Safety and Outcome of Suboccipital Mini-Craniectomy for the Evacuation of Spontaneous Cerebellar Hemorrhage.

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Abstract: Objective: Spontaneous cerebellar hemorrhage (SCH) that may cause severe brain stem compression, obstructive hydrocephalus, and cerebellar herniation is life threatening condition. Large suboccipital craniectomy has been traditionally used to evacuate SCH, which has long operative time and local tissue damage, and associated with high morbidity and mortality. We examined the effectiveness and outcome of our experience in the management of SCH with suboccipital minimal invasive "Mini-Craniectomy" (MC). **Methods:** This retrospective study was performed between July 2002 and August 2013 in two tertiary hospitals in the western region of Saudi Arabia for all patients were admitted with SCH. The patients were treated conservatively if they presented with Glasgow Coma Scale (GCS) of 13 or more and their computed tomography (CT) scans on admission revealed ahematoma sizeless than30 mm in maximal diameter and no evidence of brain stem compression or hydrocephalus. While, Surgical intervention with MC was considered for patients with GCS less than 13 and with CT findings of hematoma size more than 30 mm in maximal diameter, and/or brain stem compression or hydrocephalus. Glasgow outcome score (GOS) was identified for all patients at their 3-moth follow up. **Results:** Thirty-eight patients with SCH were included in this study with mean age of 63.5 years. Twenty-six patients (68%) were males and 12 (32%) were females. Three patients presented with GCS of 3 were offered palliative support. Non-operative management was indicated for 13 patients, and 22 patients underwent emergency MC and evacuation of cerebellar hematoma (CH). In the non-operative group, 2 patients deteriorated neurologically and underwent MC, and another patient required insertion of ventriculoperitoneal shunt (VPS) for progressive hydrocephalus. In the operative group (n= 24),2 had a local rebleed and required were reoperation, 2developed worsening of hydrocephalus and required external ventricular drains (EVD), one of them eventually requiredVPS. Suboccipital pseudomeningocele, occurred in 3 patients and resolved after 5 days of external lumbar drainage. At 3-month follow up, all patients treated conservatively (n=11) had favorable GOS.Patient who underwent MC (n=24), 19 patients (79%) had favorable GOS (3 had mild disability and 16 returned back to their baseline neurological status). Five patients (21%) had unfavorable GOS (3 patients died, 2 patients had severe disability and were dependent). **Conclusion:** The results of this study indicate that surgery for SCH through a MC is effective surgical procedure with good outcome.

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1. Introduction:

Spontaneous cerebellar hemorrhage (SCH), accounting for 10% of all cases of intracerbral hemorrhage (ICH), is a serious condition that is associated with high morbidity and mortality due rapid deterioration from brain stem compression (BSC) and obstructive hydrocephalus (OHC) [1-3]. Recently, there is general consensus from large body of evidence from previously reported randomized trials on the management guidelines of ICH that was published by the American Heart Association/ American Stroke Association Stroke Council; American Heart Association/American Stroke Association High Blood Pressure Research Council; Quality of Care and Outcomes in Research Interdisciplinary Working Group [4]. However, the evidence from the literature from nonrandomized trials was not able to come up with similar guidelines and the management of SCH has remained controversial. Indications for surgery are controversial, however, surgical evacuation of the hematoma has been the mainstay of therapy for SCH with cerebellar hematoma (CH) more than 30 mm in maximal diameter and with associated with BSC and OHC [5-11]. The standard surgical procedure in those patients was performing a large suboccipital craniotomy and evacuation of SCH, which has been associated with 20-30% mortality in large series [12-14]. This high incidence of operative mortality is partially related to the fact that SCH occurs predominantly in the older age groups and many of them suffer from other chronic disease, like diabetes, heart disease, and liver disease [5,8,10,11]. On the other hand, it was partially related to the long procedure and amount of cerebellar tissue damage. Recently, there are increasing reports advocating the safety and efficacy of the use of minimally invasive surgical techniques including endoscopic evacuation of CH [15] or CT-guided using stereotactic or navigation tools for aspiration or draining of CH with or without fibrinolysis [16-19]. In addition, direct open techniques have refined to evacuate CH through a keyhole craniotomy, a mini-craniotomy or craniectomy, with shorter time of surgery and good outcome [20,21].

In this study, we report our experience in the management of SCH and analyze the safety and outcome of patients who had evacuation of SCH performed through a suboccipital minicraniectomy (MC).

