Comparison of Burr Holes and Decompressive Craniotomy in the Surgical Treatment of Traumatic Acute Subdural Hematoma

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Abstract

Introduction: Acute subdural haematoma (ASDH) represents a challenge for neurosurgeons due to its high mortality and morbidity rates. The lethal nature of ASDH is largely explained by its frequent association with primary brain damage, consisting of contusion and brain swelling. The most severe lesion associated with ASDH is acute swelling of the hemispheres [1].

Purpose: The aim of the study is to compare decompressive craniotomy (DC) versus burr holes craniotomy and whether it has any therapeutic advantage as a treatment modality for traumatic acute subdural hematoma.

Patients and Methods: In this study, we reviewed 20 patients with traumatic acute subdural haematoma, 10 of whom were treated with haematoma evacuation via burr holes craniotomy and 10 of whom were treated with DC according to the randomization order.

Patients were analyzed for prehospital trauma conditions, followed postoperatively for 2 months to assess postoperative complications and outcome on Glasgow outcome scale (GOS).

Results: The mortality rate was higher in the craniotomy group (80% vs. 50%) than in the DC. Age and signs of herniation were significantly associated with an unfavourable outcome, regardless of the type of surgery. Apart from initial Glasgow coma scale (GCS) and the pupillary status, time elapsed between trauma and treatment is the most important and can be intervened.

Conclusion: Regarding the type of surgery. We concluded that although DC is a more lengthy procedure, with higher incidence of convulsions, subgaleal effusion than burr hole craniotomy, but it has less incidence of residual ASDH, better control on the source of bleeding, Consequently less incidence of rebleeding and need for reoperation, and has better results in lowering of the intracranial pressure (ICP), associated with lower mortality and better functional recovery.

Key Words: Acute subdural hematoma (ASDH) — Decompressive craniotomy (DC) — Glasgow coma scale (GCS) — Glasgow outcome scale (GOS) — Intracranial hypertension (ICH) — Intracranial pressure (ICP) — Traumatic Brain Injury (TBI).

Introduction

ACUTE subdural hematoma (ASDH) is one of the most common and most morbid traumatic neurosurgical emergencies with reported mortality rates ranging from 36% to 90%. Mortality rates for ASDH are significantly greater in elderly patients when compared with younger patients. Some believe the relationship of age to outcome after ASDH is a continuous function, where morbidity and mortality increase with increasing age [2].

The main factors affecting the prognosis of patients with ASDH include age, injury severity score, intracranial pressure (ICP), presence of subarachnoid hemorrhage, Glasgow coma scale (GCS), hypotension, hypoxia, and time from injury to operation [3].

Among these factors, only the time from injury to operation (that is, the operative timing) can be well intervened, Thus it has been more emphasized. However, it has been the most controversial factor so far. The mortality and functional survival rate are related to operative timing of patients with ASDH [4].

Traumatic ASDH continues to have high morbidity and mortality despite the advent of rapid transportation, CT scanning, intracranial pressure monitoring and intensive care management. Some authors suggested that outcome for these patients may be influenced mainly by the underlying brain injury than by the ASDH itself [5].
Despite the increasing acceptance of craniotomy in patients with traumatic brain injury, the value of early decompressive craniotomy in patients with acute subdural haematoma is still under debate.

There are two phases of brain injury. The primary phase occurs at the moment of impact. The secondary phase occurs in the minutes, hours, or days after the initial injury. The injured tissue is highly vulnerable to insults readily tolerated by uninjured tissue. Secondary injury is the single most important treatable cause of neurological deficit and death after traumatic brain injury (TBI).

Intracranial hypertension (ICH) is a major cause of secondary brain injury and often follows trauma or stroke. Because ICP varies with changes in the volume of the intracranial contents, the traditional approach for treating intracranial hypertension has been to reduce the volume of one or more of the compartments, which include brain parenchyma, cerebrospinal fluid (CSF), and blood volume, either surgically or nonsurgically.

An alternate approach is to increase cranial volume by removing the skull and opening the dura. The underlying brain can then swell under the relatively distensible skin. The rationale for decompressive craniectomy is to prevent secondary injury caused by intracranial hypertension.

