Original Article

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Large Craniotomy vs. Endoscopic Surgery for Treatment of Septated Chronic Subdural Hematoma: A Two-Centre Retrospective Comparison Study

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Abstract

Background & Objective: Optimal treatment method for septated chronic subdural hematoma (SCSDH) is still debatable. This study aims to compare safety and efficacy of large craniotomy and endoscopic –assisted mini-craniotomy with membranectomy for management of SCSDH with multiple membranes and analyze surgical outcome and complications.

Materials & Method: We retrospectively studied 225 cases with membranous septated CSDH including 100 cases in large craniotomy and 125 cases in endoscopic surgery from January 2011 to October 2023 in two institutions. Age, sex, etiologies, Markwalder's (Neurological) grading score (MGS) at admission, concomitant disease, hospital stay's day, outcome as MGS at discharge, recurrence and complications were assessed.

Results: There were 75% male and 25 % female patients in craniotomy group; and 87.2% male and 12.8% female in endoscopic group. In both group, age more than 50 year were significantly higher compared to age less than 50 years. Similarly, patient with MGS ≥2 had significantly more unfavorable outcome compared to MGS ≤1 at the time of admission in both groups. Organized hematoma had significantly more unfavorable outcome compared liquefied hematoma associated with septated CSDH in both groups. Similar rate of complications were found
between two groups, and hospital stay in endoscopic group was shorter as compared to large craniotomy group.

Conclusion: Endoscopic surgery was associated with shorter hospital stay however both large craniotomy and endoscopic assisted mini-craniotomy along with membranectomy are safe and effective for SCSDH.

Keywords: Chronic subdural hematoma, Septated, Craniotomy, Endoscopic surgery, Outcome

Introduction

Chronic subdural hematoma is frequently observed neurological disorders in elderly population and incidence approximately 8.2/100,00/years in the population over 70 years of age have been reported[1]. An increased in antithrombotic medications, fragile veins, brain atrophy with increased subdural space, and an increased exposure to trauma resulting from frequent fall injury may be reason for having such neurological disorder in elderly population[2]. Various treatments for organized or non-organized CSDH have been described [17,24,29]. However, range of surgical treatment needed for any type of CSDH is still debatable[12,33]. Craniotomy is safe and effective for blood evacuation and has a lower recurrence rate than burr hole or twist drill craniotomy [13]. Small or large craniotomy has been taken as most desirable method for solid hematoma, however failure of brain re-expansion, excessive swelling of brain, and recurrence of CSDH have been described[9,10,17,20,24]. Furthermore, large craniotomy with membranectomy is invasive procedure and has higher rate of morbidity and mortality in elderly patients[10]. With development of endoscope it has been used increasingly where it has a broader view of subdural space and does harm to patient, and endoscope assisted surgery is safe and effective in deceasing postoperative complication and recurrence rate have been reported[21,23,35]. The purpose of this study was to analyze the efficacy of large craniotomy or endoscopic assisted mini craniotomy with membranectomy as the initial treatment for SCSDH[20].

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Materials & Methods

This retrospective study included total 225 patients with

membranous septated CSDH where 100 cases who had undergone large craniotomy in a tertiary hospital, Nepal and 125 cases who had undergone endoscopic surgery in a tertiary Hospital, India from January 2011 to October 2024. We excluded cases with CSDH operated through burr-hole technique. Computed tomography (CT) scan and magnetic resonance imaging (MRI) were the imaging method for the evaluation of septated or non-septated as well as organized (solid) or liquefied CSDH in all patients. A protocol for clinical data collection was followed by two teams in both hospitals. The demographic data and the clinical features of these patients were recorded, including the medical history, age, sex, etiology, clinical symptoms, neurological status, location and organization of hematoma, concomitant diseases at presentation, hospital stay. Outcomes of patients were evaluated by MGS. Favorable outcome was defined as MGS of 0-1 and unfavorable outcome was defined as MGS ≥2. The recurrence was defined as symptoms and radiologically confirmed recurrent CSDH within 6 months. Fronto-temporo-parietal (FTP) craniotomy was done for large craniotomy cases and mini- craniotomy of posterior part of parietal bone was performed for endoscopic surgery cases. Closed drainage system was kept for 24 hours for all cases

Craniotomy Technique

Large F-T-P ellipsoid shaped craniotomy measuring approximately 8cm x 5cm was done under general anesthesia. The dura was reflected and outer membrane was excised following craniotomy. The removal of hematoma was performed under direct visualization. Hematoma and multilayer septations were completely removed. If neo-vascularization existed in the hematoma capsule/membrane, it was coagulated. The inner membrane was removed as much as possible except membrane attached to dura near to superior sagittal sinus or pial vessels. The draining catheter was inserted in hematoma cavity under direct vision before dural suturing and bone flap placement (Figure 1)