2.Methods:

2.1. Patient Populations:

During the period from July 2002 and August 2013, 38 patients with SCH were managed in our departments at king Abdulaziz university hospital, Jeddah and Alnoor specialist hospital, Makkah in the western region of Saudi Arabia.The patient charts were retrospectively reviewed for demographics and clinical presentation and Glasgow Coma Score (GCS) on admission. Radiological assessment of computed tomography (CT) scan findings on admission was recorded for measurement of the maximal diameter of CH, location of CH (vermian, hemispheric or both), presence BSC, OHC, and blood in the ventricles. Evidence ofBSC wasdemonstrated asatight posterior fossa on CT scans, and according to Weisberg [22], the presence of one or more of the following findings: obliteration of basal cisterns in the posterior cranial fossa, enlargement of the 3rd and lateral ventricles, and/or effacement of the 4th ventricle.

We excluded from this studypatients with brain stem hemorrhage, and CH that was due to trauma, secondary tumors, vascular malformation, aneurysm, coagulopathy, or following posterior fossa surgery.

Although there is no currently guidelines for the management of SCH, but we followed the general guidelines for the management of spontaneous intracerebral hemorrhage in adults (2007 update) from the American Heart Association/American Stroke Association Stroke Council [4].

Non-operative management was indicated for patients with the following criteria: admission GCS ≥ 13, CH < 30 mm in maximal diameter, and no evidence of OHC or BSC.Patients under conservative treatment were managed in ICU with adequate control of blood pressure and other medical diseases, close neurological follow-up, and daily CT scan follow up in the first week. Device to measure intracranial pressure was not inserted, and no recombinant activated Factor VII, steroids or diuretics were given. Patient with who presented with coma (GCS 3) and absent brain stem reflexes ventilated in ICU for palliative care.

Surgical intervention was considered if one or more of the following criteria were observed (either on admission or during conservative management): admission or drop of GCS < 13, CH size ≥ 30 mm in maximal diameter, and/or presence of BSC or OHC.

2.2. Surgical Procedure:

Endotracheal intubation and general anesthesia were used for all patients. Patients were operated in prone position with the head fixed using 3-point Mayfield fixation. The scalp incision and MC were designed over the shortest and most superficial area of the CH based on the CT scan. Longitudinal paramedian scalp incision (about 4cm in length) was done and carried down to the occipital squama. The occipital bone was thinned using high-speed drill. Then, a small circular craniectomy (2-3cm in diameter) was done. A cruciate incision of the dura is made and at this stage, the cerebellar tissue bulges through the dural opening. In 9 patients, the hematoma spontaneously has ruptured through the overlying thin rim of cerebellar cortex. In the remaining 15 patients, a small cortical incision using irrigating bipolar was done and carried down to the hematoma. Initially, the hematoma was left to come out spontaneously under the effect of the high posterior fossa pressure. Then, the remaining was removed using normal saline irrigation and gentle suction. Hemostasis was achieved using copious irrigation and, if needed, a small hemostatic fibrillar collagen. Once, the cerebellum became lax and CSF came out spontaneously dural edges is primarily approximated usingabsorbable sutures or using a graft from surrounding pericranium, and then the muscles and scalp were closed in layers.

2.3. Postoperative Course and Outcome:

After surgery, patients were managed by sedation and mechanical ventilation following the same protocol used in the conservative group. Follow up brain CT scans with in 24 hours, then daily for the first few days, were performed to evaluate the evacuation of hematoma and assess the presence of BSC or OHC. Patient was weaned off ventilator when GCS became more than 8. Tracheostomy was done for patients with evidence of lower cranial nerve palsy and for patients who had GCS8 or less one week after surgery. After weaning off the ventilator, medically stable patients were shifted to the ward. Patients' outcome was assessed with

Glasgow outcome scale (table 1) at discharge and at outpatient clinic visits.

3. Results:

The demographics of the included 38 patients were summarized in table 2. The mean age was 63.5 years (range, 43-84 years), and 26 patients (68%) were males. The commonest symptom in the study group was occipital headache radiating to the neck in 27 patients (71%), and sudden deterioration in the level of consciousness in 11 patients (29%). However, deterioration in the level of consciousness occurred in 10 of the 27 patients with occipital headache before their arrival to the hospital. Associated symptoms included vomiting in 22 patients (58%), and dizziness in 8 patients (21%). All patients were admitted within 24 hours from their initial symptoms. Thus, on admission, GCS was 13-15 in 17 patients (45%), and <13 in 25 patients (55%) (3 of them had GCS 3 with lost brain stem reflexes). Thirty-one patients (82%) were known hypertensive, however, all patients had high blood pressure on admission. Fifteen (39%) patients had diabetes mellitus, 8 (21%) had ischemic heart disease, and one (3%) had chronic renal failure, but none of them had hematologic disorders.

