procedure.

57.1 Overview

The possibility of hydrocephalus, brain oedema or a new or recurrent intracranial haematoma must be investigated by repeated computed tomography (CT) scans in case of neurological deterioration or intractable intracranial hypertension in a head-injured patient. Subacute surgery (secondary surgical intervention) should then be considered.

The relevant surgical procedures and their respective indications are described in Part V in this book on acute surgical treatment; these principles also apply to subacute surgery. Drainage of cerebrospinal fluid is moreover discussed in the following section. In general, the monitoring and treatment strategies described elsewhere in Parts VII and VIII should be consulted for detailed information on timing, thresholds and complementary interventions.

T. Sundstrøm (✉)
Department of Neurosurgery, Haukeland University Hospital, Bergen, Norway

Department of Clinical Medicine, University of Bergen, Bergen, Norway
e-mail: tjsu@helse-bergen.no, kgwe@helse-bergen.no

E. Helseth
Institute of Clinical Medicine, University of Oslo, Oslo, Norway

Department of Neurosurgery, Oslo University Hospital, Oslo, Norway
e-mail: ehelseth@ous-hf.no

K. G. Wester
Department of Clinical Medicine, University of Bergen, Bergen, Norway
e-mail: Knut.Wester@uib.no

T. Sundstrøm et al. (eds.), *Management of Severe Traumatic Brain Injury*,
https://doi.org/10.1007/978-3-030-39383-0_57

Tips, Tricks and Pitfalls

- Continuously re-evaluate the level of treatment according to new developments.
- 'Do not treat the patient with a new CT scan'.
- Always look at the patient and think about possible technical malfunctions and the reliability of the monitoring equipment.
- When doubt exists and consciousness is depressed, intracranial pressure should always be monitored, and significant mass lesions should be removed.
- The first 48 h are most critical in a surgical perspective, but intracranial haematomas can occur at any point in time during neurointensive care.
- *Prophylactic* craniectomy is an unwarranted procedure.
- Decompressive craniectomy for refractory high intracranial pressure (ICP) may save lives, but many will have a very poor functional outcome.

57.2 Background

Two major randomized trials have investigated the use of decompressive craniectomy in adults (Cooper et al. 2011; Hutchinson et al. 2016). Decompressive craniectomy has also been studied in two smaller randomized trials, one in adults (Qiu et al. 2009) and one in children (Taylor et al. 2001). There is still uncertainty related to the effectiveness and safety of decompressive craniectomy, but it may be a valid option in selected patients (Sahuquillo and Arikan 2006; Ardissino et al. 2019). For details, please refer to Chap. 26 on decompressive craniectomy.

The randomized controlled Decra study, published in 2011, concluded with an increased risk of a poor outcome for patients with refractory high intracranial pressure (ICP) undergoing bifronto-temporoparietal craniectomy as compared to those receiving conservative medical treatment (Cooper et al. 2011). The craniectomy was performed early (within 72 h) in patients with a moderately increased intracranial pressure (20 mmHg) for a short period of time (15 min) and with diffuse brain injuries without mass lesions. Twenty-three percent of the patients assigned to conservative treatment nevertheless underwent a late craniectomy as a life-saving intervention, and these patients were included in the final analyses demonstrating a poorer outcome with craniectomy. This aggressive approach in a subgroup of patients does not really bring clarification to the major problems. Early prophylactic craniectomy most likely does not have any other effect than preventing a later craniectomy if the ICP cannot be controlled.

The randomized controlled Rescue-ICP study, published in 2016, showed that decompressive craniectomy in patients with traumatic brain injury and refractory high ICP resulted in lower mortality and higher rates of vegetative state and severe disability than in patients receiving medical care (Hutchinson et al. 2016). The rates of moderate disability and good recovery were similar in the two groups. The type of decompressive craniectomy (bifrontal or unilateral) was decided upon by the surgeon.