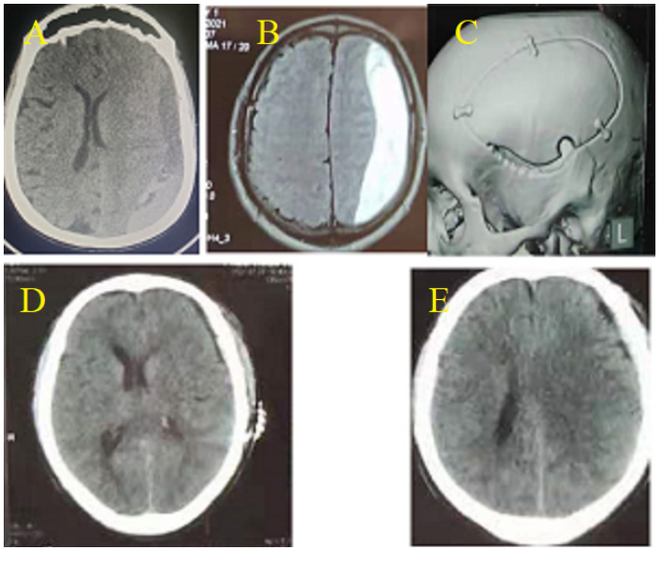

Figure 1. Computed tomography scan (A) and magnetic resonance imaging (B) showed left large CSDH with heterogeneous signal on T-2 weighted image, Large craniotomy with placement of bone flap with plate and screws(C), Postoperative CT head showing complete evacuation of hematoma and membranes, Follow up CT head at 6month with no recurrence of CSDH (E).

Neuroendoscopic technique

Endoscopic surgery was done under general anesthesia. Skin incision of the initial surgery on the convexity of the skull was extended to approximately 5cm and burr hole was created to perform spheroid -shaped mini-craniotomy that measured approximately 2.5cm x 2.5cm. The dura was reflected and outer membrane was excised following craniotomy. After removal of outer membrane and hematoma, a 300 rigid endoscope (Karl Storz, Germany) with diameter of 4mm and length of 18cm, connected to HD monitor is used for intraoperative visualization. The hematoma evacuated using suction tube and entire circumference of the hematoma cavity was irrigated, while septations which formed multiple loculated compartments in the hematoma were excised and removed. If neo-vascularization existed in the hematoma capsule/membrane, it was coagulated. The inner membrane was incised and removed to allow for brain expansion. The draining catheter was inserted in hematoma cavity under endoscopic guidance (Figure 2).

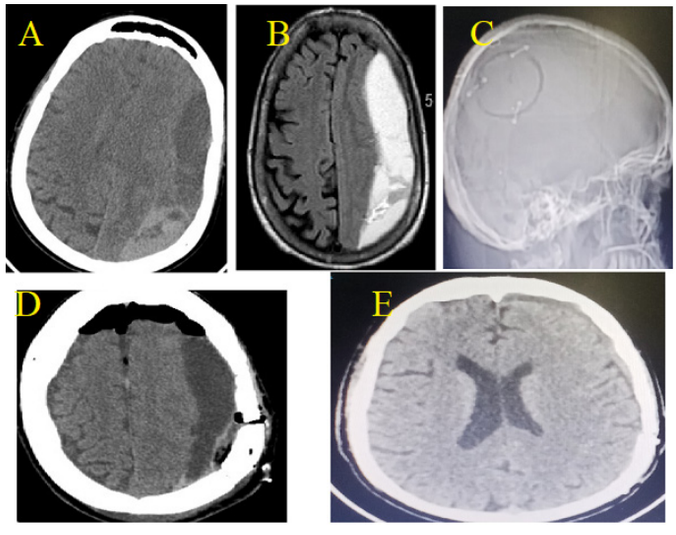

Figure 2. Computed tomography scan (A) and magnetic resonance imaging (B) showed left large CSDH with heterogeneous signal on T-2 weighted image, Small craniotomy over high convexity of parietal bone with placement of bone flap with plate and screws(C), Postoperative CT head showing evacuation of hematoma and membranes and pneumocephalus, Follow up CT head at 6month with no recurrence of CSDH (E).

Data analysis

The quantitative data were presented as mean ± SD and enumeration data were recorded as number. The descriptive analysis was used on demographic data. The student t test was used for continuous variables or Chi-square test and Fisher's exact test were used to categorical variables. Data were analyzed by SPSS software (version 18.0, USA). Statistical significance was assumed if $P<0.05$.

