Management of Extracranial Injuries

58

Nikolaj Preus Hatting and Rico Frederik Schou

Recommendations

Level I

There is insufficient data to support a Level 1 recommendation.

Level II

Major extracranial injury is a prognostic factor for mortality in TBI patients.

Level III

In the initial phase, only damage control surgery (DCS) is recommended.

The trauma team should decide and agree upon the timing of the procedures.

ICP monitoring is recommended during extracranial surgery (DCS).

Stabilization in a neuro-ICU is recommended only in isolated TBI; a dedicated trauma ICU is recommended in multitraumatized patients.

Physiological parameters should be maintained within near-normal values. Of special concern is hypotension, where systolic blood pressure above 90 mmHg is advised if concomitant uncontrollable internal bleeding is present.

58.1 Overview

The patient with multitrauma injuries (in addition to traumatic brain injury (TBI)) is at increased risk of adverse events and secondary cerebral insults. After the initial assessment and primary survey (see other chapters), the trauma team is often presented with multiple injuries that require immediate treatment, preferably at the same time.

Therefore, it is important for the trauma team to consent upon an approach for managing the injuries in a prioritized order.

In the initial phase, only the most life-threatening extracranial injuries should be treated. Damage control surgery (DCS), where control of only hemorrhage and contamination is managed, is recommended. It is focused surgery without any unnecessary or time-consuming procedures. DCS is always followed by a "second look" hours or days after the initial DCS. In the meantime, the patient should be admitted to the ICU for further stabilization.

N. P. Hatting
Department of Neuroanesthesiology and Neurointensive Care, Odense University Hospital, Odense, Denmark
e-mail: Nikolaj.Preus.Hatting@rsyd.dk

R. F. Schou (✉)
Department of Neuroanesthesia and Neurocritical Care, Odense University Hospital, Odense, Denmark
e-mail: Rico.Frederik.Schou@rsyd.dk

T. Sundstrøm et al. (eds.), *Management of Severe Traumatic Brain Injury*,
https://doi.org/10.1007/978-3-030-39383-0_58

If DCS is necessary, it is recommended to monitor ICP perioperatively in addition to the standard monitoring setup for anesthesia. It is recommended to seek advice from a specialist in neuroanesthesiology or to invite for joint venture and combine the knowledge of the trauma anesthesiologist and the neuroanesthesiologist.

The timing for extracranial surgery should be considered carefully and weighed against the severity of the TBI; non-vital surgery should be postponed until the patient is stable and beyond the acute phase (1–3 days).

Tips, Tricks, and Pitfalls

- Team decision regarding timing of surgery.
- Establish ICP monitoring in patients undergoing extracranial surgery, especially if GCS <9.
- Seek advice from a neuroanesthesiologist and/or neurosurgeon regarding the level of neuromonitoring, what values to aim for and management of potential adverse events in the perioperative period.
- Choose and titrate anesthetic drugs and opioids according to the level and extent of cumulative injuries.
- Hypovolemia due to bleeding is a major cause for hypotension in the multitrauma patient.
- Beware of coagulopathy and hypotension.

58.2 Background

As for the patient with isolated TBI, the primary concern is to prevent secondary damage and injury from occurring. The multitrauma patient has an increased mortality rate and an even greater risk of adverse events; special care must be undertaken to prevent and counter these complications (McMahon et al. 1999; Lingsma et al. 2013). Pitfalls to avoid are hypotension, hypoxia, fluctuations in $PaCO_2$, hypo-/hyperglycemia, hypo-/hyperthermia, coagulopathy, and raised ICP (Watanabe et al. 2018; van Leeuwen et al. 2012).

The trauma team should agree on a course of action that will prioritize the management of the primary brain injury in relation to extracranial injuries, also in accordance with the general principles for maintaining oxygen supply and adequate perfusion to vital organs.

The team should decide the timing of procedures; intracranial and/or extracranial: resuscitative DCS in the trauma bay area, management of intrahospital transportation to operating theatre, or stabilization in ICU area before and in between surgery.

