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DECOMPRESSIVE CRANIECTOMIES IN TRAUMATIC BRAIN INJURIES – REINVENTING THE WHEEL- THE INDIAN ARMED FORCES EXPERIENCE

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ABSTRACT The Brain Trauma Foundation 4th edition guidelines and the RESCUE ICP trial, both, lay a lot of stress on the ICP monitoring in cases of decompressive Craniectomies for traumatic brain injuries. Based on the different epidemiology of head injury in various parts of the world, the availability of resources and the case series in study the authors try to analyse whether the ICP value is the "Magical figure" as it is projected to be & the way ahead.

KEYWORDS : Decompressive Craniectomies, Traumatic Brain Injuries

INTRODUCTION:

Decompressive craniectomy is an age old procedure and no new age fancy or a modern craze! However, even today, controversy exists regarding the indication, timing, and overall utility of this procedure.

The authors present the outcome of a retrospective analysis of 34 cases of decompressive craniectomy following traumatic brain injury at the apex tertiary care centre of the Indian Armed Forces along with review of various guidelines and evolving epidemiological trends in other parts of the world, to chart the possible road map to future. The authors in all humility request the esteemed readers for an "Open" mind to see an "Opened" mind.

DECOMPRESSIVE CRANIECTOMY – AN OVERVIEW:

Decompressive craniectomy or "Trepanation" as the Greek used to call it, has its roots in the word "Borer" or "Auger." Trepaned skulls have been unearthed in all parts of the world including India, Egypt, China, Greece etc dating as early as 7000 years ago. (Fig 1a)

Fig 1 a) Trepanned skull from Egypt about 6,000years ago

1b) skull unearthed at Burzahom, Kashmir dating 4,000 years ago

Ausclepius, probably a war surgeon who covered the Battle of Troy and also the Hippocratic Corpus mentions treapantion as possibly as one of the world's oldest surgeries. Evidence of craniectomy in ancient India has been found in a skull unearthed at Burzahom, Kashmir dating 4,000 years ago[1] (Fig 1b)

Interestingly, Paleo-neurosurgical science has proven that many of these trepanations have been antemortem with objective evidence of healing noted in the discovered specimens. Over the ages there has been mention of people using various tools for craniotomies like "Tumi" in Peru, "Flint stone" and "Obsidian" in Europe, sharpened seashells in South Pacific, till the Hippocratic School invented the "Trephine" drill at around 400BC.

Indication:

In past, the indications for craniectomy have had their own share of controversies. It included headache, epilepsy, depression, stroke, trauma, tumour, warding off evil spirit and the list seemed endless.

Trauma and craniectomy: The present day concept:

Surgical decompression to treat elevated intracranial pressure was conceptualized in modern neurosurgery in the beginning of 20th century. Wide variety of decompressive craniectomies were proposed by surgeons down the ages in the modern neurosurgical practice. (Fig 2)

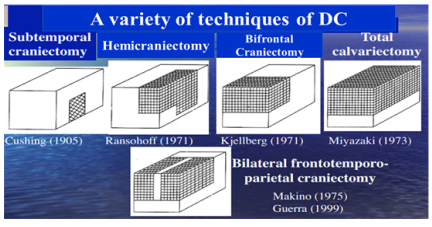


Fig 2. Several techniques of decompressive craniectomies in practice with their respective founders

" Primary" decompressive craniectomy refers to a large bone flap removal to treat depressed fracture with or without evacuation of intracranial hematoma or lobectomy of burst 'pulpy' brain, in the early phase of traumatic brain injury.

The term "Secondary" decompressive craniectomy is used as part of therapeutic protocol where in the decompression is performed as a third tier intervention, when the ICP (intracranial pressure) remains elevated despite all other measures. (2)

Decompressive Craniectomy – Latest Guidelines

Universally accepted guidelines as per "**Brain trauma Foundation**" Edition 4 (level 2 recommendation) state that Bifrontal decompressive craniectomy in severe traumatic brain injury with diffuse cerebral oedema (without mass lesion and with elevated intracranial pressure) although decreases the intracranial pressure and minimises the ICU stay, but does not improve the Glasgow Outcome Score (GOS) at 6months and hence not recommended.

The brain trauma Foundation guidelines also recommend a fronto-temporo-parietal decompressive craniectomy not less than 12 cm X 15 cm for improved neurological outcome in cases with unilateral mass effect with or without haematoma.

The recommendations also suggested incorporation of result of the **"Rescue ICP" trial** (**R**andomised **E**valuation of **S**urgery with **C**raniectomy for **U**ncontrolled **E**levation of **I**ntra**C**ranial **P**ressure) as and when the trial was completed which was near completion at the time of issue of these guidelines.

