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Comparative study between the outcome of decompressive craniotomy versus craniectomy in the management of acute subdural hematoma

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Abstract

Background Acute Subdural hematoma is a very crucial entity in traumatic brain injury, presented with disabling morbid complications and a high mortality rate; therefore, it is a massive socio-economic burden, leading to either direct or secondary brain injury, as hypoxia.

Aim and objectives Comparative study between decompressive craniotomy (DC) and craniectomy in the management of acute subdural and their consequences. Assessing the most effective management protocol for ASDH with the least morbidity, short hospital' stay and avoidance of re-operation.

Method The study design is a prospective comparative randomized study, conducted on 30 patients with ASDH operated and managed starting December 2019 inclusive April 2021 at the Neurosurgery Department Cairo University Hospitals. They were divided equally into two groups: 15 had decompressive craniectomy and another 15 cases were operated upon with craniotomy. All patients were diagnosed with traumatic ASDH.

Results The mean GCS pre-operative in DC was (9.4) mean with a range from (6 to 13) and the post-operative mean was (11.13) with a range from (4 to 15) compared to the results in the craniotomy group; the pre-operative mean was (9.6) with a range from (6 to 10) and the post-operative GCS mean (11.53) ranging from (6 to 14) that had a *P* value of 0.69.

Conclusion There is no statistical significance in comparing decompressive craniectomy and craniotomy in dealing with ASDH, yet early time of surgical evacuation and duroplasty have shown to have good prognostic factors.

Keywords Acute subdural hematoma, Trauma, Craniotomy, Craniectomy

Introduction

Trauma is the most frequent cause of death in young adults worldwide, leading to traumatic brain injury (TBI). Approximately one-thirds of patients with (TBI) undergo emergency cranial surgery due to acute subdural hematoma (ASDH) [1].

The incidence is increasing in lower income countries, with the World Health Organization predicting that TBI and road traffic accidents will be the third greatest cause of disease and injury worldwide [2].

Acute Subdural hematoma is the most common and most morbid traumatic neurosurgical emergency, with reported mortality from 36 to 90%. The bleeding is

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commonly due to bridging veins laceration in the subdural space [3].

Mortality and morbidity, due to acute subdural hematoma, are related to the extent of the underlying brain injury. Subdural hematoma that is not associated with an underlying brain injury is sometimes termed a simple subdural hematoma, where the term complicated referred to those with significant injury to underlying brain parenchyma [4].

Insults resulting from traumatic brain injury (TBI) are commonly divided into primary and secondary according to etiologies; primary brain injury occurs at the time of impact and results in axonal shearing and associated areas of hemorrhage. Secondary brain injury occurs from insults to the brain after the initial injury, such as hypoxia and cerebral edema.

Subdural hematomas primarily exert a rise in the intracranial pressure (ICP) due to the size of the hematoma then leading to swelling of the underlying brain. Intracranial hematoma expansion leads to the elevation of the intracranial pressure with change in the volume of intracranial content, leading to the sequential hypoxia and development of secondary brain injury. The rationale in treating intracranial hypertension (ICH) is to reduce one or more of the intracranial contents which are brain parenchyma, blood vessels or CSF either surgically or non-surgically. An alternate approach is to create an extra space by opening the dura with or without removing of bone flap from the skull which is termed decompressive craniectomy or craniotomy [5].

These are the two types of operations for evacuation of ASDH, decompressive craniectomy DC (where the bone flap is removed and not replaced back) or craniotomy (where the bone flap is replaced) [6]. There is an ongoing debate about the optimal method of ASDH evacuation [7]. However, there are currently no clear indications that favor decompressive craniectomy (DC) or craniotomy (CR) in the management of ASDH [8].

Patients and methods

Study design

The study was conducted in the department of Neurosurgery, Cairo university hospitals, within a period of time between December 2019 to April 2021. The study included 30 patients with unilateral traumatic acute subdural hemorrhage. 15 patients were operated upon by decompressive craniectomy with keeping the bone in the anterior abdominal wall, while in the other 15 patients, the bone was relocated.

All patients (or first-degree relatives) were informed about the surgical procedure, risks and possible consequences. All signed an informed consent according to ethics committee principles.

Patients' age ranged between 20 and 50 years old diagnosed with traumatic ASDH, fitting surgical criteria as presence of midline shift greater than or equal to 5 mm, hematomas exceeding 1 cm in thickness and with Glasgow coma Scale range from 6 to 12. Non-traumatic cases or posterior fossa ASDH were excluded from the study, also cases with serious extracranial injuries, GCS less than 6 or medically un-fit patients for surgical intervention.

Pre-operative assessment was done to all cases and neurological assessment using GCS and the characters of the CT brain, such as obliterated cisterns or the presences of midline shift, the thickness of the hematoma and pupillary diameter and symmetry.

Postoperatively, all patients were admitted to the ICU, assessment to patient vital stability, neurological assessment was done using GCS and GOS, and radiological assessment (CT brain) to rule out any residual hematoma or the need for re-operation.

