Depressed Skull Fractures

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Abbreviations

ASM: Anti-seizure medications

CSF: cerebrospinal fluid

CT: computed tomography

DSF: Depressed skull fracture

GOS: Glasgow outcome score

MRV: magnetic resonance venography

PTS: post-traumatic seizure

TBI: traumatic brain injury

WHO: world health organization

Glossary

Skull fractures are classified in three ways: by pattern into (linear, comminuted, and depressed), by anatomic location into (vault, basilar), and by skin integrity into (open, and closed).

Depressed skull fractures must by definition have displacement of bone greater than the full thickness of the adjacent calvarial thickness.

Open fractures, by definition, have either a skin laceration over the fracture or the fracture runs through the paranasal sinuses and the middle ear structures, resulting in communication between the external environment and the cranial cavity.

Pneumocephalus is the presence of air within the cranial cavity.it is usually associated with disruption of the skull: after head and facial trauma.

Executive Summary

This topic is concerned with management guidelines of depressed skull fractures.

Recommendations

Initial Management: (as a part of initial TBI management)

- Avoid hypoxia.
    - ✧ Strong recommendation.
- Secure the airway (endotracheal intubation) in patients with GCS ≤8 who are unable to maintain their airway or who remain hypoxic despite supplemental O2.
    - ✧ Strong recommendation.

- Avoid hypotension.
    - ✧ Strong recommendation.
- We recommend ICU admission and close neurosurgical observation with CT monitoring if needed (if not available, refer to a tertiary center).
    - ✧ Strong recommendation.
- The availability of equipped neurosurgery operating room is essential for management (if not available, refer to a tertiary center).
    - ✧ Strong recommendation.
- Anti-seizure medications (ASM):

  Consider the use of ASMs (e.g., phenytoin, valproate, or carbamazepine) to decrease the incidence of early PTS (within 7 days of TBI).
    - ✧ Conditional recommendation

Definitive management

- surgical management may be indicated in Patients with open (compound) depressed cranial fractures (evidenced by CT) with:
    - Depression greater than the thickness of the cranium.
    - Clinical (CSF leak / hernia cerebri) or radiographic (pneumocephalus) evidence of dural violation.
    - Underlying significant intracranial hematoma or hemorrhagic contusions.
    - Frontal sinus involvement.
    - Gross cosmetic deformity.
    - Wound infection.
    - Dural venous sinuses compromise impeding blood flow as evident in 3D CT and MRV brain.
        - ✧ Conditional recommendation

- Surgery may be indicated for closed depressed skull fractures if:
  - the depression is causing a focal deficit through pressure on the adjacent cortex.
  - the closed fracture is depressed and causing a cosmetic abnormality, for example fractures over the forehead.
    - ✧ Conditional recommendation
- Surgery (if indicated) is recommended as soon as possible after stabilization and coverage of umbrella of antibiotics.
    - ✧ Strong recommendation
- patients with open (compound) depressed cranial fractures may be treated conservatively in the absence of the previously mentioned surgical indications.
    - ✧ Conditional recommendation

Introduction

Head Trauma is a serious problem worldwide. Depressed skull fracture accounts for significant morbidity and mortality as it complicates the head injury in up to 6% subjects. Compound fractures account for up to 90%, the associated infection rate of DSF is 1.9 to 10.6%, an average neurological morbidity of approximately 11%, an incidence of late epilepsy of up to 15%, and a mortality rate of 1.4 to 19%.[1]

Controversy surrounds appropriate management of depressed cranial fractures. The rationale for aggressive treatment of depressed cranial fractures stems from their association with infection and late epilepsy. Cosmetic deformity also plays a role in surgical decision making. Such complications, and their potential sequelae, are well documented.[2]

Another challenge to traditional thinking that has surfaced in the literature involves the proper surgical management of compound depressed cranial fractures with respect to the bone fragments. Conventional treatment involves operative debridement, elevation of the fracture, removal of bone fragments, and delayed cranioplasty. However, this subjects the patient to a second operation (i.e., cranioplasty), with its attendant risks and complications.[2,3]

Scope and Purpose

The purpose of this multidisciplinary guideline is to identify improvement in the diagnostic tools and treatment strategies in managing patients with depressed skull fractures and to create actionable recommendations to implement these strategies in clinical practice. This is targeting adults depressed skull fractures because Management of skull fractures in Pediatrics have special considerations (Growing skull fractures, compound elevated skull fracture, ping pong fractures).