Intracranial hypertension is the most frequent cause of death and disability following severe TBI. The Brain Trauma Foundation (BTF) guidelines, have been established to guide the management of and indications for surgical decompression in TBI patients. Within these guidelines, decompressive craniotomy (DC) or craniectomy is considered in two different situations; either it is performed prophylactically at the time of evacuation of a space occupying intracerebral haemorrhage or it is performed in patients with diffuse brain swelling and ICH after maximal medical treatment. Despite improvement in medical treatment modalities and neuromonitoring, including aggressive medical intervention such as barbiturate coma showed no improvement in outcomes for these patients. An intracranial pressure (ICP) measurement >20mm Hg measured by ventriculostomy or by a parenchymal pressure monitoring device was defined as ICH. In patients without preoperative ICP monitoring, a progression of the brain swelling diagnosed by follow-up CT scan, or neurological worsening was regarded as a correlate of ICH.

Radiological evidence of progression of brain swelling consisted of compression or obliteration of the ventricles or basal cisterns. Neurological worsening was defined as a decrease in Glasgow Coma Scale (GCS) of at least two points or worsening in pupillary response to light.

**Aim of the work:**

The aim of the study is to compare decompressive craniotomy (DC) versus burr holes craniotomy and whether it has any therapeutic advantage as a treatment modality for traumatic acute subdural hematoma.

**Patients and Methods**

The study was done prospectively in the Neurosurgery Department, Trauma Casualty Unit, Cairo University on patient admitted in the period from April 2013 to November 2013, suffering from traumatic acute subdural hematoma.

Twenty patients with traumatic acute ASDH requiring surgical intervention were randomized in two groups by computer randomization (simple random sample) (SRS).

The first group was treated by decompressive craniotomy and the second was treated by burr holes craniotomy. Both surgical methods are internationally accepted with debate between the neurosurgeons about which has better results in patient with traumatic ASDH.

**Inclusion criteria will be:**

- The age range from 12 to 80.
- No sex predilection.
- Hematoma thickness >10mm.
- Midline shift >5mm.
- GCS less than 9, or more than 9 and decrease by 2 during the observation period.

To reduce the interference of other relative factors.

**Exclusion criteria will be:**

- Clinical brain death on admission.
- Shock (the systolic blood pressure less than 90mm Hg) for longer than 30 minutes.
- Hypoxia [pulse oxygen saturation (SPO2) less than 90%] for longer than 30 minutes.
- Serious extracranial injuries, and ASDH of the posterior fossa were excluded.
### Prehospital Report:

<table>
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<tr>
<th>Mechanism</th>
<th>How did injury occur?</th>
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<tbody>
<tr>
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<td>Presence of drugs or alcohol</td>
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<td>Deaths at scene</td>
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<td>Confounding issues</td>
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<tr>
<th>Injury</th>
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<td>Glasgow Coma Scale</td>
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<th>Vital data</th>
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<td>Oxygen saturation</td>
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<td>Temperature (if applicable)</td>
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<th>Treatment</th>
<th>Airway (airway management)</th>
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<td>Breathing (oxygen administration, needle or tube thoracostomy)</td>
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<td>Circulation (intravenous access established and fluids administered)</td>
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<td>Disability-neurologically (spine precautions)</td>
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<td>Extra information (medications administered, procedures performed)</td>
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The patients were all treated with similar prehospital emergency treatment and routine brain CT scan was performed. Mannitol (0.5mg/kg), Lasix (0.25mg/kg), were given preoperatively regarding there is no hypotension.

1- **History:**
   - A- Age, gender.
   - B- Mechanism of injury.
   - C- Time of trauma.
   - D- Time of loss of consciousness, presence of lucid interval.
   - E- Pre-hospital post-traumatic fits.

2- **Clinical findings:**
   - A- Conscious level (preoperative GCS).
   - B- Presenting symptom.
   - C- Scalp injuries, bleeding orifices.
   - D- Pupils.
   - E- Associated injuries (spine, cardiothoracic, orthopedic, ... etc).

3- **Radiological findings:**
   - A- Patients will be diagnosed as ASDH by computed tomographic (CT) scan post admission, midline shift, widest thickness of the hematoma were measured.
   - B- Imaging for associated injuries.

4- **Surgical variables:**
   - A- Type of surgery.
   - B- Time elapsed from accident to surgery.

5- **Surgical procedures:**
   All the patients underwent decompressive craniotomy or burr hole craniotomy according to the randomization order. Patient head were placed on donut with head tilted to other side of hematoma.