RESCUE ICP Trial: This International, multicentre, parallel-group randomised trial compared last tier secondary decompressive craniectomy with continued medical management for refractory intracranial pressure after traumatic brain injury.[2]

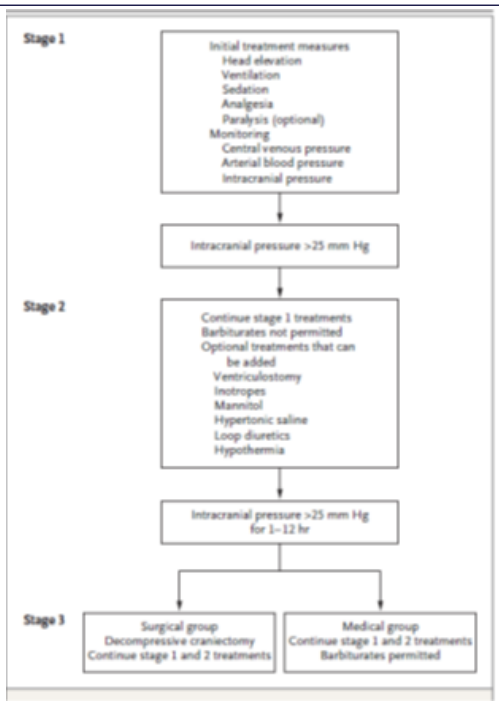


Fig 3. Management Algorithm in RESCUE- ICP Trial

The broad outcome of this study is as follows decompressive craniectomy groups showed

- lower mortality rate
- higher rates of vegetative state
- lower severe and upper severe disability
- similar moderate disability, good recovery rate

MATERIAL AND METHOD:

This retrospective study, carried out at the apex tertiary care centre of the armed forces medical setup in India, analysed the outcome of 34 cases of decompressive craniectomy carried out for trauma patients between January 2015 and December 2017. The medical records and follow up OPD visits were meticulously analysed and all patients who were alive were contacted and present neurological and functional status recorded.

Inclusion Criteria

All patients of Severe Head Injury with clinical or/& radiological features of raised intracranial pressure at presentation.

Exclusion criteria

a) All patients with fixed dilated pupils and/ or absence of brain stem reflexes at presentation
b) All patients who had severe injuries of other organ systems like abdominal or chest or open fracture of limbs
c) All patients who had other significant injuries mandating surgery in their own merit. For e.g. Open depressed fracture of the scalp, degloving wound of the scalp
d) All patients who had features of active septicaemic process at presentation who seemed to succumb due to causes other than head injury per se.
e) All patients who underwent craniotomy elsewhere before presentation

No patient was offered ICP monitoring (owing to infrastructural constraints and insufficiency of data to support definitive role of ICP monitoring to improve outcome in Head Injury patients). All patients were operated based on clinical profile based on Glasgow coma score &/or lateralising signs and radiological features of initial or follow up CT scan.

Outcome was defined in terms of survival, Glasgow Outcome Score at 6months (GOS-6) and Glasgow Outcome Score at 12months (GOS-12). Outcome was distributed into good (GOS 4-5) and bad (GOS 1-3). Patients who did not show up for follow up till 1yr after discharge as well as were not contactable at present were grouped as "Lost to follow up".

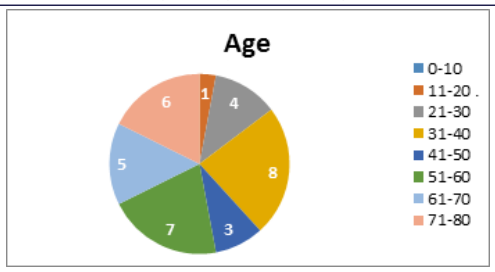


Fig 4. Age Distribution of our patients

OBSERVATION AND RESULTS:

The youngest patient was 18yrs old and the oldest 75yrs old, amongst 34 patients whom we studied. Mode of injury was RTA in 25, fall from height in 6 and fall of heavy weight in rest 3.

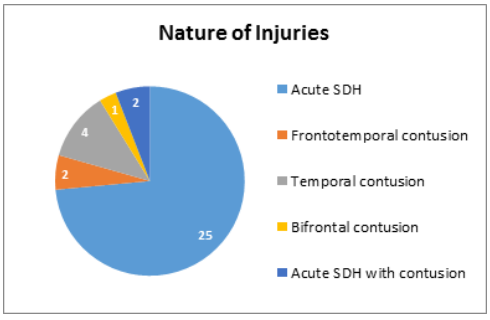


Fig 5. Nature of injuries as evidenced by the initial NCCT Head of our patients

Patients had injuries ranging from acute subdural haematoma (SDH) to frontotemporal, temporal or bifrontal contusions and associated mass effect and clinical features of raised intracranial pressure (ICP).

