Original Article

Temporalis-Based Hinge Craniotomy: Technical Modification of Decompressive Craniectomy in Head Injury

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ABSTRACT

Background: Decompressive craniectomy (DC) was proven to be an effective therapy for intractable post traumatic elevation of intracranial pressure. Hinge craniotomy is a modification for DC, decreasing the potential associated morbidities and the need for a delayed Crainoplasty. Objective: The aim of the current study is to assess a modification for this procedure, using the patient’s own temporalis muscle as a hinge for the bone flap. Patients and Methods: This is a prospective study on 20 post traumatic cases indicated for decompressive craniectomy. In situ temporalis hinged decompressive craniotomy was done for all cases. Cases were followed up regarding their GCS, midline shift in CT scans, as well as ICP monitor values. Results: 85% of cases showed midline shift improvement in postoperative CT scans, 75% of cases had postoperative GCS15. ICP monitoring was used in only 5 cases, all of which showed normalization of ICP within 48 hours. We had 3 mortalities (15%) in our study. Conclusion: Temporalis based hinging is a simple, less costly, and effective alternative for metallic plate application for in situ hinged craniotomy in cases of refractory post traumatic elevation of ICP related to head injury.

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INTRODUCTION

Elevated intracranial pressure that doesn’t respond to maximal medical management occurs in 10 to 15% of cases with severe head injury, leading to high morbidity and mortality rates. Early in the 19th century Kocher and Cushing first reported cranial decompression as an option for treatment of medically refractory intracranial hypertension. In the following period, the role of this procedure remained controversial. Currently many studies reported successful reduction in ICP with good influence regarding the clinical outcome following the use of this technique. Decompressive craniectomy is now an accepted and effective therapy for intractable elevations of intracranial pressure.

Different surgical techniques were described for decompressive craniectomy. In our study we will focus on dealing with the free bone flap. Several options were available for placement of the removed bone flap whether in vivo (subcutaneously in the abdomen or anterior thigh) or in vitro (freezer storage), or discarding the flap and latter Crainoplasty.

Several morbidities were associated with decompressive craniectomy; there is a potential risk to the exposed brain under the bone defect, postoperative seizures were reported in 35%, and hydrocephalus in 40%. Crainoplasty is a second setting surgery with its complications and risks.

The ideal procedure for decompression has to combine the effectiveness of decompressive craniectomy and limit the associated morbidities. In 2007, three investigative groups introduced the technique of in situ hinge decompressive craniectomy (HDC), also known as hinge craniotomy (HC). They described re-securing the bone flap in a noncircumferential pattern to the skull, allowing for cerebral expansion through the defect raising the bone flap. By allowing the flap to remain in place, there will be limited cosmetic defect once the cerebral edema resolves and the latter need for Crainoplasty is limited. This procedure was proven to be efficient in lowering the ICP, with close results compared to the classic decompressive craniectomy.

In this study we will investigate a similar technique to the in situ hinge craniectomy, which is using the patient’s ipsilateral temporalis muscle as a hinge for the bone flap, securing the bone in place from one side (caudally) and leaving it swinging from the opposite side without the use of fixation hardware, like plates and screws. This procedure is thought to be better for resource limited neurosurgical practice, saving both money and time of operation. This procedure is called temporalis-based hinge craniotomy (TBHC).
PATIENTS AND METHODS

This prospective study was conducted on 20 patients who were indicated for decompressive craniectomy after head injury.

A short history was taken for all cases. General trauma survey was done for all cases for diagnosis and management of any associated injury. Full neurological examination was also done. GCS was utilized for conscious level assessment. Routine laboratory investigations, non-enhanced CT brain was done to all of them (Fig. 1 & 2). Patients were managed in the Neurosurgical ICU before and after surgery.

Operative technique:

Patients were positioned supine with head rotations towards the opposite side under general anesthesia. A large fronto-temporo-parietal (FTP) skin flap was reflected, followed by elevating a large osteoplastic FTP bone flap hinged by the attached temporalis muscle. Good beveling of the flap was done in all cases to avoid sinking of the flap after reduction of ICP. Augmentative duroplasty using free pericranial flap about 15 × 10 cm and evacuation of the subdural hematoma (if present) was done for all cases. During closure the bone flap is left free floating from cranial side and fixed to the Temporalis muscle on the basal side. Parenchymal ICP monitor was inserted before the procedure through a contralateral incision (when available, used in 5 cases), readings were recorded before the surgery, immediately after, and then at 6 hours intervals for 5 days.

During the follow up period which ranges from 3 weeks to 3 months patients were assessed clinically by GCS, as well as serial follow up CT scans to asses midline shift (Fig. 3).