Management

Aiming for stabilization of the general condition of the patients regarding ensuring patency of the airway with cervical spine control, patients with GCS at admission ≤ 8 were intubated with mild hyperventilation (Pa co_2 25–28).

Anticonvulsant phenytoin was used with loading dose 15–18 mg/kg then with maintenance dose 5–8 mg/kg to prevalent early post-traumatic seizures.

Operative technique

All cases were sedated under general anesthesia, and patients were supine with little head tilt to the other side of hematoma. Question mark skin incision made 1 cm in front of the tragus with curve running backwards to parietal eminence to permit the exposure of the entire hemi-cranium.

Craniectomy or craniotomy was done along the entire supratentorial hemi-cranium and basal to the level of the root of the zygoma. After bony work, the silver lining was to do fast track duroplasty by using pericranium where we suture the pericranium flap first with edges of dura before opening it, aiming to minimize the time needed in dural closure and to avoid brain herniation due to high intracranial pressure. Then hematoma evacuation with proper hemostasis.

Craniectomy group had the bone placed in the anterior abdominal wall, while in the craniotomy group, the bone flap was re-positioned loosely without compressing the brain.

Postoperatively, all cases were admitted in the ICU for observation and re-assessment clinically and radiologically.

Results

We reviewed 30 cases of acute subdural hematoma where 15 of them were operated upon by decompressive craniectomy and 15 of them with craniotomy; according to sex, there were twenty-one males (70%) and nine females (30%), and the mean age was 40 years (16–61 y).

Mode of trauma: Road traffic accidents were the main reason 60%, Fall off height was the second reason in our series with 26.7%, leaving direct head trauma in the bottom list of reasons with 13.3%.

Laterality: In our series, both left and right sided ASD were equally divided unintentionally.

The mean of GCS pre-operative to all patients was 9.53 ranging from (6–13) compared to the GCS post-operative with a mean of 11.33 and ranging from (4–15).

Based on GCS

In analyzing the patients' improvement based on the GCS comparing pre-op to the immediate post-operative, we found the 23 cases (76.6%) improved from their initial score, 5 cases (16.7) did not show any change in their consciousness level, yet 2 cases (6.7%) had shown deterioration.

Comparing the two groups mean GCS pre-operative with the mean GCS post-operative we found that in DC group, the improvement between the pre-op score mean (9.4) with a range from (13–6) to the outcome of day one post-operative was (11.13) with a the range from (4–15). On the other group who had craniotomy, the pre-operative mean was (9.6) with a range from (10–6) to the post-operative GCS mean (11.53) ranging from (6–14). That had a P value of 0.69 to the post-operative score that shows no statistical significance.

One-month post-operative

The outcome of the 30 patients who had surgical intervention after one month follow up (66.6%) 20 out of 30 cases where consciousness did not need further medical care, 2 cases had a vegetative state out 30 cases (6.7%).

Regarding the neurological deficit 30% of the cases, 11 out of 30 had motor weakness regardless of the consciousness level after one-month follow-up. Yet 33% of the cases unfortunately experienced death.

Discussion

Acute subdural hemorrhage is a serious entity in head trauma, occurring in 5–25% of patients with severe head injuries, with high mortality and morbidity index. Resulting in long-term and lifelong physical, cognitive and behavioral consequences on the patient's own life and his community [9].

The male to female ratio was 2:1, twenty-one males (70%) to nine females (30%) that was contributed to higher percentage of males engaging in more risk-taking behavior and contact sports. In spite of male predominance, there was no observable difference in the prognosis between males and females [10].

The mean age in the study was 33 years (16–50 y). Age did not show to have any statistical significance to the outcome, mainly due to exclusion of extreme of age group in the study.

Road traffic accident was the main mode of trauma 60% of all cases, while fall all off height came in secondly with 26.7%, leaving direct head trauma in the bottom list of reasons with 13.3%. There was no difference in the outcome and prognosis between different mechanisms of injury. Elbakash et al. study, in 2016, considered the road traffic accidents as the leading cause of death among those aged from 15 to 44 years worldwide, especially in developing countries with overpopulation and the lack of proper strategy for prevention of RTAs, a reason contributing dramatically in increasing the incidence of mortality and morbidity due to RTAs [11]. The study had equal number of right sided ASDH and left sided, there was no statistical significance with P value 0.17, comparing both groups outcome.

Gap time between the trauma and the operation (decompression time) has a high prognostic factor to the outcome in management, among the many other variables such as (age, neurological examination on admission, etc.) that can affect mortality [12]; in our study, unfortunately, we could not gather this information to all cases. Yet it was obtained in 14 cases, with a range between 2 and 12 h. It was noticed that the 7 cases who were operated with gap-time of 4 h had a favorable outcome than others operated later. Seelig had reported that mortality and morbidity were considerably declined in patients operated in the first four hours after trauma, adding that mortality rate rose from 30 to 85% in cases operated after more than 4 h, making the time of decompression surgery a critical controllable variable (Seelig et al. 1981).

