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Comparison of Decompressive Craniotomy by Wide Opening of Dura with Multidural Fenestrations Technique among Acute Subdural Hematoma Patients: A Randomized Control Trial

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Abstract

Background: Surgical treatment is very crucial for the acute subdural hematoma patients. **Objective:** The purpose of the present study was to compare outcome of decompressive craniotomy with wide opening of dura and multidural fenestration technique. **Methodology:** This non-randomized clinical trial was carried out in the Neurosurgery Department of Dhaka Medical College Hospital, Dhaka, Bangladesh from January 2011 to August 2012 for a period of one year and eight months. Patients with acute subdural hematoma who fulfil the inclusion criteria for surgery and got admitted were selected as study population. Acute Subdural hematoma patient of any age, both sex with GCS 5 to 13, thickness of hematoma more than l0 mm, midline shift more than 5 mm, pupil reacting to light and patient presented within 72 hours of injury were included for this study. At admission, a detailed history of the illness was taken from the patient or attendant, thorough general and neurological examinations were carried out and were recorded. Specific treatment of head injury started and surgery done, cases were divided into two groups on the basis of surgical technique. Operative details, regular follow-up and post-operative CT scan findings were recorded. Finally GOS scoring done on the day of discharge of patient from the hospital. **Result:** A total number of 48 patients were recruited of this study of which 25 were in group A and the rest 23 patients were in group B. In group A, according to GOS Score, good recovery was 48%, moderate disability 16%, severe disability (8%), persistent vegetative state 4% and 24% patients died. In group B, good recovery was 47.83%, moderate disability 13.04%, severe disability 4.35%, persistent vegetative state 13.04% and 21.74% patients died. The mean duration of surgery was l26.32±24.86 minutes in group A and 90.95±l8.64 in group B and this difference was highly significant (P<0.00l). In addition, the mean duration of hospital stay was 23.44(±6.65) days in group A and 16.26(±4.63) days in group B and this difference between two group was statistically significant (P<0.001). **Conclusion:** In conclusion multiple dural fenestrations is an effective decompressive procedure for removal of acute subdural hematoma. *[Journal of National Institute of Neurosciences Bangladesh, 2018;4(2): 75-81]*

Keywords: Decompressive Craniotomy; Wide Opening of Dura; Multidural Fenestrations Technique; Acute Subdural Hematoma

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Introduction

Acute subdural hematoma found in 2.0% of admitted patients present with head injury[1]. Acute subdural hematoma is double of the incidence of extradural hematoma[2]. The mortality of acute subdural hematoma is about 50% to 90% and traditionally thought to be higher in aged patients (60%), 90 to 100% in patients on anticoagulation[3]. Mortality was found around 60% and can be lowered by rapid surgical intervention and aggressive medical management[4].

A mark decrease of mortality and morbidity rates observed in those patients with acute subdural hematoma undergoing craniotomy with evacuation of hematoma within 4 hours of injury; 30.0% of the patients died and 65.0% had functional recovery[5]. However when surgery was delayed for more than 4 hours post injury, the mortality rates increased to 85% and functional recovery decreased to 7.0%[6]. When the interval between the injury and operation exceed 2 hours the mortality rates increased from 47.0% to 80.0%[7].

Multidural fenestrations technique allows for the safe removal of subdural clots in patients with acute subdural hematoma, while the protective property of dura mater is not altered[8]. GOS was not statistically different between decompressive craniotomy and multiple dural fenestrations technical but duration of surgery and length of hospital stay were statistically lower in multiple dural fenestration technique[9].