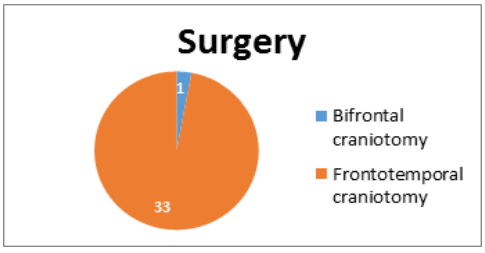


Fig 6. Nature of surgery done for our patients

33 patients underwent frontotempoparietal decompressive craniectomy and one patient underwent bifrontal decompressive craniectomy.

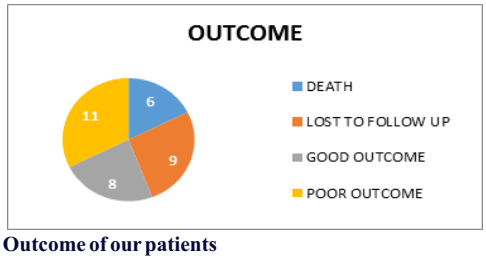


Fig 7. Outcome of our patients

5 patients died in the perioperative period and 1 died after 6weeks due to fulminant community acquired chest infection with sepsis and multiorgan dysfunction. Out of the patients who survived, 9 patients lost to follow up. Out of remaining 19 patients, 8 patients had good outcome at 6 months follow up and 9 patients had good outcome at 12months follow up.

DISCUSSION:

A. Diverse Epidemiology

The median age of traumatic brain injury is rising in the Western world, Australia & Japan. More number of cases is accounted for due to falls than due to road traffic accidents in these countries. In 1984 the median age for traumatic head injury patients in USA was 24 years with 15% of patients being above the 50 years age bracket. In 2007 the median age

for traumatic head injury patient in USA was 45 years and with 44% of patients being above the 50 years age bracket. However, as per WHO statistics the contribution of Road traffic accidents to the cause of mortality is expected to increase from 2.2% in 2004 to 3.6% in 2030 making it climb the ladder from 9th to 5th commonest killer of mankind[3]. This can only be explained by an exponential rise in the rate of traffic accidents in the rest of the world. Truly so, the Asian continent and also India has shown an increase in the number of cases of road traffic accidents with concomitant increase in extradural and Acute subdural Hematoma cases.

On one hand, we have a Level 1 Trauma centre in Cleveland USA publishing a report on decompressive craniectomy carried out on 17 paediatric cases over a period of 10years[4] and on the other hand we have a study published from India with 71 paediatric cases undergoing decompressive craniectomy over 1.5 years[5]. 89% of data published regarding traumatic brain injury in the world is published from USA, Australia, Canada, Japan and Europe. Paradoxically, these parts of the world account only for 18% of the head injury load in the world. Thus, in effect the part of the world with less than 20% of head injuries of the world are providing guidelines for those who have around 80% of such cases. The Asian and African continent in general and India in particular has to realise that efficient data keeping and observational followed by comparative studies would yield results not only enhancing our understanding of head trauma in our perspective (rather than extrapolating and applying western guidelines to our scenario, which might be quite dissimilar), but also providing the world with sturdier guidelines useable for general population.

B. Selection Bias - RESCUE ICP trial?

A total of 408 cases were selected for this multicentric study[2]. Around 50 trauma centres from all over the world was taken- distributed over 19 countries to be precise. So where was the bias?

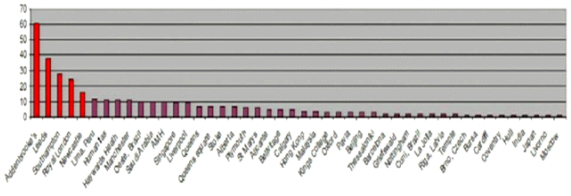


Fig 9. Number of head injury cases evaluated during the RESCUE ICP trial, country wise

About 70 % of the patients were enrolled from UK. If one includes the 17% from Italy then more than 87% of patients enrolled were from Europe. The statistical contribution of India is for all to infer & analyse from the above graph. Thus, the demographic profile of people injured and people studied may not be alike and hence the guidelines may not be applicable in our scenario.

A. Diverse Resources

I) Rescue ICP trial monitored during stage 1

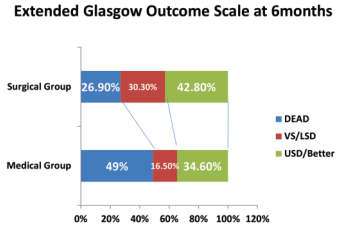
- intracranial pressure less than 25 mm Hg
- cerebral perfusion pressure more than 60 mm HG
- paco2 of less than 34 mm HG

During stage 2

- maintenance of therapeutic hypothermia not less than 34 degrees centigrade.