Results

In this two-center comparative retrospective study, we included 225 patients, including 100 patients undergoing large craniotomy and 125 patients who had endoscopic mini craniotomy treatment. Table 1

demonstrates the baseline characteristics in both craniotomy and endoscopic groups. In both groups, statistically significant difference was found with age, sex and etiology with both procedures. But, no statistically significant difference was reported with concomitant diseases, symptoms at presentation, hematoma status and neurological status (MGS) in both groups. In craniotomy groups, there was no statistically significant difference age, sex and etiology with outcomes. But, there was statistically significant difference in neurological grading scale at presentation with outcomes, where higher rate of unfavorable was noted in patient who had MGS ≥2 compared to who had MGS ≥1 at admission(p=0.0365). There was significantly higher association of organized hematoma compared liquefied hematoma with unfavorable outcome (p=0.0050) (Table 2). Similarly, there was no statistically significant difference in age, sex and etiology with outcomes in endoscopic group (p=0.0250). But there was statistically significant difference in neurological grading scale at presentation and hematoma status with outcomes (p=0.0174)) (Table 3).

Furthermore, there was no statistically significant difference of complications with these two procedures (Table 4). In large craniotomy group, three patients had recollection subdural bleeding (3%). Among three, one patient had subdural bleeding within 2days of surgery. He was under aspirin for CAD. Re-surgery was performed and he was discharged well. One patient had recollection of CSDH after 2 month and re-surgery was done. Both patients had symptoms with severe headache. Third patient had thin collection of subdural after 5 months, but he was symptomless and conservatively managed. In endoscopic group, five patients had re-collection of subdural (4%), but they were all associated with cardio-cerebrovascular diseases under antithrombotic drugs. Among five, three patients were performed re-surgery after 1 month, 3 month, and 5 month after first procedure. Two patients had thin re–collections and were managed conservatively. There was no infection or wound related complications were noted in both groups. Mortality was 2% and 3.4% in craniotomy and endoscopic group respectively.

Table. 1 Basic clinical characteristics and CT/MRI finding in patients with septated CSDH

Characteristics	Large Craniotomy	Endoscopic surgery	P- value
Age, (mean ±SD) (R) years	57.6±9(40-78)	66.21±12.13(41-89)	
<50 year	20(20%)	13(10.4%)	0.0431
>50year	80(80%)	112(89.6%)	
Sex			0.0185
Male	75(75%)	109(87.2%)	
Female	25(25%)	16(12.8%)	
Etiology			0.0291
Head injury	64(64%)	70(56%)	
Anti-thrombotic drugs	4(4%)	15(12%)	
Unknown	32(32%)	40(32%)	
Concomitant diseases			0.6007
Cardio-cerebrovascular system diseases	15(15%)	42(33.6%)	
Diabetes mellitus	23(23%)	30(24%)	
Respiratory system diseases	18(18%)	25(20%)	
No diseases	47(47%)	28(22.4%)	
Clinical symptoms at admission			0.1913
Headache	100(100%)	125(100%)	
Nausea	64(64%)	85(68%)	
Vomiting	55(55%)	62(49.6%)	
Dizziness	60(66%)	71(56.8%)	
Limb weakness	72(72%)	110(88%)	
Seizure	46(46%)	55(44%)	
Aphasia	70(70%)	80(64%)	
MGS at admission			0.8179
0	0	0	
1	16(16%)	24(19.2%)	
2	72(72%)	88(70.4%)	
3	10(10%)	8(6.4%)	
4	2(2%)	5(4%)	

CT/MRI findings			
Side: Left CSDH	74(74%)	95(76%)	0.7303
Right CSDH	26(26%)	30(24%)	
Location: Unilateral	88 (88%)	94(75.2%)	0.2040
Bilateral	12(12%)	21(16.8%)	
Status of hematoma: Organized/solid	63(63%)	88(70.4%)	0.2404
Liquefied	37(37%)	37(29.6%)	
Mean Hospital stay, day	12.16±5.09(8-30)	5.6±1.97(3-13)	<0.0001
Mean follow up, month	9.35±9.55(1-36)	10.36±7.06(1-40)	0.3591