Patients with good GCS, minimal symptoms, and no neurological deficits, no associated intracerebral hematoma, brain contusion, edema or effacement of basal cistern are treated conservatively[10]. The most often used surgical procedure for clot removal is decompressive craniectomy with opening of dura. But this technique often associated with sudden brain swelling and herniation of brain through craniotomy which is followed by rapid decompression of acute subdural hematoma[11]. Repair of dura mater is time consuming and hazardous over swollen brain, even often it is not possible to repair dura and to replace bone flap. Therefore, it is necessary to developed new techniques to avoid these problems. One modification is to use pericranium or polytetrafluoroethylene membrane as a dural graft[12]. Other one is multidural fenestrations, where dura has been fenestrated rather than opening it completely[8]. The overall survival in fenestration group was 7.83%, good recovery 43.3% and mortality 21.6%, compared with open dural flap group with good recovery 11.6% and mortality 60.0%[12]. In this present study it has been tried to compare the outcome of decompressive craniotomy with open dural flap and multidural fenestration procedure to find a more suitable one to treat acute subdural hematoma.

Methodology

Study Population and Settings: This was a non-randomized clinical trial and was carried out in the Neurosurgery Department of Dhaka Medical College Hospital, Dhaka, Bangladesh from January 2011 to August 2012 for a period of one year and eight months. Patients with acute subdural hematoma who fulfil the inclusion criteria for surgery and got admitted into the Department of Neurosurgery at Dhaka Medical College Hospital, Dhaka, were the study population. Acute Subdural hematoma patient of any age, both sex, with GCS 5 to 13, Thickness of hematoma more than 10 mm, Midline shift more than 5 mm, Pupil reacting to light and patient presented within 72 hours of injury were included in this study. Patients presented with brain damage other than lobar injury like brain stem, thalamic, hypothalamic, callosal injury, ASDH with associated polytrauma, ASDH with bilateral dilated, fixed pupil, GCS-less than 5 and more than 13, Penetrating head injury with ASDH, Patient presenting more than 72 hours after injury, ASDH with severe co-morbidity, ASDH patient under antiplatelet drugs treatment were excluded from this study. Prior to commencement of this study the research protocol was approved by the Ethical Review Committee and Research Review Committee of Dhaka Medical College, Dhaka.

Randomization and Blinding: Random Sampling technique used as per inclusion criteria and exclusion criteria. Blinding was mot performed in this study.

Allocation and Intervention: Patients were divided into two groups on the basis of surgical technique. Patients who were undergone decompressive craniotomy with wide opening of dura were designated as group A and patients who were undergone decompressive craniotomy with multidural fenestration were designated as group B. A questionnaire was prepared considering key variables like age, sex, presenting complaints, clinical findings, associated medical conditions, investigations, which was verified by the guide and then data were collected by the researcher himself. After patient selection aims, objective and procedure of the study were explained to the patient or party with understandable non- technical language. Risks and benefits were also clear to the patient or guardian. Cases were encouraged for voluntary participation and they were allowed for free withdrawal from the study. They were assured that all information's

and records were be kept confidentially. Then inform written consent was taken from each patient or guardian.

Craniotomy with wide opening of dura (group A): Elevation of wide flap of scalp with underlying temporal muscle from the skull and large craniotomy (>12cm) was done over fronto-temporo-parietal area centering the maximum thickness of hematoma on the side of lesion. Then the bluish, bulging and tense dura was completely defined. Dura was opened either by cruciate incision or large dural flap. After opening the dura, hematoma was removed very gently from cortical surface by copious irrigation with normal saline and gentle suction. Large clots were removed. Very tiny clots near the source of bleeder were not persuaded as bleeding control may be difficult. To control bleeding bipolar cautery of dural vessels, spongistan, cotton and normal saline irrigation were used. Dura was closed with or without temporal fascia graft depending on brain swelling. Skull was replaced or preserved in refrigeration for future replacement depending upon the brain swelling and extrusion. Then Scalp wound was closed after keeping a drain in situ.

