Perioperative Management of Traumatic Brain Injury

Introduction

- "a blow to head or a penetrating head injury that disrupts the function of brain"
- One lakh lives are lost every year due to TBI in India
- Nearly 95% trauma victims do not receive optimal care during '*Golden Hour'* period
- Among them 30% of lives could be saved if quality care were available to them sooner

Global data on TBI

- 50 million injured every year
- Estimated deaths – 1.2 million
- Global mortality: 97/1,000,000
- 70 % fatalities (8,500,000) under 45 years of age

- WHO Research Predicts by 2020:
- 80 % increase in developing countries
- 147 % increase in road traffic accidents (RTA) deaths in India/Rajasthan

Indian data on TBI

- 60% of all TBI caused by RTA
- Fatality rate: 70 per 10,000 vehicles
- 25X higher than in developed countries
- One person dies in India every 6 - 10 mins; will be every 3 mins by 2020
- "vulnerable road users":
  - Pedestrians (25 %),
  - Motorcyclists (17 %),
  - Four-wheel vehicle operators (15%),
  - Pedal cyclists (10 %).

- By 2050, India will have the greatest number of automobiles on the planet, overtaking the United States.
- A study conducted by CRRI-
- Increase traffic congestion in Delhi might actually have resulted in fewer accidents over last year.

Pathophysiology of Traumatic Brain Injury

TBI

↓

10 Injury to brain

↓ ↑ ICP

Inlammation/edema/excitotoxicity

↓ ↑↑ **ICP** ↓ **CPP**

Secondary injuries to brain

Secondary insults contributing to hypoxic/ ischemic brain damage

Systemic	intracranial
Hypoxemia	Hematoma
Hypotension	Raised ICP
Anemia	Seizures
Hypo/hyper carbia	Infection
Pyrexia	Vasospasm
Hyponatremia	
Hypo/hyper glycemia	

Importance of perioperative period

- Most of the poor outcomes after severe head injury are related to presence of pre-hospital secondary insults
- Perioperative period provides an opportunity to continue and refine ongoing resuscitation and to correct pre-existing secondary insults
- Perioperative period may be a window to initiate interventions, that may improve the outcome of TBI

Does the “Golden Hour” After Injury Really Matter?

Golden hour

- A traditional dogma- trauma patients should reach the hospital and to be treated with in one hour of injury
- First described by ***R Adams Cowley*** in 1975
- Several studies have suggested a decrease in mortality when trauma patients reach definitive care during the Golden Hour, but recent research demonstrates no link between time and survival.

- Although prehospital time should be minimized, the use of lights and sirens and air transport entail costs and risks that must be weighed against possible benefit for each patient.
- Also, for really seriously injured patients, arrival at the right place (a Level I trauma center) is probably much more important than the out-of-hospital time.

  - *Newgard CD et al. Ann Emerg Med 2015 Jan 14.*

Goals of perioperative management of TBI

- The key elements of TBI management-
  - ➢ Early resuscitation
  - ➢ Hemodynamic optimization
  - ➢ Emergent surgical evacuation of mass lesion
  - ➢ Control of ICP
  - ➢ Support of CPP
  - ➢ Optimization of physiological milieu

Prehospital Management

- Emergency therapy should begin at the site of accident and in the ambulance
- EMS providers- should be trained to follow an established algorithm for assessment and treatment of TBI
- The first priority is initiation of basic resuscitation protocol, prioritizing the ABCs
- Severely head injured patient to be directly taken to ***level I trauma centre-*** *BTF*

Emergency Department Management

- The initial assessment and stabilization- achieved as soon as the pt arrives in the ED
  - Evaluation of ABCs
  - Rapid assessment of neurological status, pupillary response
  - Associated extra cranial injuries
  - Evaluation of anemia/ coagulopathy/ glycemia
  - Adequate vascular access
- Non contrast CT scan is radiological procedure of choice

Airway management

- Airway management in TBI is complicated-
  - urgency of situation
  - Uncertainty of cervical spine status
  - Uncertainty of airway
  - Full stomach
  - Intracranial hypertension
  - Uncertain volume status

Technique - Best Practices

- Choice of technique depends upon-
  - ➢ Urgency /Individual expertise/ Available resources
- Generally incorporates RSI with cricoid pressure and MILS
- Newer airway devises, particularly videolaryngoscopes, may be useful in difficult airway scenarios
- Nasal intubation- avoided in patients with base of skull fracture, severe facial fractures or bleeding diathesis.