SD-standard deviation, R-range, MGS- markwalder's grading score

Table. 2 Outcomes of patients with septated CSDH who underwent large craniotomy

Characteristics	Favorable outcome **MGS(0,1)**	Unfavorable outcome MGS(2,3,4)	P- value
Age, years			
<50 year	18(90%)	2(10%)	0.5150
>50year	64(80%)	16(20%)	
Sex			
Male	55(73.34%)	20(26.66%)	0.5050
Female	20(20%)	5(5%)	
Etiology			0.2419
Head injury	53(82.82%)	11(17.18%)	
Anti-thrombotic drugs	2(50%)	2(50%)	
Unknown	25(78.13%)	7(21.87%)	
Neurological Grading, MGS at admission			
≤1	16(100%)	0	0.0365
≥2	64(76.19%)	20(23.81%)	
CT/MRI findings			
Organized/solid hematoma	39(61.90%)	24(38.10%)	0.0050
Liquefied hematoma	33(89.18%)	4(10.82%)	

Table 3.Outcomes of patients with septated CSDH who underwent endoscopic surgery

Characteristics	Favorable outcome MGS(0,1)	Unfavorable outcome MGS(2,3,4)	P- value
Age, years			0.2989
<50 year	12(92.30%)	1(7.70%)	
>50year	87(77.67%)	25(21.33%)	
Sex			0.1899
Male	90(82.56%)	19(17.44%)	
Female	11(68.75%)	5(31.25%)	
Etiology			0.2627
Head injury	50(71.43%)	20(28.57%)	
Anti-thrombotic drugs	6(40%)	9(60%)	
Unknown	28(70%)	12(30%)	
Neurological Grading, MGS at admission			
≤1	23(95.84%)	1(4.16%)	0.0250
≥2	75(74.26%)	26(25.74%)	
CT/MRI findings			0.0174
Organized/solid hematoma	63(71.59%)	25(28.41%)	
Liquefied hematoma	34(91.89%)	3(8.11%)	

Table 4: Complications following procedure of patients with septated CSDH

Complications	Large craniotomy	Endoscopic surgery	P- value
Local Infection	0	0	0.0000
Recurrence	3(3%)	5(4%)	0.9999
Hygroma	10(10%)	15(12%)	0.6711
Re-operation	2(2%)	3(2.4%)	0.9999
Seizure	28(28%)	34(27.2%)	0.9199
mortality	2(2%)	4(3.2%)	0.6964

Discussion

Chronic subdural hematoma was first reported by Rudolf Virchow in 1857 and is frequently detected neurosurgical diseases in the elderly population characterized by abnormal collection of blood products in the subdural space. The incidence of CSDH is 13.5/100,000 /year and is five times more in people older than 65 years18. Similarly, in our study, patients older than 50 years (≥80%) were significantly higher rate compared to patients younger than 50 years in both groups. This is because uses of an increase of antithrombotic medications, venous fragility, brain atrophies causing increased subdural space, and an increased exposure to trauma resulting from frequent fall injury 3, 38 .64% of patients in craniotomy group were significantly associated with head injury and 56% of patients in endoscopic group were statistically associated with head injury for development of multi-septated CSDH. Similarly, 4% of patients in craniotomy group and 12% of patients in endoscopic group under antithrombotic medications were another significant causative agent for these CSDH in our study. Huang jinhao et al described that head injury was still main causes of CSDH, and less than 50% patients had no determined etiological cause 15 , which is similar to result our study. The repeated hemorrhage from fragile sinusoidal vessels of outer membrane is considered to causative agent for progressive enlargement of hematoma; occurring after minor head injury 11 and later develop multiple septation leading to the formation of encapsulated area of a solid consistency [2,25,34].

Our study showed that dominant patients with SCSDH were male, which is similar to result of other literatures[15,38,39] ,where there was statistically significant difference between sex and procedures with ratio of male to female was 3:1 in craniotomy groups and 6.8:1 in endoscopic group(p=0.0185). The frequently experienced symptoms by patients were headache followed by motor weakness, dizziness, aphasia and seizure in both groups, which is consistent with reports described by some literature[8,15,19,26,31] .The concomitant diseases of SCSDH were also considered the most often gerentological diseases like the cardio-cerebrovascular followed by diabetes mellitus

(DM) and respiratory system diseases in endoscopic group, and DM, respiratory diseases and cardio-cerebrovascular diseases in craniotomy groups. These reports were found consistent with report of other literature[15]. However, patient with no any concomitant diseases were higher rate in craniotomy group as compared endoscopic group. This might be reason that patient with clinical morbidities are being selected for minimal invasive endoscopic surgery than craniotomy surgery for CSDH[4, 16, 27].