In initial brain CT scan, 23 (61%) patients had CH ≥ 30 mm in maximal diameter and 15 (39%) had CH <30 mm. Fifteen (39%) patients had early hydrocephalus and 17 (45%) had evidence brain stem compression and hydrocephalus (table 2). Hemorrhage was hemispheric in 30 (79%) patients, and both hemispheric and vermian in 6 (16%) patients, and 2 patients (5%) had pure vermian hematoma. In addition, 4 (11%) patients hadintraventricular hemorrhage (IVH).

3.1. Non-Operative Group:

According to the clinical and radiological assessment, 13 (34%) patients fulfilled the criteria for conservative treatment. In this group, 10(77%) showed gradual clinical and radiological improvement and were discharged within 2 weeks. One patient (8%) required VPS for late (2 weeks from onset of SCH) developing hydrocephalus. Two other patients (15%) developed deterioration in their level of consciousness within 48 hours from admission. Follow up brain CT scan in the two patients showed an increase in the size of the hematoma, hydrocephalus, and evidence of brain stem compression, and they were operated.

3.2. Operative Group:

On arrival to our emergency room, threepatients presented with GCS 3 and were clinically fulfilled brain dead criteria. They received palliative treatment and died within few days. Twenty-two patients fulfilled the criteria for surgical treatment. Eighteen out of them had admission GCS < 13 and 4 had GCS ≥ 13. The twenty-two patients had CH ≥30 mm in maximal diameter. In addition, 12out of 22 patients (55%) had OCH and 14 (64%) had BSC.

Twenty-four patients required MC and evacuation of CH. The mean operative time was 75 minutes (range from 50-120 minutes). Bleeding from the bed of the hematoma was controlled by saline washing alone in 18(75%) patients. In addition, a small hemostatic fibrillar collagen was used to control the bleeding source in 6(25%) patients. Postoperative mechanical ventilation was used for all patients in the postoperative period (n=24): 7 patients for one day, 12 for 2-6 days, and 5 for 7-14 days. All five patients who required mechanical ventilation for more than 6 days had admission GCS between 3-5 and 2 of them had lower cranial nerve palsy. Follow up brain CT scan at 24 hours after surgery revealed residual hematoma in 14 patients (58%) with mean size of 13 mm (range, 8 to 20 mm).Two patients (8%) were re-operated for re-evacuation of CH within 48 hours of the first surgery; one of them died after 11 days and the other survived with mild disability. The preoperative OHC and BSC markedly improved within 3 days postoperatively in 20 patients (83%) as in figure 1.

However, 2 patients (8%) required external ventricular drain (EVD) for several days for treatment of IVH and hydrocephalus, one (4%) required VPS, and 3 (13%) required a temporary external lumbar drain for 5-days due to postoperative persistent subcutaneous CSF collection.

At 3-month follow-up, all patients who were not operated by MC (n=11) were fully conscious and independent for their daily activities. However, mild ataxia was evident in 3 (27%)of them. Nineteen patients (79%) had favorable GOS; 16 of them returned back to their original premorbid neurological status and 3 had mild disability, but they were independent for their daily activities. On the other hand 5 (21%) patients had unfavorable GOS. Three (12.5%) patients died; one from chest infection and two from rebleeding. In addition, 2 (8%) patients had severe disability (lower cranial nerve palsy and significant hemiparesis) and were dependent for their daily activities.