The main assessment tool in our series was GCS assessment for all cases; mean pre-operative GCS in the DC group was 9.4 ranging from (6–13) with improvement to post-op GCS mean 11.35 ranging from (4–15). In the craniotomy group, pre-operative mean was 9.6 with a range from (10–6) to the post-operative GCS mean 11.53 ranging from (6–14) that had a P value of 0.69 to the post-operative score that shows no statistical significance, aligning with Chen et al. claiming in his retrospective study of 102 patients with acute ASDH undergoing DC 58.8% (n = 60) versus craniotomy 41.2% (n = 42). Comparing the two groups of his study, no statistically significant difference ($P = 0.5$) was determined [13].

Assessment based on the Glasgow outcome score GOS (43.3%) of the cases 13 out of 30 had a considerable favorable outcome (GOS score 4–5) while 17 cases (56.6%) considered to have an unfavorable outcome (GOS score 1–2). Compared to Akbik, (44%) had a poor outcome at discharge, while (27%) had a good outcome at discharge, mentioning mortality rate to be 39% [14]. In comparing the Glasgow outcome between the two groups, we found two cases who developed vegetative state (GOS 4) in the craniotomy group; on the other hand, the number of deaths in DC group was higher 6 cases to 4 cases in craniotomy group.

In our series, we had only one case with wound infection counted as 3.3% of the total number. Managed by collecting culture & sensitivity test and started antibiotics that was modified according to culture and sensitivity. Later, surgical debridement of the wound edges was needed. Mentioning that post-craniotomy intracranial infection incidence is 6.8% contributing to a number of factors, e.g., skin colonization, long hospital stay or immunocompromised patients following trauma [15].

Decompressive craniotomy might bear the incidence of re-operation in case of sustained intracranial tension or residual SDH, compared to craniectomy group. In our series, no re-operation in both groups was required (Phan et al. [17]).

Mortality percentage in the study was 33.3%, divided to 6 DC and 4 craniotomy (20% and 13%), respectively, and that showed no statistical significance. Previous study reported the outcome of ASDH treated with DC versus craniotomy, showing that the DC group had higher mortality than the craniotomy group (53% vs. 32.3%), but that as well has no significant difference in the outcomes between these two groups [16]. While higher mortality rate was documented in craniectomy DC group, craniotomy patients have higher rates of morbidity [17].

Conclusions

Acute subdural hematoma is a serious issue facing the medical sector as well as the society, due to its serious consequence, high mortality rate and unfortunately the great morbidity, altering individual's function and performance post-operative.

The initial presentation of ASDH patient as GCS and pupillary status is the most prognostic indicator for the surgical outcome.

Time interval between the incident and decompression time is an important factor in the postoperative outcome of the patient, along with other important factors like hematoma thickness, degree of midline shift, and the presences of any associated injuries whether cranial or extracranial.

We concluded that in the management of ASDH, there was no statistical significance in the outcome between decompressive craniectomy and craniotomy, yet we recommend duroplasty to all the cases and reducing the time gap between the incident and the operation, for a favorable outcome, leaving the decision of whether to remove the bone or re-position it to the surgeon evaluation intra-operative.

Abbreviations

Abbr	Full term
ABP	Arterial blood pressure
ASDH	Acute subdural hematoma
ATLS	Advanced trauma life support
CBF	Cerebral blood flow
CPP	Cerebral perfusion pressure
CR	Craniotomy
CSDH	Chronic subdural hematoma
CT	Computerized tomography
DC	Decompressive craniectomy
GCS	Glasgow coma scale
GOS	Glasgow outcome scale
ICP	Intracranial pressure
MAP	Mean arterial pressure
MLS	Mid-line shift
MRI	Magnetic resonance imaging
MVA	Motor vehicle accidents
RTA	Road traffic accident
SD	Standard deviation

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Author contributions
HMA participated in data collection and analysis, discussing results and concluding, is the first author of the research, contributed to operating on the cases and patients' follow-up on the cases, Cairo university, Egypt. HMHS, Assistant Professor of Neurosurgery, Faculty of Medicine, Cairo University, contributed to reviewing literature and supervision on the research steps. WAA, Professor of Neurosurgery, Faculty of Medicine, Cairo University, contributed to supervising on procedures and technical notes. AEA, Professor of Neurosurgery, Faculty of Medicine, Cairo University, contributed to modulating the study and protocol design, analysis of data and editing final format. MTE, Professor of Neurosurgery, Faculty of Medicine, Cairo University, involved in the final research revision and format, mentorship and guidance through research steps.

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Available.

Declarations

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Ethical committee (REC) Al-Kasr Ainy school of medicine approved, Code: (MD-222-2019) 28-12-2019.

Consent for publication
All patients were consented and informed about the procedure and its complication, as well as, their participation in the research.

Competing interests
The authors declare that they have no competing interests.

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