   - A- The ASDH was evacuated and decompression by elevation of cranio-bone flap was performed. The surgical procedure was performed as follows: After a large reversed question mark incision was made, the skin is reflected as a single layer then a generous craniotomy flap with the temporalis muscle overlying it was reflected with the following margins: anteriorly, frontal to the floor of the anterior cranial fossa; superiorly, within 2 cm of the superior sagittal sinus, posteriorly, within 1 cm of the asterion; and inferiorly, to the floor of the middle fossa. The dura was opened in a semicircular fashion to evacuate the subdural hematoma, and the additional decompressive dural release incisions were performed with duroplasty from pericranium grafts done.

   - B- In case of burr holes evacuation, 2 burr holes were located at the periphery of the thickest part of the hematoma after localization on the CT. The incisions of the scalp are made so that they can be incorporated into the craniotomy flap if required. After the underlying periosteum is separated a generous burr hole >2.5cm in diameter is performed, and the dura is subjected to diathermy and opened in a cruciate fashion and irrigation drainage with warm saline performed till wash was clear then a drain was tunneled under the skin and secured.

6- **The following will be assessed:**
   - Residual ASDH.
   - Need for Re-operation.
   - Hydrocephalus.
   - Convulsions.
   - Acute brain swelling.
   - Subdural, subgaleal effusion.
   - Wound infection.

7- **Postoperative treatment:**
   Based on the conditions of intracranial pressure after operation, mannitol (0.5mg/kg), Lasix (0.25mg/kg), were given. Antibiotics, haemostatics, and neurotrophic drugs were routinely used for all the patients.
8- **Follow-up and outcome:**

A- Postoperatively patients will be admitted to the ICU and will have at least one CT scan performed within 72 hours after operation. All survivors will be followed-up after operation with CT scan and neurological examination including GCS at one week interval over a period of 2 months.

B- They will be assessed by the Glasgow coma Scale (GCS) and the outcome will be graded using the Glasgow Outcome Score (GOS), which defines:
- Grade I as death,
- Grade II as persistent vegetative state,
- Grade III as severe disability (being conscious but disabled),
- Grade IV as moderate disability (being disabled but independent), and
- Grade V as good recovery.

C- Unfavourable outcome was defined as GOS 1-3 and favourable outcome as GOS 4 and 5 [4].

**Results**

The data collected from 20 cases of traumatic acute subdural hematoma in this study were evaluated. The study included 20 patients, 14 males and 6 females. Their age ranges between 18 and 63 years with a mean age of 42.2 years ±S.D 13.96 (survivor was 28.6 and for non-survivor was 49.5). There was a trend of increasing mortality associated with age.

Male to female ratio was 3:1.

Mechanism of injury was fall from height in 45%, road traffic accidents in 45% and blunt head trauma in 10% of cases.

The overall mortality (Grade I) was 65%, the functional recovery rate (Grades IV and V) was 20% and 15% respectively, and (Grades II and III), left severely disabled or vegetative was 5% and 5%.

The factors affecting the prognosis of the patients with ASDH were assessed as follows.

- **Age:** Significant higher mortality is found in the patients over 50 years old.

- **Sex:** In spite of a 3:1 male predominance, there was no significant difference in the prognosis between males and females.

There was no significant difference in mortality and functional recovery rate regardless mechanism of injury.

- **Time from injury to operation:** To simplify the influence of operative timings, it was subdivided within <2, 2-4, 4-6 and >6 hours after injury. Time was (<2h) in 5% (1 case), (2-4h) in (5 cases) 25%, (4-6h) in (8cases) 40% and (>6h) in (6 cases) 30% of cases. With the interval timing of operation prolongation, the mortality increases and the functional recovery rate decreases. In the present study, mortality in (2-4 H group) was (2 out of 5 cases) 40% of the group cases, in (4-6H) group 75% (6 out of 8 cases) of the group cases, in (>6H group) was (5 out of 6 cases) 83% of the group cases.

In addition, time from injury to operation in non-survivors (non–survivors 5 hours & 27.7 minutes) was significantly longer than that in survivors (survivors: 3 hours & 51. 4 minutes).

The mean time from injury to operative intervention was 4 hours and 54 minutes.

The leading initial symptoms was deterioration of level of consciousness. The average GCS was 5.5 (survivors: 7.8; non-survivors: 4.2).

**Pupillary reflex:** Bilateral absence of pupillary reflexes (2 cases) was associated with an 100% mortality and 75% mortality in unilateral absence of pupillary reflex (3 out of 4 cases).