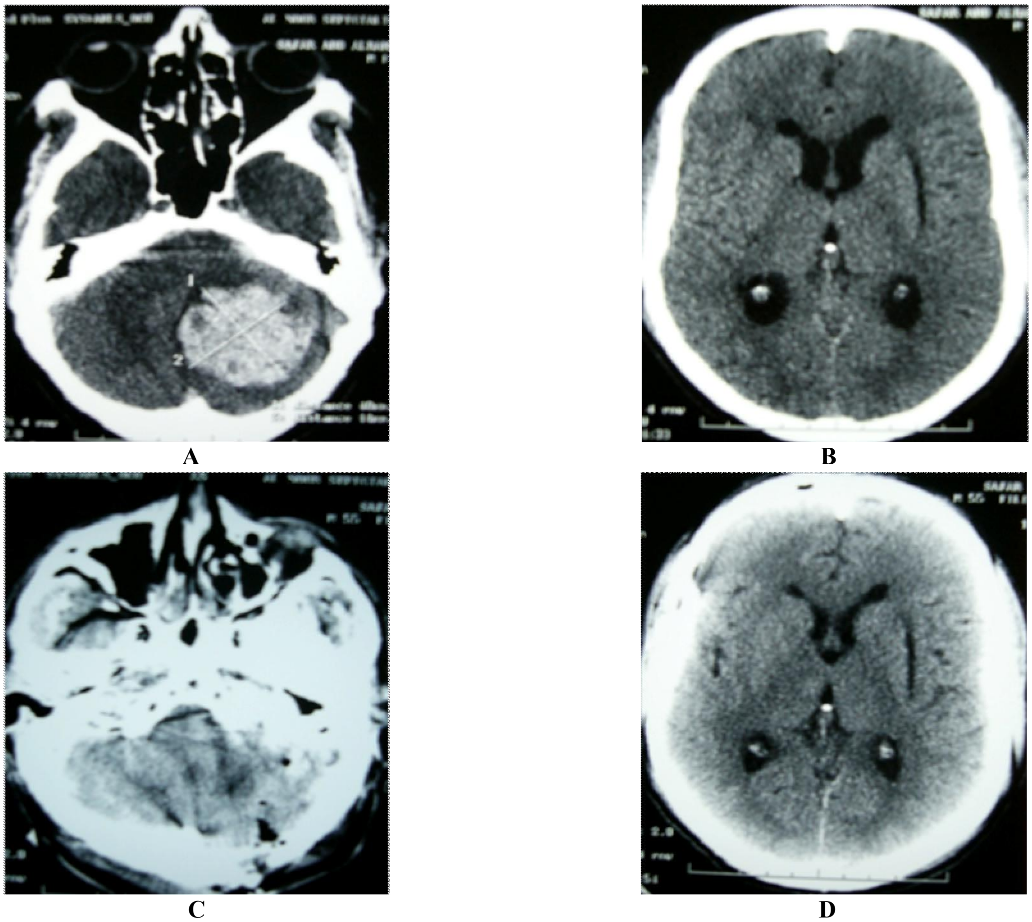

Figure 1: ***Case illustration****:* a 74-year-oldmale presented with headache GCS of 9. On admission, brain CT scan showed a 43 x 50 mm diameter left SCH with BSC and OHC (A and B). He underwent emergency MC and evacuation of the hematoma with good outcome. Postoperative follow up brain CT scan showed no residual of the hematoma and relief BSC and OHC (C and D).

Table 1: Glasgow Outcome Scale

Scale	Term	Definition
1	Dead	No life
2	Vegetative state	Unaware of self and environ
3	Severe disability	Unable to live independently
4	Moderate disability	Able to live independently
5	Mild disability	Able to return to work/school

Table 2: Demographics of the study group (n= 38)

Age (yrs.)	Mean		63.5
	Range		43-84
Sex (%)	Males		26 (68%)
	Females		12 (32%)
GCS on admission	13-15		17
	9-12		8
	4-8		10
	3		3
CT scan findings	Size of hematoma (mm)	≤30	15 (39%)
		> 30	23 (61%)
	Location	Right	21
		Left	17
		Hemispheric	30 (79%)
		Hemispheric and Vermian	6 (16%)
		Vermian	2 (5%)
	Brain stem compression		17 (45%)
	Hydrocephalus		15 (39%)
	Intraventricular hemorrhage		4 (11%)

4. Discussion:

Patients with SCH with associated BSC and OBH are at significant morbidity and mortality and require immediate surgery. Lack of guidelines in the literature made the selection criteria for the surgical intervention of SCH unclear [4,5,8-10]. However, several factors have been considered in this regard including the size and location of CH, the admission GCS, and radiological findings of the subarachnoid spaces in the posterior fossa and ventricular sizes. Several authors agreed to consider CH larger than 3 cm as indication for surgical intervention. Furthermore, others recommended surgical intervention for smaller CH located within the vermis because it is located closure to the brain stem and CSF pathways [4,13].

Cohen et al, found that patients with hematomas less than 3 cm in maximal diameter had 100% and 57% good outcomes following conservative and surgical treatment, respectively [6]. In the current study, 3 out of 13 patients (23%) with CH less than 30 mm required surgery; 2 patients required MC for evacuation of expanding hematoma causing clinical and radiological deterioration, and one patient with persistent headache despite regression of the CH size required VPS. These results are similar to general notion for treatment of patients with CH less than 30 mm with 25% of patients may deteriorate and require surgical intervention. All 13 patients in our study had good GOS.

Whether patients with CH ≥ 3 cm and having GCS ≥ 13 should undergo surgery remains debatable. Some authors recommended observing those patients due to the scarce clinical and radiological progression observed of such patients in their category [3]. Others recommended operating upon this group of CH patients and not to wait for further neurological deterioration because the literature is full with cases of neurological deterioration days after symptom onset [8,23]. From the results of our study and reports of others in the literature, the most important prognostic factors are the GCS at presentation and the presence of BSC or OHC and recommend urgent surgical intervention and evacuation of SCH [24,25,29].