The ongoing Rescue-ASDH trial (http://www.rescueasdh.org) is a multicentre, pragmatic parallel-group randomized trial of decompressive craniectomy versus craniotomy for adult patients undergoing evacuation of acute subdural haematoma. This study will probably help to define the value of craniectomy in patients with acute subdural haematoma.

In 2016, the Brain Trauma Foundation published the fourth edition of the guidelines for the management of severe traumatic brain injury (https://www.braintrauma.org). In this update, they included recommendations for decompressive craniectomy. The authors stated that these are living guidelines and that new studies, such as the pending results of the Rescue-ICP trial (Hutchinson et al. 2016), would be incorporated as soon as they become available. However, these

recommendations have not been updated as of February 2020.

Intracranial haematomas or contusions diagnosed by the initial CT scan can evolve with enlargement of bleeding and/or perifocal oedema, thereby requiring surgery at a later stage. A recent systematic review and meta-analysis of mild TBI patients with brain injuries identified by CT scan, estimated the risk of clinical deterioration to be 11.7% and neurosurgical intervention to be 3.5% (Marincowitz et al. 2018).

Delayed intracranial haemorrhage after blunt head trauma in patients with an initial, normal CT scan is very rare. In a recent study, the authors found an incidence of 0.3% of delayed intracranial haemorrhage in older patients (55 years or older), irrespective of anticoagulant or antiplatelet use (Chenoweth et al. 2018). This finding clearly indicates that routine observation and serial cranial CT scans may not be warranted in these patients.

Carotid dissection and cerebral vasospasms are other conditions to be aware of. Both conditions can cause neurological deterioration in a subacute manner. Carotid dissection is often associated with neck trauma (e.g. seat belt injury) and may be followed by development of a hemiparesis without corresponding findings on initial CT scans. Traumatic arterial spasms are not that uncommon and have a similar time course to that seen with aneurysmal subarachnoid haemorrhage. The clinical significance of vasospasms in traumatic brain injury is still uncertain (Armin et al. 2008).

New or recurrent haematomas are not infrequent after acute surgery for head injuries (Seifman et al. 2011). The vasculature can be injured, and clotting mechanisms can be compromised. Rebleeding at the operative site requiring reoperation has been reported in up to 7% of patients undergoing craniotomy and evacuation of traumatic intracranial haematomas (Bullock et al. 1990). The use of correct surgical techniques and adequate choice of procedures are therefore essential to avoid post-operative complications (see Part V on acute surgical treatment).

57.3 Specific Paediatric Concerns

One small prospective, randomized study has investigated the use of early bitemporal craniectomy without duraplasty in children (Taylor et al. 2001). The children had a median age of 120.9 months. Thirteen children were randomized to craniectomy and 14 children to conservative management; the median GCS scores were 6 and 5, respectively. Notably, children with GCS scores higher than 8 were included in this study. The craniectomy was performed at a median of 19.2 h (range 7.3–29.3 h) after the accident. Children who had sustained intracranial hypertension during the first day after admission (ICP 20–24 mmHg for 30 min, 25–29 mmHg for 10 min, 30 mmHg or more for 1 min) or had evidence of herniation (unilaterally dilated pupil or bradycardia) were eligible for randomization. A trend was shown towards greater improvement in intracranial pressure, less time required in the intensive care unit and improved clinical outcome by adding decompressive craniectomy to conventional medical treatment. Based on this study, a Cochrane review concluded that decompressive craniectomy might be justified in patients below the age of 18 years when full medical treatment is unable to control the intracranial pressure (Sahuquillo and Arikan 2006).

In a systematic review, Ardissino et al. reported a possible benefit of decompressive craniectomy in paediatric patients with TBI for reducing high ICP (>25 mmHg) refractory to medical treatment. The authors also noted that this is supported by low-quality evidence only and that there are substantial uncertainties about the implications for long-term neurological outcome (Ardissino et al. 2019).