Technique of multiple Dural Fenestrations (group B): After elevation of wide flap of scalp with underlying temporal muscle from the skull large craniotomy was made over fronto-temporo-parietal area on the side of lesion. Then the bluish, bulging and tense dura is completely defined. By using no knife, scissors and delicate skin hook multiple dural linear incisions were made. These incisions were horizontal, parallel to the vessel, 5mm to 8mm long, 3mm to 5mm apart from each other over the entire exposed area. The knife tip should not penetrate the dura more than 0.5mm to 1 mm. A suction tube is gently applied over the dura and the clots are delicately aspirated through the dural fenestrations with simultaneous use of normal saline wash. Then subdural washing is performed using soft 6F-8F feeding tube and normal saline to remove blood and clots. In case of active bleeding one of the small incisions near the bleeder is enlarge for adequate hemostasis. The dural vessels can always be cauterized locally for any bleeding. The completion of the procedure is indicated by the change in the color, consistency and flattening of the dura. To avoid incisional injury to the peripheral brain within the craniotomy, the peripheral fenestrations were made before central fenestrations over the maximum thickness. In case of large dural tear or continued bleeding open dural flap was made. Thus acute subdural hematoma is removed through dural fenestrations while at the same time the integrity of the dura, arachnoid, pia, brain and vasculatures is largely preserved. The bone flap is replaced and partially fixed using 2/0 vicryl with loose knot. Then the edges of fascia and scalp approximated after keeping a drain in situ.

Post-operative management: ICU support for every patient with endotracheal intubation or tracheotomy and or mechanical ventilation, oxygen by face musk/ nasal catheter, continuous monitoring of oxygen saturation by pulse oxymeter, continuous monitoring of blood pressure with other vital signs, maintain fluid and electrolyte balance with IV crystalline saline solution and supplementary KCl, ICP control by slight hyper ventilation (PCO2values 30-35 mm of Hg), 20% manitol (0.25-l gm / kg body weight, intermittent bolus doses), (occasionally by furosemide) for 72 hrs or propofol 3-5 mg/ kg body weight / hour, use of anticonvulsant- IV phenytoin/Phenobarbitone/IV Diazepam, continuous penile catheter and maintain intake- output chart, general care of unconscious patient (Care of V skin, bowel, bladder, eyes, maintain oral hygiene etc.), relevant investigations like Arterial blood gases, Serum electrolytes, Serum creatinine, random blood sugar, complete blood count etc. Other supportive measures e.g. antibiotics (IV Ceftriaxone + Flucloxacilin), analgesics, antiulcerant, glycemic control etc. We could not monitor ICP, because facilities not available in our hospital. Physiotherapy and rehabilitation exercise like Chest Physiotherapy and breathing exercise, passive movement of limbs etc.

Follow-up and Outcome Measures: Patients were evaluated clinically and by imaging at discharge from hospital and functional outcome measured by Glasgow Outcome Scale (GOS). Main outcome variables were Glasgow Outcome Scale (GOS), duration of surgery, length of hospital stay. Outcome of surgery for Acute Subdural Hematoma measured using Glasgow Outcome Scale (GOS). Death, persistent vegetative state, severe disability, moderate disability, good recovery were .

Statistical Analysis: The data were collected and edited manually. Then the data was entered into SPSS (Statistical Package for Social Science, version 20) computer software program. The entered data were checked and verified. The same program analyzed the data. For statistical analysis, we used the t-test and Levine's test for equality of variance to determine significant differences between the groups. Differences were considered statistically significant at $p<0.05$. The data were presented in tabulated form. Statistical calculations were performed by the same software.

Results

A total number of 48 patients presented with acute subdural hematoma who were operated in the Department of Neurosurgery of Dhaka Medical College & Hospital, Dhaka, Bangladesh were included in current study. The comparative results of the cases (multiple dural fenestration, Group-B) and controls (wide opening of dura, Group-A) revealed similar demographic variables in both the groups. The mean age of the all patients was 32.39±11.63 years; however, in group A the mean age was 32.68±l2.59 years and in group B the mean age was 3l.9l±l0.75 and their age ranged from 10 to 56 years. The age distribution showed the highest peak of incidence at the third and lowest peak at the sixth decade of life. Highest peak of incidence (41.66%) 3rd decade. Lowest peak 6th decade (8.33%). (Table 1).