Cohen, *et al.,* observed that patients with CH ≥ 3 cm in maximal diameter who were not operated immediately had a good outcome in only 33% of cases, compared with a good outcome in 50% of cases operated by wide craniectomy [6]. In our study, 3-month GOS was favorably in 70% of patients with CH ≥ 3 cm who where operated.

One concept that requires careful evaluation is the presence of obliteration of the basal cisterns and BSC in a smaller (<30 mm) CH [3,23,25]. Hematomas of similar size may exert widely differing amounts of compression on the cisterns. The observation of the current study and those of others showed that the amount of compression probably depends also on various factors, including the patient's age, the amount of cerebellar atrophy, and the anatomy of the posterior fossa [23,25]. Therefore, identification of BSC may justify early surgical intervention.

The methods of surgical intervention for evacuation of SCH have also been controversial. Traditionally, large occipital craniectomy and external ventricular drainage for OHC with tight dural closure at the end of surgery is the standard surgical technique. The rationale for this is that the exposure should be wide enough to allow for treatment of an unsuspected pathologic condition, such as a hemorrhagic tumor or a vascular malformation [13,16,24]. We believe that this may not by favored for patients with SCH for several reasons: First, the bleeding in those patients rarely arises from a single artery, but it originates most often from the cavity walls and can be easily controlled using saline irrigation, a hemostatic gelatin sponge or fibrillar collagen and can be achieved through a small craniectomy. Second, using the new generations of high resolution CT with the ability to do CT angiography, one can preoperatively exclude the possibility of hemorrhagic tumor or vascular malformations in suspected cases of SCH in younger non-hypertensive patients. Careful preoperative diagnosis in those patients is very important for operative planning. Third, MC greatly decreases the surgical time and local tissue trauma. Forth, from our experience in this study, the loose closure of the dura in those patients would allow temporary CSF leakage into the extracranial soft tissues which usually absorbed and resolved with time.

Evacuation of CH in our patients was rapidly followed by a significant decrease in ventricular size. Two patients (8%) in the operative group required external ventricular drainage for few days and only one patient (4%) in this group required VPS. On the other hand, 1 out of 11 patients (9%) in the conservative group required VPS. We believe CSF diversion should be done only for cases that will continue to have ventricular dilatation after adequate posterior fossa decompression. This is important to avoid the transtentorial upward herniation reported in patients with CH treated solely with ventricular drainage [11,26].

Although we do have no experience with CT-guided stereotactic fibrinolysis technique for removal of SCH, published data imply that this procedure is effective for hematomas that are considered borderline-namely those on the borderline between conservative and surgical management [16.18,19].

Although this technique has been used for evacuation of SCH, only few report containing small numbers of patients have been published describing its results. Larger series should be available to prove the effectiveness of the CT-guided stereotactic fibrinolysis technique in drainage of SCH.

Several studies [8,12,27-30] have analyzed the clinical and imaging features that are predictive of poor outcome in spontaneous cerebellar hemorrhage. Clinical features on hospital admission that correlated with a poor outcome have included systolic blood pressure greater than 200mmHg (presumed to be part of the Cushing response), gaze paresis [23,30], and a decreased level of consciousness [8,11], which are all indications of compression at the brain stem level. The CT scan features indicative of a poor prognosis are a midline location [26,27], an obliterated fourth ventricle and basal cisterns [25,27], upward herniation [10], intraventricular hemorrhage [13], and hydrocephalus [5]. The observations in our study and those reported by others indicated that high systolic blood pressure and a decreased level of consciousness, but with intact brainstem reflexes, on admission do not correlate with poor prognosis if those patient were operated on urgent basis. In our study, 10 patients with GCS < 9 on admission were operated by MC; 6 of them had favorable outcome, two were dependent on others for their daily activities and two died. In addition, the midline location of CH, the presence of OHC and BSC in the CT scan did not correlate with poor prognosis in the current study, but the presence of these factors indicates the need for urgent surgical evacuation of the hematoma. However, only 4 of our patients had 4th ventricle hemorrhage and none of them had brainstem hemorrhage. This may explain in part the relatively good outcome in our patients.

Conclusion:

The results of this study demonstrate that conservative management of SCH can be achieved with good results in patients presented with good GCS and small CH. However, emergency evacuation of SCH for patients with GCS of l3 or less with evidence of BSC or OHC and hematoma size 30 mm or more. The procedure can be safely and effectively performed through MC with good outcome.

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