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TEMPORALIS HINGE CRANIOTOMY AS AN ALTERNATIVE TO DECOMPRESSIVE CRANIECTOMY

Neurosurgery

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ABSTRACT

Introduction: Traumatic brain injury is major cause of death, disability and economic cost to our society. Decompressive craniectomy is proven surgical management of traumatic brain injury with raised intra cranial pressure. Decompressive craniectomy has certain complications like syndrome of trephined, development of post operative hydrocephalus, CSF leakage. Secondary surgery to restore bone flap required in decompressive craniectomy which increase psychological and monetary burden over patients and increase patient load over health care facilities. An alternative option require for decompressive craniectomy that has advantages of decompressive craniectomy and avoid complication and disadvantages of decompressive craniectomy. **Objective:** To study Temporalis hinge craniotomy as an alternative method for decompressive craniectomy in terms of operative time, duration required for postoperative intensive care unit treatment, progression to decompressive craniectomy, postoperative complications, glasgow outcome scale at 3 months. **Material and Methods** The study was conducted from April 2022 to May 2025 in the Department of Neurosurgery at Civil Hospital, Ahmedabad. Total 29 patients were included in the study as per selection criteria. Patients were randomized into undergoing the Decompressive craniectomy (DC) or Temporalis hinge craniotomy (tHC) procedures. All patients underwent routine preoperative investigations, and after providing informed written consent, they were taken up for the surgical procedure. All patients were treated with established head injury protocols and pre-operative and post-operative intensive care as required. **Results** Total 29 patients included in this study. Among 29 patients 15 patients (51.72%) operated for temporalis hinge craniotomy while 14 patients (49.27%) operated for decompressive craniectomy Majority patients undergone decompressive craniectomy had intracerebral hematoma while contusion was primary reason in patients undergone tHC. Majority patients (79.31%) had GCS between 9-12 in both group. Mean midline shift in pre-operative scan was 10.13 mm. Mean operative time was 121.3 min for tHC and 132 min for DC(p=0.012). Average postoperative ICU stay was 7 days in both group. 1 patient operated for tHC required conversion to conventional decompressive craniectomy due to refractory raised ICP while 2 patients operated for DC required ventriculoperitoneal shunt due to development of postoperative hydrocephalus. Mean GCS score was around 13 in both groups(p=0.26). Majority of patients had GOS 4 at end of 3 months. We had 1 mortality in each group due to reason unrelated to surgery. **Conclusion** Temporalis hinge craniotomy is probable alternative candidate for patients requiring decompressive craniectomy. tHC avoids post-operative complications of decompressive craniectomy due to removal of bone flap like syndrome of trephined, hygroma, cosmetic deformity, secondary surgery, resorption of bone flap without added complications. It also avoid psychological and economic burden to patients for secondary surgery to restore bone flap and reduces patient load in high volume health care centre for the same in case of DC.

KEYWORDS

Decompressive craniectomy, Raised intracranial pressure, Temporalis hinge craniotomy, Alterantive to decompressive craniectomy

INTRODUCTION

Traumatic brain injury (TBI) is the major cause of disability, death, and economic cost to our society.[1] Cranial decompression for the treatment of medically refractory intracranial hypertension was first reported by Kocher in 1901 and Cushing in 1908. In the century following its introduction, its role remained controversial. Recently, many have reported a significant reduction in ICP and even a positive effect on outcome using decompressive craniectomy (DC). Like any other surgical procedure, there is morbidity associated with DC. Decompressive craniectomy is associated with a varied spectrum of complications because of absence of a bone flap.[2] The main complications that may occur following a DC include vulnerability of the underlying brain to direct injuries due to the loss of bone, the need for a second surgery to perform a cranioplasty, and a higher incidence of infection, hydrocephalus, syndrome of the trephined, intracerebral hematoma, delayed seizures, cerebrospinal fluid leak (3–5%), extra-axial collection (both epidural [20%], and subdural [5%]).[2,3,4] Studies have shown that many of these morbidities get reversed following replacement of the bone flap.[5,6] Neurological worsening has also been described after craniectomy with improvement following cranioplasty. In addition, as many as 17% of patients will have chronic, debilitating headaches that only improve with replacement of the cranial plate. Cranioplasty requires a second operation performed under general anesthesia and exposes the patient to additional potential complications. Cranioplasty has a significant infection risk with many patients requiring removal of the autologous cranial plate or prosthetic implant with subsequent revision. The ideal procedure for cranial decompression would be one that combines the effectiveness of DC but limits the aforementioned difficulties with which it is associated. A relatively novel and less well-utilised technique to achieve cerebral decompression in patients with brain swelling and/or raised ICP is the 'hinge craniotomy' (HC), also known as hinged decompressive craniectomy. HC requires metallic implant to fix cranial plate to skull. Modification of HC is Temporalis Hinge craniotomy (tHC) uses patients temporalis muscle on which bone is hinged. This method (tHC) is cost effective because it does not requires metallic implant or separate surgery for reposition of bone plate.