In our outcome analysis, even there was no significant difference, even though age more than 50 years had higher rate of unfavorable outcome (16%) compared to age less than 50 years in craniotomy group; and similarly in endoscopic group, unfavorable outcome was higher rate (25%) with age more than 50 years compared to age less than 50 years. There was no statistically difference between etiology and outcome in both group. Neurological grading score, MGS was significantly correlated with outcomes in both groups. Grading score, MGS ≥2 at admission had higher rate of unfavorable outcome of 23.81% in craniotomy studies and 25.74% in endoscopic studies as compared to MGS≤ 1. Similarly, organized/solid hematoma statistically significant difference with outcomes, where organized/solid hematoma had favorable outcome of 61.90% and liquefied hematoma had favorable outcome of 81.18% (P=0.0050) in craniotomy group. Similarly, organized/solid hematoma had 71.59% of favorable outcome and liquefied hematoma resulted favorable outcome of 91.89% (P=0.0174) in endoscopic groups. Large craniotomy introduces superior and safer procedure for solid (organized)/ liquefied to manage hematoma/intermittent hematoma as well as both outer and inner membranectomy which is important for compressive brain expansion[9,10,20]. Recently minimal invasive endoscopic surgeries for organized/solid or liquefied SCSDH has been accepted as superior to large craniotomy which has broader view to subdural space from mini-craniotomy[5, 14, 32].

No local infection was reported in both craniotomy and endoscopic group, which is consistent with report of other literature 31. Furthermore, there were no statistically significant difference between complications with both procedures, approximately equal rate of hygroma, seizure, recurrence, re-surgery and death were found in both craniotomy and endoscopic surgery. 1.8%-50% of postoperative seizure following large craniotomy and endoscopic surgery of organized /solid CSDH was described in previous literature[6,7,22,28,36]. In our study, we found that postoperative seizure in large craniotomy and endoscopic group were 28% and 27.2% respectively. Aggressive membranectomy from multi-septated CSDH, breakdown products of hemoglobin on the cortical surface and sudden drop off intracranial pressure following intracranial decompression by craniotomy may induce seizure [8, 14, 36].

The thick membrane/multi-septation in the hematoma may lead to higher rate of recurrence have been reported[10,17, 29].In our study, 3% and 4% recurrence following SCSDH surgery were noted in craniotomy and endoscopic procedures respectively. Among them, 2% in craniotomy and 2.4% in endoscopic groups were undergone for re-surgery; and remaining symptomless patients were treated with conservatively. Large craniotomy with membranectomy with tearing inner membrane may help to reduce recurrence of SCSDH37.Neurosurgeons have excised outer and inner membranectomy completely in both groups as much as possible. However, 23% recurrence has been described in large craniotomy surgery which may be due to partial membranectomy[21] .In our craniotomy group, one patient was undergone re-surgery within 24 hours which may be because of blood oozing from incised membrane who had not been coagulated well, which is consistent with a study done by Mustafa where 11.9% recurrence of hematoma was occurred within 24 hour of Craniotomy [9].

Postoperative mortality was 2% in craniotomy group and 3.2% in endoscopic group within a month after procedure. Similarly, some study described that postoperative mortality was 14.28% following large craniotomy surgery for CSDH within 28 days after surgery where causes of death were pneumonia, deep vein thrombosis (DVT), pulmonary emboli[9] .Furthermore, postoperative mortality in endoscopic surgery for SCSDH was 1.47% after 8days of surgery where causes of death was congestive heart failure[32] .In our study, causes of death was found to be congestive heart failure, pneumonia and epiletptic status leading to ischemic stroke. Hospital stay is comparatively shorter in endoscopic surgery as compared to large craniotomy group. Similarly, 5.6 days (ranging 3-13) in endoscopic surgery and[12.16] (ranging 8-30) in large craniotomy surgery was found in our study which is consistent with some literatures [9,32]. However, endoscopic surgery is minimal invasive procedure; it can damage to cortical surface because of blind angle or surgical error on unfamiliar hand, and may take longer operation time. Thus there is still controversial for selecting most effective procedures for treatment of SCSDH.

Limitations

Despite this study showed both procedures were safe and effective treatment method for SCSDH, it has some limitation such as: it is a non –randomized, retrospective study, both surgeries done by different neurosurgeons in two different hospital where surgical skills, preoperative protocol as well as postoperative management may be unlike; numbers of cases are not equal and enough, follow up period are not longer to find the exact number of recurrence rate.

Conclusion

Our study shows that both large craniotomy and endoscopic assisted mini craniotomy along with membranectomy for SCSDH is safe and effective however, shorter hospital stays in endoscopic surgery as compared to large craniotomy surgery. To evaluate the optimal benefits of these procedures, larger numbers of case series from multiple centers along with longer follow up period are required to study.

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Conflict of interest: All authors certify that they have no affiliations with or involvement in any organizations or entity with any financial interest, or non-financial interest.

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