Table 1: Age Distribution of the Study Groups (n=48)

Age group	Study Groups		Total	P Value
	Group A	Group B		
10 to 20 years	2(8.0%)	3(13.04%)	5(10.41%)	0.84
21 to 30 years	11(44.0%)	9(39.13%)	20(41.66%)	
31 to 40 years	5(20.0%)	6(26.09%)	11(22.91%)	
41 to 50 years	4(16.0%)	4(17.39%)	8(16.66%)	
>50 years	3(12.0%)	1(4.35%)	4(8.33%)	
Total	**25(100.0%)**	**23(100.0%)**	**48(100.0%)**	
Mean (±SD)	32.68±12.59	3l.91±10.75	32.3±11.63	
Range	10 to 56 years			

Regardless of surgical technique used that is craniotomy with wide opening of dura mater or craniotomy with multidural fenestration technique, good recovery (GOS score 5) was seen in 23(47.9l%) patients, moderate disability seen in 7(l4.58%) patients, 3(6.25%) patients remained severely disable, persistent vegetative state developed 4(8.33%) patients and lastly 11(22.91%) patients died after surgery. In group A, according to GOS score at the time of discharge from hospital, 12(48.0%) patients showed good recovery (GOS score 5), 4(l6.0%) patients experienced moderate disability, 2(8.0%) patients were found to have severe disability, 01(4.0%) patients developed persistent vegetative state and 6(24.0%) patients died. In group B, 11(47.83%) patients showed good recovery (GOS score 5), 3(l3.04%) patients experienced moderate disability, 1(4.35%) patients were found to have severe disability, 3(l3.04%) patients developed persistent vegetative state and 5(21.74%) patients died (Table 2).

Table 2: Outcomes Variable among the Study Population

Outcomes	Study Groups		Total
	Group A	Group B	
Good Recovery	12(48.0%)	11(47.8%)	23(47.9%)
Moderate Disability	4(l6.0%)	3(l3.1%)	7(l4.58%)
Severely Disable	2(8.0%)	1(4.3%)	3(6.25%)
Persistent Vegetative	1(4.0%)	3(l3.0%)	4(8.33%)
Died After Surgery	6(24.0%)	5(21.8%)	11(22.91%)
Total	**25(100.0%)**	**23(100.0%)**	**48(100.0%)**

The mean duration of surgery was l26.32±24.86 minutes in group A and 90.95±18.64 minutes in group B. The mean duration of surgery was longer in group A than in group B and this difference was strongly significant (P<0.00l). In addition, the mean duration of hospital stay was 23 .44±6.65 days in group A, and 18.l7±3.39 days in group B. The mean duration of hospital stay was longer in group A than in group B and the difference between two groups was statistically significant (P<0.00l). Other variables of the study, such as mean GCS in group A was 9.76±12.40 and in group B was 9.26±12.45 and P<0.48, the mean hematoma thickness (preoperative CT scan) in group A was 12.68±17.54 mm and in group B was 13.91±17.98 mm and P<0.58, the mean midline shift in CT scan in group A was 8.80±16.69 mm and in group B was 9.69±15.62 mm and P<0.62, the mean time interval between incidence and surgery in group A was 12.56±15.88 hours and in group B was 10.95±16.69 hours and P<0.38 were not statistically significant. The mean duration of surgery in group A was 126.32±24.86 minutes and group B was 90.95±18.65 minutes, duration of hospital study in group A were 23.44±6.65 days and group B were l8.17±3.39 days (p<0.05) that difference between two group was statistically significant. Mean differences of GCS, thickness of hematoma and midline shift in preoperative CT scan, time of interval between injury were not statistically significant (p >0.05) (Table 3).