MATERIAL AND METHODOLOGY

The study was conducted as a parallel group randomized, controlled trial from April 2022 to May 2025 in the Department of Neurosurgery at Civil Hospital, Ahmedabad. Total 29 patients were included in the study as per selection criteria. Patients were randomized into undergoing the Decompressive craniectomy (DC) or Temporalis hinge craniotomy (tHC) procedures. All patients underwent routine preoperative investigations, and after providing informed written consent, they were taken up for the surgical procedure. All patients were treated with established head injury protocols and pre-operative and post-operative intensive care as required. All required data filled up in proforma and statistical analysis done with t-test where required.

Inclusion criteria

- Patients requiring decompressive craniectomy
- GCS >= 7 at admission
- Patients or patient's relative who are willing to give informed consent
- Patient age >=12 years

Exclusion criteria

- Patient age <12 years
- GCS at admission <7
- Patient requiring bilateral decompressive craniectomy, bifrontal decompressive craniectomy or posterior fossa decompressive craniectomy
- Patients or patient's relatives not willing to participate in study

Surgical technique

- **Decompressive craniectomy**

For unilateral DC, the patient was placed supine with a small rolled towel underneath the ipsilateral shoulder and the head turned toward the contralateral side. Once the site was prepped and draped, a large question mark incision was made starting at the level of zygoma and

curving posteriorly above the ear, over the parieto-occipital region, then superiorly and anteriorly, approximately 2 cm lateral to the midline, and stopping just behind the hairline. The posterior extent of the incision was more than 15 cm behind the keyhole to allow for an adequate craniectomy flap. The superficial temporal artery was preserved and temporalis was dissected up to the zygoma to allow for maximal temporal decompression. The anteroposterior dimension was at least 15 cm and extended down to the floor of the temporal fossa. An adequate number of burr holes were made and underlying dura was separated using a Penfield dissector. Cutter was used to make the craniectomy and temporal extent expanded. Hemostasis with the bone and epidural space was achieved using bone wax and dural tack up stitches, respectively, and the dura was opened carefully in a cruciate fashion. After evacuation of the hematoma, wound drain was placed and scalp closure was done in layers and bone flap sent for ethylene oxide sterilization.[7]

- **Temporalis Hinge Craniotomy (tHC)**

The patient was placed supine with a small rolled towel underneath the ipsilateral shoulder and the head turned toward the contralateral side. Once the site was prepped and draped, a large question mark incision was made starting at the level of zygoma and curving posteriorly above the ear, over the parieto-occipital region, then superiorly and anteriorly, approximately 2 cm lateral to the midline, and stopping just behind the hairline. The posterior extent of the incision was more than 15 cm behind the keyhole to allow for an adequate craniectomy flap. The superficial temporal artery was preserved and temporalis was dissected up to the zygoma to allow for maximal temporal decompression. The anteroposterior dimension was at least 15 cm and extended down to the floor of the temporal fossa. An adequate number of burr holes were made and underlying dura was separated using a Penfield dissector. Cutter was used to make the craniotomy and temporal extent expanded using a rongeur. The bone flap was then returned floating in situ over the swollen brain but still attached to the ipsilateral temporalis muscle. The anterior and posterior vertical cuts in the temporalis muscle were then sutured back. These suture lines were carried superiorly only as far as the upper border of the main belly of the temporalis, at the superior temporal line. This was to ensure that the bone flap would remain mobile to accommodate the extracranial cerebral expansion. A wound drain was placed next and two-layer water-tight scalp closure performed as usual.[8]

RESULT

Table 1: Summary of demographic data

Variables	Temporalis hinge	Decompressive craniectomy
No. of patients	15	14
Male: Female	13:2	10:4
Mean age (years)	42.86 ± 12.75	46.07±14.85
Surgical indication		
Intracerebral hematoma	3	8
Subdural hematoma	5	4
Contusion	7	2
Side of surgery		
Right	6	9
Left	9	5

In this study patient randomly divided for Temporalis hinge craniotomy and Decompressive craniectomy. As indicated in table no. - 1 majority of patients (46.67%) undergone temporalis hinge craniotomy had contusion while ICH (57.14%) was major indication of Decompressive craniectomy.