The target audience

The guideline is intended for all clinicians who are likely to diagnose and manage patients with depressed skull fractures, and it applies to any setting in which patients with skull fractures would be identified, monitored, or managed.

Methods

A comprehensive online search for guidelines and articles was undertaken to identify the most relevant articles to be reviewed and guidelines to consider for adaptation.

Inclusion/exclusion criteria followed in the search were:

- Selecting only national and/or international guidelines.
- Specific range of dates for publication (using Guidelines published or updated 2005 and later)

- A large series none controlled, prospective clinical trials of treatment using surgical versus nonsurgical management have been reviewed.
- Selecting peer reviewed publications only.
- Selecting guidelines written in English language.
- Papers with the following characteristics were also excluded: case series with less than 10 patients evaluated by CT scan and with incomplete outcome data (mortality or GOS (Glasgow outcome score)), case reports, operative series with operations occurring longer than 14 days from injury.
- Selected articles were evaluated for design, prognostic significance, therapeutic efficacy, and overall outcome.
- Excluding guidelines written by a single author, not on behalf of an organization to be valid and comprehensive, a guideline ideally requires multidisciplinary input
- Excluding guidelines published without references
- The following characteristics were summarized in a table:
  - Developing organization/authors
  - Date of publication, posting, and release
  - Country/language of publication
  - Date of posting and/or release
  - Dates of the search used by the source guideline developers

All retrieved Guidelines were screened and appraised using the AGREE II instrument (www.agreetrust.org) by at least two members. The panel decided on a cut-off point or ranked the guidelines (any guideline scoring above 50% on the rigour dimension was retained). we choose for adaptation:

Guidelines for the Management of Severe Traumatic Brain Injury 4th Edition: Brain Trauma Foundation: September 2016.[4]

Evidence assessment

According to WHO handbook for Guidelines we used the GRADE (Grading of Recommendations, Assessment, Development and Evaluation) approach to assess the quality of a body of evidence, develop and report recommendations. GRADE methods are used by WHO because these represent internationally agreed standards for making transparent recommendations.

The four levels of evidence are:

- High certainty evidence
- Moderate certainty evidence
- Low certainty evidence
- Very low certainty evidence

Table (1): **Quality of evidence in GRADE**

Quality level	Definition
High	We are very confident that the true effect lies close to that of the estimate of the effect.
Moderate	We are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low	Our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low	We have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

GRADE: Grading of Recommendations Assessment, Development and Evaluation.

Downgrade in presence of	Upgrade in presence of
Study limitations -1 Serious limitations -2 Very serious limitations	Dose-response gradient +1 Evidence of a dose-response gradient
Consistency -1 Important inconsistency	Direction of plausible bias +1 All plausible confounders would have reduced the effect
Directness -1 Some uncertainty -2 Major uncertainty	Magnitude of the effect +1 Strong, no plausible confounders, consistent and direct evidence
Precision -1 Imprecise data	+2 Very strong, no major threats to validity and direct evidence
Reporting bias -1 High probability of reporting bias	

Table (2): Factors that determine How to upgrade or downgrade the quality of Evidence.

The strength of the recommendation

The strength of a recommendation communicates the importance of adherence to the recommendation.

Strong recommendations

With strong recommendations, the guideline communicates the message that the desirable effects of adherence to the recommendation outweigh the undesirable effects. This means that in most situations the recommendation can be adopted as policy.

Conditional recommendations

These are made when there is greater uncertainty about the four factors above or if local adaptation has to account for a greater variety in values and preferences, or when resource use makes the intervention suitable for some, but not for other locations. This means that there is a need for substantial debate and involvement of stakeholders before this recommendation can be adopted as policy.

When not to make recommendations

When there is lack of evidence on the effectiveness of an intervention, it may be appropriate not to make a recommendation.

- ***Recommendations***

  Initial management

Items:	**Strength of Recommendation**	**Level of Evidence**
■ Avoid hypoxia	Strong	Moderate-Quality Evidence[4]
■ Secure the airway (endotracheal intubation) in patients with GCS ≤8 who are unable to maintain their airway or who remain hypoxic despite supplemental O2	Strong	Moderate-Quality Evidence[4]
■ avoid hypotension	Strong	Moderate-Quality Evidence[4]
■ We recommend ICU admission and close neurosurgical observation with CT monitoring if needed (if not available, refer to a tertiary center).	Strong	High-Quality Evidence[5]
■ The availability of equipped neurosurgery operating room is essential for management (if not available, refer to a tertiary center).	Strong	High-Quality Evidence[5]
■ Antiseizure medications (ASM): Consider the use of ASMs (e.g., phenytoin, valproate, or carbamazepine) to decrease the incidence of early PTS (within 7 days of TBI).	Conditional	Moderate-Quality Evidence[4]