If the patient is suffering from TBI, bilateral lung contusion, multiple fractures, acid/base disorder, and/or coagulopathy, it is indeed relevant to consider DCS if the magnitude of extracranial injuries, for example, includes large vessel damage, tamponade, pelvic or large bone fractures with concurrent hemorrhage, or intraabdominal organ damage needing resection (Rotondo et al. 1993; Taeger et al. 2005; Keel et al. 2005; DASAIM 2011).

The anesthesiologist in care of the patient should confer with the neurosurgeon and the neuroanesthesiologist regarding the level of neuromonitoring. Patients presenting with GCS <8 should not go through extracranial surgery without ICP monitoring. In patients with a GCS 9–13, ICP monitoring should be considered. Patients with GCS 14–15 should possibly only have ICP monitoring established in the prospect of long-lasting or very extensive extracranial surgery (Farahvar et al. 2012; DASAIM 2011).

In the absence of ICP monitoring, ensuring a MAP >80 mmHg is likely to ensure a CPP >50 mmHg. Intraoperative hypotension has been reported to occur in 60% of TBI patients undergoing surgery for associated orthopedic surgery (Algarra, Lele et al. 2016).

It is recommended to achieve and maintain a systolic blood pressure above 90 mmHg (Brain 2007). When extracranial hemorrhage control is achieved, target a systolic blood pressure 110–

120 mmHg as comparative to isolated TBI (Berry et al. 2012; Brenner et al. 2012).

To ensure adequate circulation and perfusion, normovolemia should be achieved using warm, non-glucose-containing isotonic crystalloid solutions. Hypertonic saline solutions increase intravascular volume and decrease cerebral volume and hence ICP (Algarra, Deepak et al. 2016). The target value of s-Na^+ should be 140–150 mmol/L as hypernatremia (>150 mmol/L) is correlated with increased early mortality (Verdantam et al. 2017).

Albumin is currently not recommended in any guidelines (SAFE Study 2004). Starches and other colloids should be avoided. Vasopressors should be either phenylephrine or norepinephrine (Sookplung et al. 2011). Anemia is associated with increased mortality and poor outcome in TBI (Hare et al. 2008). However, many cerebro-protective mechanisms become effective with anemia, and no studies have yet demonstrated improvement in brain tissue oxygenation with blood transfusion. Optimal hemoglobin level in TBI patients is unclear, but there is no benefit of liberal transfusion strategy (Hgb > 6.2 mmol/L) (Salim et al. 2008). Management of ongoing hemorrhage should follow international guidelines.

There are no guidelines for management of coagulopathy in TBI, though it is present in approximately one third of TBI patients and leads to increased mortality and poor outcome (Talving et al. 2009; Watanabe et al. 2018). The CRASH-2 trial demonstrated that tranexamic acid was associated with a reduction in mortality.

Hyper- and hypoglycemia after TBI are associated with increased morbidity and mortality (Jeremitsky et al. 2005). The current evidence suggests a target glucose range of 5–8 mmol/L (Sharma and Vavilala 2012).

In the period of stabilization, the patient with isolated TBI will benefit from being admitted to neuro-ICU area. If the patient is multitraumatized with concomitant extracranial injuries, a dedicated trauma ICU is recommended over neuro-ICU as this lowers mortality rate (Lombardo et al. 2017)

58.3 Specific Pediatric Concerns

Knowing the pitfalls regarding the compensatory mechanisms in infants and smaller children, it is possible to anticipate and intervene at the earliest possible time.

The recommendation regarding pediatric trauma patients follows the adult protocol, taking into account the difference in reference values and the potential need for expertise in extracranial pediatric surgery and anesthesia (Auner et al. 2014).

References

Algarra NN, Lele AV, Prathep S, et al. Intraoperative secondary insults during orthopedic surgery in traumatic brain injury. J Neurosurg Anesthesiol. 2016;29(3):228–35.

Algarra NN, Deepak S. Perioperative management of traumatic brain injury. Curr Anesthesiol Rep. 2016;6:193–201.