RESULTS

The data collected from 20 cases, with traumatic brain injury, operated upon by temporalis hinged decompressive craniotomy was analyzed. The age of our cases ranged from 19 to 62 years, with a mean age of 42.9 ± 2.7 years. We had 14 males (70%) and 6 females (30%). The Preoperative diagnosis was acute subdural hemorrhage (ASDH) in 8 cases (40%), Unilateral brain edema in 3 cases (15%), ASDH + sub arachnoid hemorrhage in 2 cases (10%), ASDH + extradural hemorrhage in 2 cases (10%), ASDH + infarction in 1 case (5%) and ASDH + Intraventricular hemorrhage 4 cases (20%)

Preoperative midline shift in CT scan was found in all cases as follows: 7 cases with 10 mm shift (35%), 6 cases with 11 mm shift (30%), 3 cases with 12 mm shift (15%), 3 cases with 15 mm shift (15%), and only one cases with >15 mm shift (5%). The severity of head injury, according to Stein classification, was severe head injury in 11 cases (55%), moderate head injury in 7 cases (35%) and critical head injury in 2 cases (10%)

Postoperatively, 13 cases (65%) showed initial improvement in their post-operative GCS, 4 cases were stationary (2 of these 4 cases showed delayed recovery), and the remaining 3 cases deteriorated. The mean increase in GCS was 4 degrees. The midline shift resolved in 17 cases (85%), while it didn’t improve in the remaining 15% of cases.

The ICP was measured in 5 cases, the initial readings were 28, 25, 25, 24, 21 cmHg. The immediate post-operative reading showed average drop by 3 cmHg. All five cases showed normal ICP values within the first 48 hours post-operatively, and the monitors were removed.

As regards the overall outcome, we had 3 mortalities in our series (15%), 2 cases (10%) had persistent vegetative state, while the remaining 15 cases (75%) had regained their normal GCS (4 cases has motor weakness)

Wound complications: Two cases showed local wound infection with mild sloughing of the wound edges, during the period of elevated ICP, local wound care and with resolution of elevated ICP solved these complications. None of these patients needed surgical grafting or coverage. Also after resolution of the ICP elevation all the bone flaps returned to their normal position, with cosmetically accepted appearance without the need for Crainoplasty in any of our cases.

Fig. 1: 27 Years old male. Pedestrian car accident. (a) Preoperative GCS was 10/15. TBHC was done. (b) The images show improvement in midline shift. The patient was discharged GCS 15/15 but with left sided weakness.
DISCUSSION

Several previous studies have proven the efficacy of decompressive craniectomy in reduction of medically refractory cases of post-traumatic elevated ICP. Since the introduction of the new technique of in situ hinged decompressive craniectomy in 2007, several studies were focused on the comparison between the classical DC and the new technique. The hinged craniotomy was proven to be at least as good as the old classic decompressive craniectomy in providing postoperative ICP control and clinical outcome.  

The introduction of the in situ hinged decompressive craniectomy has overcome some of the difficulties met with decompressive craniectomy. The brain is kept protected with the bone flap during therapy and hence removing the risks of leaving the brain unprotected. The procedure also spares the patient from complications of dealing with the bone flap, whether storing it in subcutaneous tissue of abdomen or in Vitro storage, minimizing the risk of infection, bone flap necrosis, and second setting surgeries.  

Hinging the bone flap is done with the aid of metallic miniplates and screws. Fixation is done from the basal side of the craniotomy flap, leaving the opposite side free moving in and out. The swinging movements of the bone flap allows expansion of the cranial cavity during periods of elevated ICP, providing more space for cerebral expansion and hence helping in reduction of ICP. This is an apparently enough volume to modulate the Monro-Kellie doctrine.  

The technique of hinging the bone flap on the ipsilateral Temporalis muscle isn’t a new one; it’s just a modification of the in situ hinge decompressive craniectomy. It’s inexpensive, economically feasible in any resource limited practice environment. This technique will allow the bone flap to be raised upwards expanding the cranial cavity as the plate hinged technique allows. It is time saving, and doesn’t depend on the availability of any hardware. It also spares the patient from the potential of a second surgery for fixing the loose side left during the first surgery.  

In our study we had an overall recovery rate (GCS 14&15) in 15 cases (75%); we had persistent vegetative state in 2 cases, and mortality in 3 cases (15%).
Concerning the midline shift in CT-scans, it resolved in 85% of cases. We used ICP in only 5 cases (due to limited availability), all of which showed normalization of ICP values within 48 hours. These results were near to other studies concerning with in situ hinged craniectomy. Adeleye et al in 2011 published results about this new technique, his results were close to our results, proving the efficacy of the technique ².

Wound complications, like skin breakage, lacerations and CSF leakage might be considered as limitations for this technique, in our study we met only 2 cases of local skin inflammation over the suture line. They were self-limited and didn’t need any surgical intervention. These wound troubles are not related to the temporalis hinged technique but they are also met in any in situ craniectomy due to the presence of the bone flap.

CONCLUSION

Temporalis-hinged decompressive craniotomy was proven to be a simple, inexpensive, time saving technique. It’s suitable for use in economically limited centers; it also saves the patient from another surgery for plate fixation. This technique was proven to be as effective as the plate method in terms of improvement in GCS, midline shift, as well ICP monitor values.

REFERENCES