Table 2: - GCS at time of admission

Group	GCS <9	GCS 9-12	GCS 13-15
Temporalis hinge	2	12	1
Decompressive craniectomy	3	11	0

As indicated in table no. 2 majority patient undergone surgical procedure had pre-operative GCS between 9 to 12. Both group has comparable GCS at time of admission (p=0.47)

Table 3: - Midline shift in preoperative scan

Group	Mean midline shift (mm)
Temporalis hinge	10.06 ± 1.67
Decompressive craniectomy	10.21 ± 3.09

As per table no.-3. In both group there was comparable midline shift in brain imaging.(p=0.87)

Table 4: - Operative time in both method

Group	Mean operative time (min)
Temporalis hinge	121.73
Decompressive craniectomy	132

As per table no. 4 operative time was significantly higher in Decompressive craniectomy group compared to Temporalis hinge group (p=0.012). Higher time required in decompressive craniectomy due to requirement of separation of pericranial and temporalis muscle layer from bone

Table 5: - Post-op. ICU stay

Group	Mean ICU stay (post op) (days)
Temporalis hinge	6.73 ± 1.16
Decompressive craniectomy	7 ± 1.36

As shown in table no: - 5 average ICU stay was around 7 days in both group. No significant difference in post operative ICU stay in both group (p=0.57)

Table 6: - Additional intervention required

Additional intervention	Temporalis hinge	Decompressive craniectomy
Ventriculo peritoneal shunt	0	2
Bone flap removal	1	NA

2 patient from Decompressive craniectomy group required ventriculo-peritoneal shunt for development of post operative hydrocephalus while 1 patient from Temporalis hinge group required removal of bone flap due to refractory raised ICP (Table no.6).

Table 7: - GCS at time of discharge

Group	GCS at time of discharge
Temporalis hinge	13.7
Decompressive craniectomy	13.15

As per table no.7 both group patient had comparable GCS at time of discharge. (p=0.26)

Table 8: - GOS at 3 month[9]

GOS	Temporalis hinge	Decompressive craniectomy
1	1	1
2	0	1
3	3	2
4	8	8
5	3	2

As per table no. 8 most of patients had GOS score of 4 at end of 3 months in both group while GOS 1 at end of 3 months in 1 patient in each group.

Table 9: - Mortality in both method

	Temporalis hinge	Decompressive craniectomy
Alive	14 (93.33%)	13 (92.87%)
Dead	1 (6.67%)	1 (7.14%)

As shown in table 9 in both group 1 patient from each could not survive after surgical procedure due to post-operative complication unrelated to surgery. Both patient had sudden deterioration of GCS and cardiorespiratory arrest which was not related to neurological cause.

DISCUSSION

The use of HC for cerebral decompression was introduced in 2007 by three investigative groups.[10][11]

These studies were primarily technical reports describing the nuances of the procedure (such as enlarging the subgaleal space, plating of the autologous flap, and performing a galeatomy). Although adequate postoperative ICP control was reportedly obtained, no objective data were provided to demonstrate this assertion. Overall, the survival of the patients treated appeared satisfactory.

Decompressive craniectomy is associated with a varied spectrum of complications because of absence of a bone flap.[2] The main complications that may occur following a DC include vulnerability of the underlying brain to direct injuries due to the loss of bone, the need for a second surgery to perform a cranioplasty, and a higher incidence of infection, hydrocephalus, syndrome of the trephined, intracerebral hematoma, delayed seizures, cerebrospinal fluid leak (3–5%), extra-

axial collection (both epidural [20%], and subdural [5%]).[2,3,4] Studies have shown that many of these morbidities get reversed following replacement of the bone flap.[5,6] With regard to the timing of cranioplasty, studies have shown that patients with an early cranioplasty had a better functional outcome.[12,13] Hence, every effort should be made to reduce these specific complications associated with the absence of a large area of the bone flap. We believe that temporalis hinge craniotomy serves purpose to provide adequate space to brain to expand (as has been achieved in DC) and was also effective in reducing the above mentioned complications.