- Appropriate pharmacological selection is important
- Sodium thiopental, etomidate and propofol decrease cerebral metabolic rate for oxygen (CMRO2) and attenuate increases in ICP with intubation
- Propofol & Thiopental may cause CVS depression leading to hypotension
- Etomidate- hemodynamic stability during induction? Adrenal insufficiency
- The choice of muscle relaxant for RSI is succinylcholine or rocuronium
- Succinylcholine may contribute to increased ICP the clinical significance?

Anesthetic Management

- The major goals of anesthetic management of TBI are-

➢ To facilitate early decompression

➢ Provide adequate analgesia and amnesia

➢ Treat intracranial hypertension and maintain adequate cerebral perfusion

➢ Provide optimal surgical conditions

➢ Avoid secondary insults

Anesthetic technique

- IV or volatile anaesthetic agents??
- There is little evidence to support the use of one over the other
- All volatile agents reduce CMRO2, produce cerebral vasodilatation- resulting in increased CBF and ICP.
- However, at concentrations up to 1 MAC these effects are minimal
- Sevoflurane appears to have the best profile.
- N_2O is best avoided

- I.V. agents reduce CMRO2, CBF, and ICP.
- Neuromuscular drugs are recommended to prevent coughing or straining

Ventilation

- Ventilation should be adjusted to ensure adequate oxygenation ($PaO_2 > 60$ mmHg) and normocarbia ($PaCO_2$ 35-45 mmHg).
- Monitoring arterial $PaCO_2$ is recommended
- Hypercarbia ($PaCO_2 > 45$ mmHg) to be avoided
- Hyperventilation should be used judiciously for short-term control of ICP
- Excessive and prolonged hyperventilation may cause cerebral vasoconstriction leading to ischemia

Monitoring

- Multimodal monitoring
- American Society of Anesthesiology (ASA) monitors
- Arterial catheterization is recommended for continuous BP monitoring, ABG and glucose monitoring in patients who require surgical intervention
- ICP monitoring is recommended in all salvageable patients with a severe TBI (GCS < 9) and an abnormal CT scan

- Jugular venous oximetry is often useful for assessment of adequacy of global cerebral oxygenation
- Brain tissue oxygen monitors have the advantage of identifying focal areas of ischemia which may not be picked up by jugular venous oximetry.
- Near Infrared Spectroscopy (NIRS) offers the capacity to conveniently and non-invasively monitor cerebral oxygen in the intensive care unit.

- Transcranial Doppler (TCD) ultrasonography is a non-invasive, nonradioactive, bedside monitor, which can provide useful instantaneous cerebrovascular information including changes in cerebral blood flow velocity, cerebral vasospasm and autoregulation

Intravenous Fluids, Blood Pressure Management and Vasopressor Use

- BP management, including choice of fluids and vasopressors, is of paramount importance
- BTF guidelines for the management of TBI recommend avoiding hypotension (SBP < 90 mmHg) and maintaining CPP between 50 and 70mmHg.
- Perioperative hypotension should be treated promptly
- Hypertonic saline may be beneficial resuscitation fluid for TBI patients
- Current evidence does not support preference of one vasopressor over the other to support cerebral perfusion and the choice may have to be individualized to patient characteristics

Coagulopathy

- Coagulation disorders may be present in approximately one-third TBI patients and is associated with an increased mortality and poor outcome
- Brain injury leads to the release of tissue factor.
- Patients with GCS ≤8, associated cerebral edema, SAH and midline shift are likely to have coagulopathy

Hyperosmolar therapy

- Mannitol is commonly used for hyperosmolar therapy
- The recommended dose of mannitol is 0.25-1 g/kg body weight
- In patients with severe TBI and elevated ICP refractory to mannitol treatment, 7.5% hypertonic saline administered as second tier therapy

Glycemic Control

- Hyperglycemia after TBI is associated with increased morbidity and mortality
- Hyperglycemia can cause secondary brain injury
- Hypoglycemeia is equally deleterious to brain
- Given the current evidence for glucose control for TBI in perioperative period, a target glucose range of 80-180 mg/dl is reasonable

Therapeutic Hypothermia and Steroids

- Hypothermia reduces cerebral metabolism during stress, reduces excitatory neurotransmitters release, attenuates BBB permeability
- Yet, clinical evidence in terms of mortality and functional outcomes is still inconclusive.
- Accordingly, the BTF/AANS guidelines task force has issued a Level III recommendation for optional and cautious use of hypothermia for adults with TBI