Auner B, et al. Pediatric multiple trauma. Chirurg. 2014;85(5):451–61.

Berry C, Ley EJ, Bukur M, Malinoski D, Margulies DR, Mirocha J, et al. Redefining hypotension in traumatic brain injury. Injury. 2012;43(11):1833–7.

Brain TF. Guidelines for the management of severe traumatic brain injury. J Neurotrauma. 2007;24(suppl 1):S1–106.

Brenner M, Stein DM, Hu PF, Aarabi B, Sheth K, Scalea TM. Traditional systolic blood pressure targets underestimate hypotension-induced secondary brain injury. J Trauma Acute Care Surg. 2012;72(5):1135–9.

DASAIM Neuroanesthesia Group. Recommendation for anesthetic management of patients with TBI and need for extracranial surgery. Danish Society for Anesthesiology and Intensive Care Medicine, DASAIM, Recommendation, Nov. 2011; 2011.

Sharma D, Vavilala MS. Perioperative management of adult traumatic brain injury. Anesthesiol Clin. 2012;30(2):333–46.

Farahvar A, et al. Increased mortality in patients with severe traumatic brain injury treated without intracranial pressure monitoring. J Neurosurg. 2012;117(4):729–34.

Hare GM, Tsui AK, McLaren AT, Ragoonanan TE, Yu J, Mazer CD. Anemia and cerebral outcome: many questions, fewer answers. Anesth Analg. 2008;107:1356–70.

Jeremitsky E, Omert LA, Dunham CM, Wilberger J, Rodriguez A. The impact of hyperglycemia on patients with severe brain injury. J Trauma. 2005;58:47–50.

Keel M, et al. Damage control in severely injured patients. Eur J Trauma. 2005;31:212–21.

Lingsma H, et al. Prognosis in moderate and severe traumatic brain injury: external validation of the IMPACT models and the role of extracranial injuries. J Trauma Acute Care Surg. 2013;74(2):639–46.

Lombardo S, et al. Neuro, trauma, or med/surg intensive care unit: Does it matter where multiple injuries patients with traumatic brain injury are admitted? Secondary analysis of the American Association for the Surgery of Trauma Multi-Institutional Trials Committee decompressive craniectomy study. J Trauma Acute Care Surg. 2017;82(3):489–96.

McMahon CG, et al. Unexpected contribution of moderate traumatic brain injury to death after major trauma. J Trauma. 1999;47(5):891–5.

Rotondo MF, et al. Damage control: an approach for improved survival in exsanguinating penetrating abdominal injury. J Trauma. 1993;35(3):375–83.

Myburgh J, et al. Saline or albumin for fluid resuscitation in patients with traumatic brain injury (SAFE-Study). N Engl J Med. 2004;350:2247–56.

Salim A, Hadjizacharia P, DuBose J, Brown C, Inaba K, Chan L, et al. Role of anemia in traumatic brain injury. J Am Coll Surg. 2008;207:398–406.

Sookplung P, Siriussawakul A, Malakouti A, et al. Vasopressor use and effect on blood pressure after severe adult traumatic brain injury. Neurocrit Care. 2011;15:46–54.

Taeger G, et al. Damage control orthopedics in patients with multiple injuries is effective, time saving and safe. J Trauma. 2005;59(2):409–16; discussion 417.

Talving P, Benfield R, Hadjizacharia P, Inaba K, Chan LS, Demetriades D. Coagulopathy in severe traumatic brain injury: a prospective study. J Trauma. 2009;66:55–61.

van Leeuwen N, et al. Prognostic value of major extracranial injury in traumatic brain injury: an individual patient data meta-analysis in 39,274 patients. Neurosurgery. 2012;70(4):811–8.

Verdantam A, et al. Morbidity and mortality associated with hypernatremia in patients with severe traumatic brain injury. Neurosurg Focus. 2017;43(5):E2.

Watanabe T, et al. Outcomes after traumatic brain injury with concomitant severe extracranial injuries. Neurol Med Chir (Tokyo). 2018;58(9):393–9.