The third edition of the Brain Trauma Foundation guidelines for the acute management of paediatric severe traumatic brain injury was published in 2019 (Kochanek et al. 2019). Based on 16 Class III treatment series, they provided a level III recommendation stating that decompressive craniectomy is suggested to treat neurological deterioration, herniation or intracranial hypertension refractory to medical management.

References

Ardissino M, Tang A, Muttoni E, Tsang K. Decompressive craniectomy in paediatric traumatic brain injury: a systematic review of current evidence. Childs Nerv Syst. 2019;35:209–16.

Armin SS, Colohan AR, Zhang JH. Vasospasm in traumatic brain injury. Acta Neurochir Suppl. 2008;104:421–5.

Bullock R, Hanemann CO, Murray L, Teasdale GM. Recurrent hematomas following craniotomy for traumatic intracranial mass. J Neurosurg. 1990;72:9–14.

Chenoweth JA, Gaona SD, Faul M, Holmes JF, Nishijima DK, Sacramento County Prehospital Research Consortium. Incidence of delayed intracranial hemorrhage in older patients after blunt head trauma. JAMA Surg. 2018;153:570–5.

Cooper DJ, Rosenfeld JV, Murray L, Arabi YM, Davies AR, D'Urso P, Kossmann T, Ponsford J, Seppelt I, Reilly P, Wolfe R, DECRA Trial Investigators, Australian and New Zealand Intensive Care Society Clinical Trials Group. Decompressive craniectomy in diffuse traumatic brain injury. N Engl J Med. 2011;364:1493–502.

Hutchinson PJ, Kolias AG, Timofeev IS, Corteen EA, Czosnyka M, Timothy J, Anderson I, Bulters DO, Belli A, Eynon CA, Wadley J, Mendelow AD, Mitchell PM, Wilson MH, Critchley G, Sahuquillo J, Unterberg A, Servadei F, Teasdale GM, Pickard JD, Menon DK, Murray GD, Kirkpatrick PJ, RESCUEicp Trial Collaborators. Trial of decompressive craniectomy for traumatic intracranial hypertension. N Engl J Med. 2016;375:1119–30.

Kochanek PM, Tasker RC, Carney N, Totten AM, Adelson PD, Selden NR, Davis-O'Reilly C, Hart EL, Bell MJ, Bratton SL, Grant GA, Kissoon N, Reuter-Rice KE, Vavilala MS, Wainwright MS, Marincowitz C, Lecky FE, Townend W, Borakati A. Guidelines for the management of pediatric severe traumatic brain injury, third edition: update of the Brain Trauma Foundation guidelines. Pediatr Crit Care Med. 2019;20(3S Suppl 1):S1–S82.

Marincowitz C, Lecky FE, Townend W, Borakati A, Fabbri A, Sheldon TA. The risk of deterioration in GCS 13-15 patients with traumatic brain injury identified by computed tomography imaging: a systematic review and meta-analysis. J Neurotrauma. 2018;35:703–18.

Qiu W, Guo C, Shen H, Chen K, Wen L, Huang H, Ding M, Sun L, Jiang Q, Wang W. Effects of unilateral decompressive craniectomy on patients with unilateral acute post-traumaticbrain swelling after severe traumatic brain injury. Crit Care. 2009;13(6):R185. https://doi.org/10.1186/cc8178.

Sahuquillo J, Arikan F. Decompressive craniectomy for the treatment of refractory high intracranial pressure in traumatic brain injury. Cochrane Database Syst Rev. 2006;1:CD003983. https://doi.org/10.1002/14651858.CD003983.pub2.

Seifman MA, Lewis PM, Rosenfeld JV, Hwang PY. Postoperative intracranial haemorrhage: a review. Neurosurg Rev. 2011;34(4):393–407.

Taylor A, Butt W, Rosenfeld J, Shann F, Ditchfield M, Lewis E, Klug G, Wallace D, Henning R, Tibballs J. A randomized trial of very early decompressive craniectomy in children with traumatic brain injury and sustained intracranial hypertension. Childs Nerv Syst. 2001;17:154–62.