The associated injuries was present in 50% (10 out of 20 cases) mainly orthopedic fractures of long bones (4 cases) 20%, fracture ribs (2 cases) 10%, hemothorax with fracture ribs (2 cases) 10% and mild abdominal collection (1 case) 5%. The four cases with hemothorax and fracture ribs died indicating more severe trauma to the patients.
Radiological findings showed the ASDH was left sided in 50% of cases, right sided in 45% of cases and bilateral in 5% cases.

Average hematoma thickness was 1.54cm and the average midline shift was 0.91 cm.

Associated neurological injuries was brain contusions in (5 cases) 25% of cases and extradural hematomas in (2 cases) 10% of cases. Compression of the basal cisterns indicating herniation was present in 20% (4 cases) and was associated with 100% mortality.

**Complications:**

Mortality was 65%, (80% in the Burr holes group (8 cases), 50% on the DC group (5 cases). Residual ASDH was 60% (6 cases) in the burr holes group of which half of them required re-operation by bone flap to evacuate the sizable residual ASDH and decrease the ICP. In the DC group residual ASDH was 20% (2 cases) and only one case required reoperation to remove bone flap and perform frontal lobectomy to decrease ICP. One case in the DC developed contralateral contusion postoperative but its size was non-surgical.

One case(5%) in the Burr holes group and another case (5%) in the DC group developed hydrocephalus (HCP) that require CSF diversion.

The incidence of convulsions postoperative was 30% (3 cases) in the DC group and 10% (1 case) in the burr holes group. The incidence of subgaleal effusion postoperative was 40% (4 cases) in the DC group and 20% (2 cases) in the burr holes group. The incidence of wound infection was 20% (2 cases) in the DC group, and 10% (1 case) in the burr holes group and the cases responded to antibiotics and repeated dressing without the need for debridement.

Intra operative acute brain swelling (ABS) was 60% (6 cases) in the burr holes group and 50% (5 cases) in the decompressive craniotomy group.

**Glasgow outcome scale:** The overall mortality (Grade I) was 65%, (Grades II, severely disabled) was 5% and (grade III vegetative) was 5%. (Grades IV moderate disability) was % and (grade V functional recovery) was 15%.
**Discussion**

Regarding the age, in our study there was a trend of increasing mortality with age, mean age of survivors was 28.6 while in non-survivors was 49.5. Moreover the incidence of mortality in patient >40 years was 83%, <40 years was 25%. Increasing age remains a strong predictor of poor outcome after acute ASDH.

Similarly, other studies reported advanced age to be a significant risk factor for poor outcome for patients sustaining ASDH, with a mortality rate of 70% in patients older than 40 years. They provided evidence that morbidity and mortality after acute ASDH are a continuous function of age, with morbidity and mortality increasing as age increases [9].

Regarding operative timing, it is an accepted fact in medical literature that the earlier the removal of hematomas or factors that increase ICP, the better the results. In the present study, mortality in (2-4 H group) was 40% of the group cases, in (4-6H) group 62.5% of the group cases, in (>6H group) was 83% of the group cases. This fact was confirmed by Seelig et al., where a considerable reduction of death was shown when patients with ASDH were operated before 4 hours after admission to hospital [4].

There was no significant difference in mortality and functional recovery rate regardless mechanism of injury. Regarding the Sex, in spite of a 3:1 male predominance, there was no significant difference in the prognosis between males and females. Similarly other studies had the same results [8].

The average GCS was 5.5 (survivors: 7.8; non-survivors: 4.2). 10% of patient had moderate head injuries, 90% had severe head injuries and 50% had associated injuries mainly orthopedic. This may be attributed to the more severe injuries the patient was subjected to in the patients of our study and the delay of arrival to hospital (70% admitted after 4 hours from trauma) due to traffic crowndness and lack of large neuro-trauma centers for referral.

**Fig. (4): Comparison of GOS between burr holes and DC group.**

Bilateral absence of pupillary reflex was associated with a 100% mortality and 75% mortality in unilateral absence of pupillary reflex. Previous study had same results, bilateral absence of pupillary reflexes was associated with a 88% mortality and unilateral was 75% mortality [4].

Higher residual ASDH was (60%) in the burr holes group of and (30%) required re-operation by bone flap to evacuate the sizable residual or re-bleeding ASDH and decrease the ICP. In the DC group residual ASDH was 20% and only one case (10%) required reoperation to remove bone flap and perform frontal lobectomy to decrease ICP.

The incidence of convulsions postoperative was 30% in the DC group and 10% in the craniotomy group.

The incidence of subgaleal effusion postoperative was 40% in the DC group and 20% in the craniotomy group.