Table 3: Mean differences of GCS, thickness of hematoma and midline shift in preoperative CT scan, time of interval between injury and operation, duration of surgery and duration of hospital stay in study groups (Mean±SD)

Variables	Study Groups		P value
	Group A	Group B	
GCS	9.76±2.40	9.26±2.45	0.48
Hematoma Thickness	12.68±7.54	l3.91±7.98	0.58
Midline shift (mm)	8.80±6.69	9.69±5.62	0.62
Time Interval (hour)	12.56±5.88)	10.95±6.69	0.38
Duration of Surgery (min)	126.32±24.86	90.95±18.65	<0.001
Hospital Stay(day)	23.44±6.65	l8.17±3.3	0.001

Group A= wide opening of dura (WOD); group B= multiple dural fenestration (MDF); Time Interval =Time of interval between injury and operation (hour)

Discussion

The diversity of medical and surgical treatment of acute subdural hematoma is limited[4]. Commonly used surgical procedure is large craniotomy with wide opening of dura. Besides poor outcome this procedure is associated with long operating time due to time consuming duroplasty with pericranium or artificial dura, second operation for cranioplasty where bone flap not replaced but preserved, loss of natural protective coverings of brain, and in many cases the development of acute brain swelling and extrusion of brain tissue through craniotomy[8]. It was shown that rapid decompression of acute subdural hematoma can result in sudden increase of cerebral blood flow, with the probability of hyperemia increasing due to disruption of cerebral blood flow auto regulation in that region, because the dilated blood vessels cannot constrict after sudden restoration of normal perfusion pressure of brain[10].

To avoid these complications Guilburd and Sviri[8] proposed, a new technique, dural fenestrations for the treatment of acute subdural hematoma. Authors found that it is possible to removed almost entire hematoma without complete opening of dura by multiple dural fenestrations, in a mesh like fashion, without the hazard of brain extrusion and mushrooming during the intervention. They found this technique to be easily performed, have no immediate or late complications and to take a shorter time than the classic approach[8]. In classic approach tight closure of dura, even with graft allow decompression of brain but can't avoid brain mushrooming. Although removal of bone flap, which was proposed by Britt and Hamilton, could lower ICP, it is not significant in severe brain swelling. During surgical treatment of ASDH bone decompression achieved using dural graft seems successful in some cases but surely enhances cerebral swelling and exacerbates brain edema in others[12]. We believe that multidural fenestrations procedure allow further decompression of blood and CSF for a few days.

In this study regardless of surgical technique used that is craniotomy with wide opening of dura mater or craniotomy with multidural fenestration technique, a favorable outcome that means good recovery (GOS score 5/4) was seen in 23(47.91%) patients, moderate disability seen in 7(14.58%) patients, 3(6.25%) patients remained severely disable, persistent vegetative state developed 4(8.33%) patients and lastly 11(22.91%) patients died after surgery. The purpose of this study was to compare the outcome measures (GOS) of patients with acute subdural hematoma who were operated upon with two different surgical techniques. We found that the GOS is not statistically different between two groups. But our analysis showed that the operating time and duration of hospital stay in the fenestration group (group-B) was significantly lower than patients who underwent craniotomy and wide opening of dura mater (Group-A).

In this study, the mean duration of surgery 90.95±18.64 minutes among patients who underwent multidural fenestration (group B) was 72% of the other (group A) (with mean duration of surgery 126.32±24.86 minutes. In contrast, the duration of hospital stay in those patients who survived was shorter (69.36%) in the multidural fenestration group (group B) than the other group (group A). It might be due to slow recovery following prolong surgery. But this results are similar to the results found by Chabok et al[9] where means good recovery (GOS score 5) was seen in 28.60% in group A and 33.3% in group B patients, moderate disability seen in 23.8% in group A and 20.8% in group B patients, 14.3% in group-A and 12.5% in group B patients remained severely disable, and 33.3% in group A and 33.3% in group B patients died and no body developed persistent vegetative state.