In our study total 29 patients included. Study results demonstrate both group are comparable in demographic data (table 1), post operative outcome and mortality in both group (table 8 & 9).

There is no significant difference in post operative ICU stay (p=0.57) (table 5) in our study. Average ICU stay was 7 days because in our institute limited availability of ICU bed and high patients load patients required to shift from ICU to general ward once they are stable. This is comparable to study done by Harifi MM et al.(14) where no significant difference in both group for ICU stay.

One patient operated for Temporalis hinge craniotomy required removal of bone flap due to refractory raised intracranial pressure which is diagnosed by persistant midline shift, cisternal compression and anisocoria while 2 patient operated for Decompressive craniectomy required ventriculoperitoneal shunt for development of post op hydrocephalus (table 6). The mechanism of hydrocephalus is attributed to obstruction of the arachnoid granulations by surgical debris. Early cranioplasty would restore normal ICP dynamics and probably normalize the hydrocephalus.[15]

GOS at end of 3 month score was 4 in majority of patients in both group. Both group had comparable GOS score at end of 3 month (p=0.68) (table 8). Similar result found in study done by Harifi MM et al.(14)

Mortality was 1-1 from each group unrelated to surgical reason (table 9). Patient operated for decompressive craniectomy expired due to septicaemia while patient operated for temporalis hinge craniotomy expired due to myocardial infraction in post-operative period.

CONCLUSION

Temporalis hinge craniotomy is an alternative procedure for decompressive craniecotmy with comparable outcome. Patient operated for decompressive craniectomy requires second surgery for restoration of bone flap which can be avoided with temporalis hinge craniotomy with similar post operative outcomes. With help of temporalis hinge craniotomy, complications of decompressive craniectomy like syndrome of trephined[16], hygroma,[17] cosmetic deformity, secondary surgery, resorption of bone flap[18] can be reduced without any additional procedure to the patients. With help of temporalis hinge craniotomy patient's psychological and monetary burden for second surgery can be avaoided. Patient burden for second surgery for cranioplasty can be reduced in high volume center by this method. Only one disadvantage of tHC is that bone flap removal and conversion to decompressive craniectomy required if refractory raised ICP, only one patient in this study required conversion to decompressive craniectomy.

IMAGES

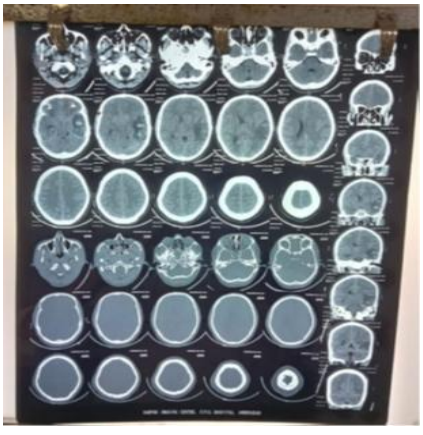

Image 1: Pre operative CT scan showing left temporo parietal contusion

Image 2: Intra op image showing sutured temporalis hinge bone flap.

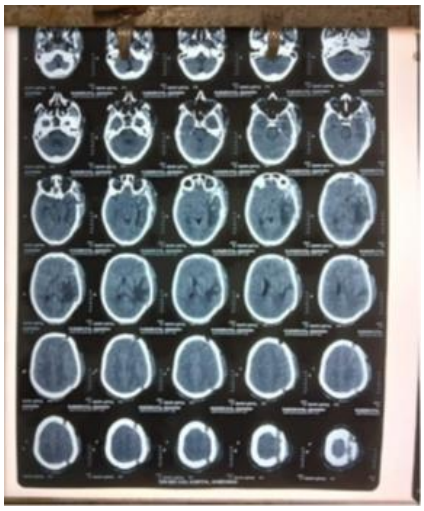

Image 3: Post operative CT scan showing elevated temporalis hinge bone flap to accommodate edematous brain.

LIMITATION OF STUDY

Limitations of our study is limited size, heterogenous population, lack of long term follow up. In addition in our study ICP data is not available. As our institute is tertiary care hospital many patient came with brain imaging done outside so volumetric analysis cannot be done.

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