One has to introspect as to how many centres in our country have the capability for the above monitoring.

ICP monitoring and periodic ABG analysis does need not only the machines, but also the manpower. Most trauma ICUs enrolled for the RESCUE ICP trial are in UK & Italy, which can boast of one nurse: one patient ratio. The situation in the armed forces, though way better than in most Government care setups in the country, is still far from this state



Going through the brain trauma Foundation Edition IV guidelines and the RESCUE ICP trial one may be tempted to presume that the intracranial pressure is a magical figure. But is that true? Randall M Chestnut et al moved from Europe to South America and carried out a study which was deemed unethical in Europe. He carried out an analysis of outcome of cases of traumatic brain injury with and without ICP monitoring. Surprisingly the outcome appeared to be similar[6]! This may appear bewildering and paradoxical. The logic behind this may be the fact that most decisions for surgery are not based only on the magical ICP number but rather it is based on ICP, radiological deterioration and clinical status profile taken together. Usually a worsening of intracranial pressure would corroborate definitely with worsening clinical profile and mostly with a worse radiology as well. Thus, even if one omits to monitor intracranial pressure, the clinical profile and the radiological parameters would tend to guide the care provider in the correct direction.

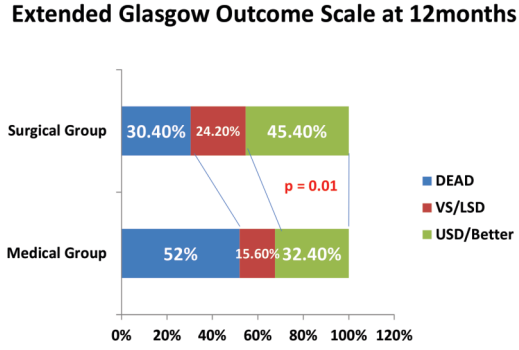


Fig 10a) Results of patients in Rescue ICP trial at 6months 10b) Results of patients in Rescue ICP trial at 12months

If one analyses the rescue ICP trial outcome one realises that the surgical group did have a lower number of deaths (Black) but at the same time higher number of cases with poor outcome score (Red). The good outcome (Green) was higher in craniectomy group as compared to those being managed medically however it was not statistically significant at 6months. Interestingly, if one again analyses the Glasgow outcome score **after 12 months** the **good outcome becomes statistically significant** in the surgical group.

However there is a catch. Most patients participating in the trial where from Italy and UK. **Both Italy & UK have free rehabilitation facilities for cases of traumatic brain injuries for one year post injury**. The fact cannot be overemphasised that this would have impact on the outcome. With no such facility being readily available in our country we need to realise that the outcomes may differ. In fact people are already questioning as to why the Glasgow outcome score at discharge should not be the criteria for assessment of outcome in the absence of any rehabilitation facilities in our country[7].

Finally, when the authors started to analyse the data at our Centre it suddenly dawned upon us that out of 34 cases of decompressive craniectomy at our Centre we had only one case of secondary decompressive craniectomy. It meant that most of the decompressive craniectomies were carried out to remove mass lesions or in presence of mass effect with lateralising signs. Does that mean that medical management was effective to control raised ICP in cases with diffuse axonal injury with cerebral oedema? Or the cases with rise in ICP without radiological changes (Can that happen?) could have been missed, especially in absence of ICP monitoring in all cases!

Limitations

We do realise that this is a small sample size to derive any statistically significant conclusions.

The follow up of patients continued on medical management was not assessed and compared.

CONCLUSION

It is recommended that guidelines of Brain Trauma Foundation and RESCUE ICP trial be followed in centres where feasible economically and infrastructurally.

ICP monitoring to be carried out when indicated[8], if feasible. However, there is insufficient data to suggest that decision to subject a patient to decompressive craniectomy purely on clinical and radiological basis

without ICP monitoring would be inferior or incorrect as compared to when based on ICP monitoring also taken into account. However, elaborate counselling of the next of kin to this effect is considered mandatory to avoid litigations quoting the same as potential cause of deterioration/ death of the patient

Meticulous data keeping and compilation (preferably with multicentre participation) would facilitate understanding the comparison of treatment modalities in our scenario and formulation of guidelines which are more pertinent for Indian subcontinent. Given the proportionate number of patients of Head Trauma in Indian subcontinent, this could also change the way head injuries are dealt with in the rest of the world.

Glasgow outcome score at discharge to be studied and analysed as a viable option.

Can the cohesive family values & joint family system in India with necessary training of family members be an adequate and effective alternative to the one year free rehabilitation in Europe? Can establishment of long term Post Head Injury rehabilitation centres be proven worthy in view of our Government managed care status? We need studies to corroborate or refute this.

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