We used two types of surgical techniques for evacuation of blood clot. Group-A decompressive craniotomy with wide opening of dura and Group-B decompressive craniotomy with multidural fenestration. We have tried to compare the efficacy of these two techniques for treatment of acute subdural hematoma. Out of 48 cases, 25(52.08%) patients were operated with wide opening of dura (Group A) and 23(47.91%) patients with multidural fenestration technique (Group B). Glasgow Outcome Scale (GOS), duration of surgery, length of hospital stay of the cases that underwent wide opening of dura (group A; n=25) were compared with those underwent multidural fenestration (group B; n=23). In few cases hemostasis can be difficult to control through small dural opening. In these cases dural opening can be enlarged as much as necessary to achieve satisfactory hemostasis. But in our study we could not face such kind of problem. There is some hazard of further brain injury during incision of dura and suctioning through the dural opening. This was avoid by meticulous and careful fenestration of dura and applying gentle suction using narrow gauge suction tube, and not directly applying suction over the fenestration. Inadequate removal of clots-it is important to note that almost all subdural clots were removed in the majority of cases, residual hematomas were negligible, none was more than

20.0% of original hematoma, and nobody required reoperation.

Regardless of surgical technique used that is craniotomy with wide opening of dura mater or craniotomy with multidural fenestration technique, good recovery (GOS score 5) was seen in 23(47.9l%) patients, moderate disability seen in 7(l4.58%) patients, 3(6.25%) patients remained severely disable, persistent vegetative state developed 4(8.33%) patients and lastly 11(22.91%) patients died after surgery. In group A, according to GOS score at the time of discharge from hospital, 12(48.0%) patients showed good recovery (GOS score 5), 4(l6.0%) patients experienced moderate disability, 2(8.0%) patients were found to have severe disability, 01(4.0%) patients developed persistent vegetative state and 6(24.0%) patients died. In group B, 11(47.83%) patients showed good recovery (GOS score 5), 3(l3.04%) patients experienced moderate disability, 1(4.35%) patients were found to have severe disability, and 3 (l3.04%) patients developed persistent vegetative state and 5 (21.74%) patients died. The mortality of acute subdural hematoma with brain swelling is very high and it was over 75.0%[14] and outcome is poor even with early surgery. Therefore, the ability to control ICP is more critical to outcome than the absolute timing of surgery for subdural blood removal. The mortality of traumatic acute subdural hematoma is about 50.0% to 90.0%[4] and traditionally thought to be higher in aged patients (60%), 90 to 100% in patients on anticoagulant therapy[7]. But in developing countries like Bangladesh outcomes is poor and mortality is very high about 60% to 90%; however Bangladesh is far behind regarding suitable health infrastructure, modern diagnostic facilities, expert neurosurgical services and advance life support facilities[10]. Even all medical colleges can't provide essential neurosurgical services like management of acute subdural hematoma and our outcomes is comparatively poor and death and disability rate is very high.

In this study, although the dura remained open, none of the patient presented with CSF fistula but three cases developed local wound swelling and aspiration revealed liquid blood and solved the problem by repeated aspiration. One patient developed wound gap following sub glial hematoma drainage and required wound closure. One patient developed superficial wound infection and required daily dressing and 2ndery wound closure.

Limitation of The Study: Intracranial pressure (ICP) monitoring is one of the most important parts of the management of severe head injury irrespective of acute subdural hematoma. But it is not possible for us to monitor ICP due to unavailability of monitor in our hospital. Another important part of the management of acute subdural hematoma is care of the patients in intensive care unit (ICU). In hospital, though limited bed in ICU, it provided ICU support for every patient required ICU support. Solvent patients take this facility from other hospital and clinics and return back to DMCH. Serial imaging studies (CT scan of brain) is necessary to confirm that the acute subdural hematoma has removed completely by surgery.

Conclusion

In conclusion multiple dural fenestrations is an effective decompressive procedure for removal of acute subdural hematoma. It is recommended using dural fenestrations technique but further large scale comparative clinical studies should be performed to evaluate the real value of this technique and to assess impact on morbidity and mortality rates. However, it is necessary to use techniques that can be easily performed in a shorter time without compromising the outcome.

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