The incidence of wound infection was 20% in the DC group, and 10% in the craniotomy group. Intraoperative acute brain swelling (ABS) was 60% in the craniotomy group and 50% in the decompressive craniectomy group.

In previous studies, burr hole versus DC group the incidence was (50-60% versus 40%) for residual ASDH, (20-30% versus 27%) for reoperation, (6-14% versus 7-20%) for convulsion, (10-40%) for hydrocephalus in DC group, 51-62% for ABS in the DC group, 5-20% for infection in DC group, 26-60% for subgaleal effusion in the DC group without comparative result in the burr hole group [10].

**Regarding the Glasgow outcome scale:**

Comparing the burr hole versus the DC group with the GOS which states Grade I as death (80% versus 50%), Grade II as persistent vegetative state (10% versus 0%), Grade III as severe disability (being conscious but disabled) (0% versus 10%), Grade IV as moderate disability (being disabled but independent) (10% versus 10%), and Grade V as good recovery (0% versus 30%).

Mortality was higher (80%) in the burr hole craniotomy group than (50%) in the DC group,
similarly previous studies showed 75% in the burr hole group versus 57% in the DC group [11].

In the literature, overall mortality from acute ASDH ranges from 55 to 79%. There may be a trend of decreasing mortality over the last 25 years. Yanaka K. [11] found no significant difference related to type of surgery. Tokutomi T. [12] had highest mortality (75%) occurred in patients with evacuation via irrigation.

The preconditions necessary for surgical evacuation of traumatic acute subdural hematomas have previously been well-defined. However, there is no consensus regarding which surgical technique should be employed for evacuation of traumatic acute subdural hematomas [13].

Over the past two decades, there was a revival of DC, with results that proved superior to the previous. But what has changed? There is no doubt that part of the improvement owes to technological advances in intensive care, transportation to hospital and ATLS recommendations that reduced mortality as a result of severe TBI.

This study had presented worse results in comparison with the above mentioned international series. Death rate was 65% (13 patients) and 25% of patients (5) had favorable outcome, one severely disabled and one remained in a vegetative state. Some factors may have contributed negatively to the results. As far as subjects are concerned, 7 patients (35%) were over 50 years of age; 16 (80%) had GCS <8, 50% of patients had polytrauma, 30% of which had pupillary abnormalities (anisocoria or mydriasis). Another factor was lack of ideal conditions for all patients. But of all these factors to bad prognosis was age and GCS upon admittance was important in agreement with other authors. It is worth emphasizing characteristics of the hospital where the study was carried (Kasr El-Ainy hospital), which is a reference center for trauma. Although it has a large number of ICU beds, there is always a larger number of patients in the polytrauma room.

Study limitations:

This study had some limitations. The most obvious is the lack of any non-operative-treatment group with which to compare the results. However, conservative treatment would often be hard to justify, considering the poor clinical condition of the patients already receiving maximal medical therapy and, on the other hand, knowing that DC often normalizes increased ICP in ASDH, which is the standard goal in modern neurointensive care.

Although lack of ICP monitoring devices (e.g. Miniature strain-gauge or fibreoptic transducers) to evaluate the relief of elevated ICP after surgery which was judged upon only radiologically.

Although extended period of follow-up more than 6 months at least is required for analysis of rehabilitation and return to work to be included in the final judgment during comparison of these surgical techniques.

Conclusions:

Improving the outcome of patients with acute subdural haematoma’s is a difficult task. Apart from initial GCS and the pupillary status, time elapsed between trauma and treatment is the most important and can be improved by rapid transportation after trauma. Even equally significant appropriate monitoring of the ICP. Other factors determining prognosis are age hematoma thickness, midline shift and associated injuries.

Regarding the type of surgery, we concluded that although DC is a more lengthy procedure, with higher incidence of convulsions, subgaleal effusion than burr hole craniotomy, but it has less incidence of residual ASDH, better control on the source of bleeding, consequently less incidence of rebleeding and need for reoperation, and has better results in lowering of the ICP (judged radiologically), associated with lower mortality and better functional recovery.

Burr hole craniotomy should be reserved to cases without severe brain edema or severe midline shift or for spontaneous non traumatic ASDH due to medical problems in which DC would be lengthy, and will not benefit from its advantage in lowering of the ICP.

Bilateral dilated fixed pupils was associated with 100% mortality, so some surgeons would not prefer to proceed for surgical interventions in such cases.

References


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