Definitive management

	Strength of recommendation	**Level of evidence**
■ surgical management may be indicated in Patients with open (compound) depressed cranial fractures (evidenced by CT) with: ▪ Depression greater than the thickness of the cranium. ▪ Clinical (CSF leak / hernia cerebri) or radiographic (pneumocephalus) evidence of dural violation. ▪ Underlying significant intracranial hematoma or hemorrhagic contusions. ▪ Frontal sinus involvement. ▪ Gross cosmetic deformity. ▪ Wound infection. ▪ Dural venous sinuses compromise impeding blood flow as evident in 3D CT and MRV brain.	Conditional	Moderate certainty evidence[2, 3]
■ Surgery may be indicated for closed depressed skull fractures if: ➢ the depression is causing a focal deficit through pressure on the adjacent cortex. ➢ the closed fracture is depressed and causing a cosmetic abnormality, for example fractures over the forehead.	Conditional	Moderate certainty evidence[2]

■ Surgery (if indicated) is recommended as soon as possible after stabilization and coverage of umbrella of antibiotics.	strong	Moderate certainty evidence[2]
■ patients with open (compound) depressed cranial fractures may be treated conservatively in the absence of the previously mentioned surgical indications.	Conditional	Moderate certainty evidence[2]

Implementation Considerations:

training for neurosurgeons on guidelines application.

Clinical / Radiological Indicators:

1) Glasgow outcome score on admission and to be repeated every 8 hours.
2) Cranial CT scan on admission to determine the site and extent of the skull fracture, associated hematoma, and to be repeated after surgery.

Research Gaps

Delayed versus early skull bone reconstruction following surgery for compound depressed skull fracture.

Updating the guideline

To keep these recommendations up to date and ensure its validity it will be periodically updated. This will be done whenever strong new evidence is available and necessitates updating.

Annexes:

Glasgow Coma Scale

	Adults & Older Children	Young (Pre-School) Children	Infants or Ventilated
BEST EYE RESPONSE (4)			
4	Open spontaneously	Open spontaneously	Open spontaneously
3	Open to voice	Open to voice	Open to voice
2	Open to pain	Open to pain	Open to pain
1	No opening	No opening	No opening
BEST VERBAL (OR GRIMACE) RESPONSE (5)			
5	Orientated	Alert, babbles, coos, words or sentences to usual ability	Spontaneous normal facial/oro-motor activity
4	Confused	Less than usual ability and/or spontaneous irritable cry	Less than usual spontaneous activity or only response to touch
3	Inappropriate words	Cries inappropriately	Vigorous grimace to pain
2	Incomprehensible sounds	Occasional whimpers and/or moans	Mild grimace to pain
1	No verbal response	No verbal response	No response to pain
BEST MOTOR RESPONSE (6)			
6	Obeys commands	Obeys commands or normal spontaneous movement	Obeys commands or normal spontaneous movement
5	Localises pain	Localises pain or withdraws to touch	Localises pain or withdraws to touch
4	Withdraws to pain	Withdraws to pain	Withdraws to pain
3	Decorticate flexion to pain	Decorticate flexion to pain	Decorticate flexion to pain
2	Decerebrate extension to pain	Decerebrate extension to pain	Decerebrate extension to pain
1	No motor response	No motor response	No motor response

Derived from NICE Head Injury Guideline (2007)

References

1. **Amir S:** Depressed skull fracture: surgical management and outcome. In J. Med. Sci. (Peshawar, Print) July 2017, Vol. 25, No. 3.
2. **Bullock MR, Chesnut R, Ghajar J, Gordon D, Hartl R, Newell DW, et al**: Surgical Management of Depressed Cranial Fractures. In Neurosurgery, 2006. 58: S2-56-S2-60.
3. **Ali M, Ali L, Roghani IS:** Surgical management of depressed skull fracture. J Postgrad Med Inst 2011; 17: 17-20.
4. **Guidelines for the Management of Severe Traumatic Brain Injury 4th Edition:** Brain Trauma Foundation: September 2016.
5. **Greenberg's Handbook of Neurosurgery**: Head Trauma – General Information, Grading, Initial Management July 2022; 53: e1000–e1018.