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Evaluating the Effectiveness of Minimally Invasive Surgery Using External Ventricular Drainage Systems in Draining Chronic Subdural Hematomas

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ABSTRACT

AIM: To show the effectiveness of minimally invasive surgery with external ventricular drainage systems (EVDS) in the treatment of chronic subdural hematomas by comparing with it with classic surgery with closed drainage system (CDS) with intracranial hematoma volume measurements and predict infection risks by comparing two different surgeries with each other with intracranial air volume measurements.

MATERIAL and METHODS: From 2014 to 2020, the data of 28 patients with chronic subdural hematoma who underwent surgeries two large burr holes, saline irrigation, and CDS or one small burr hole, no saline irrigation, and EVDS were retrospectively who had preoperative computed tomography (CT) postoperative 1st-3rd day CT, and postoperative 7th-10th day CT were included in the study. Pre- and postoperative subdural liquid collection volumes and postoperative intracranial air volumes were measured using Sectra Medical Workstation. Results were compared between these two groups.

RESULTS: There were no significant differences in the preoperative and 7th–10th day liquid volumes between these two groups ($p > 0.05$). There were significant differences in the postoperative 1st–3rd day air volume between these two groups ($p < 0.001$).

CONCLUSION: The statistical results showed that surgeries with EVDS are as effective as surgeries with CDS in draining chronic subdural hematomas. We also determined that the intracranial air volume is significantly less in surgeries with EVDS. For this reason, we believe that EVDS can reduce the risk of postoperative infection.

KEYWORDS: Subdural hematoma, Chronic, Minimally invasive surgery, Infection

ABBREVIATIONS: CDS: Closed drainage system, **CSH:** Chronic subdural hematoma, **CT:** Computed tomography, **EVDS:** External ventricular drainage system, **SEPS:** Subdural evacuating port system

INTRODUCTION

Chronic subdural hematomas (CSHs) are common entity in neurosurgical practice. Some well-known traditional surgical methods are described in the literature. Besides frequently performed surgeries, some less invasive and effective surgical methods are also reported (1,6). We found that searches in the literature are mostly in the direction of less invasive surgery, reduced risk of infection, and effective evacuation of hematoma (8,14).

Drainage of CSH with two large burr holes and placement of a closed drainage system (CDS) is accepted as first-line therapy. This frequently used technique is found to be less invasive with decreased postoperative complications compared to large craniotomies (13).

In the literature, some publications presented that CSH drainage is provided effectively with a smaller incision and smaller single burr hole. It has been estimated that there will be fewer complications in the postoperative period in

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surgeries performed with these techniques. Moreover, this technique would restrict air entry into the subdural space and decrease the development of postoperative infection (4,10).

In our department, we most frequently used two large burr holes and CDS. We also used minimal invasive technique with small single burr hole and external ventricular drainage system (EVDS). To show the effectiveness of minimal invasive technique, we compared these two different techniques with each other by measuring postoperative subdural hematoma volumes. Additionally, to predict infection risks, we compared these techniques with each other by measuring postoperative subdural air volumes.

MATERIAL and METHODS

From 2014 to 2020, a total of 132 patients with CSH treated with burr hole craniostomy surgeries were retrospectively investigated. Patients with multiple membranes were operated by craniotomy and are out of the scope of this study. At the end, this retrospective study included data from 14 patients who had undergone CSH surgery with two large burr holes and CDS (group 1) and 14 patients who had undergone the same surgery with single small burr hole and EVDS (group 2). Patients who underwent preoperative computed tomography (CT), postoperative 1st–3rd day CT, and postoperative 7th–10th day CT were included in the study. Patients who could not meet this requirement and had image quality impairments that prevented measurement in their tomography were excluded from the study. General anesthesia was induced with endotracheal intubation for all patients in groups 1 and 2. All patients received ceftriaxone according to their weight, starting before incision and continuing for 3 days.

The surgical method in group 1 included two large burr holes (2 cm diameter), saline irrigation (until the collection liquid became clear), and CSD placement. CSD consisted of a flat silicone catheter and silicone drainage bag. The drainage bag had a mechanism that prevented the backflow of liquid and air. Postoperatively, negative pressure was not applied to the drainage bag, and only positive air pressure in the bag was released once every 4 hours. The surgical method in group 2 included one small burr hole (1 cm diameter), no saline irrigation, and placement of EVDS. EVDS consisted of a ventricular catheter and EVD bag. The EVD bag was placed 30 cm off the floor, using a fluid column gravity siphon for continuous negative pressure. Almost all inserted drains were removed within three days postoperatively. Rarely, this period was extended up to the 5th day depending on the amount of fluid draining into the bag.

Volume measurements were obtained with Sectra Medical Workstation, which detects the selected area density and allows automatic volume measurement in the entire intracranial region with the same density.

In this study, to determine the efficacy of surgeries, regardless of the clinical status of the patients, subdural collection volumes in the preoperative period were compared with volumes in the postoperative period. For this purpose, data obtained from preoperative and postoperative CT (7th–10th day) were used (Figure 1). Results were statistically compared between these two groups.

Moreover, air volume measurement was performed from the postoperative CT image of the patients to evaluate infection risks. For this purpose, data obtained from postoperative CT (1st–3rd day) were used (Figure 2). Results were again statistically compared between these two groups.

In the statistical analysis, data were expressed as mean ± standard deviation. Two way-repeated measures analysis of variance was used for time comparison according to groups and group's effect. Analysis was conducted using commercial software (IBM SPSS Statistics 20, SPSS Inc., an IBM Co., Somers, NY). A p value < 0.05 was considered statistically significant.

This study was approved by the Clinical Research Ethics Committee of Tokat Gaziosmanpasa University (Date: 16.03.2022; No: 23-KAEK-077).

RESULTS

For this study, 128 patients who had undergone surgery for CSH were retrospectively analyzed. Patients who did not meet the imaging criteria for the measurements were excluded from the study. A total of 28 patients who met the imaging criteria were included in the study: 14 patients in group 1 and 14 patients in group 2. Of the 14 patients in group 1, 10 (71.4%) were male and 4 (28.5%) were female, and the mean age was 70.1 years. Of the 14 patients in group 2, 11 (78.5%) were male and 3 (21.4%) were female, and the mean age was 74.5 years.

No infection was detected in the postoperative period in any of the patients included in the study. The medical records revealed that infection developed in the postoperative period in two patients in group 1, and they were excluded from the study. No infection was detected in the postoperative period in any of the patients in group 2.

Drain occlusion did not develop in any of the patients included in the study. However, early postoperative occlusion developed in the drain of one patient in group 2. Thereupon, the distal catheter was washed with heparinized fluid, and when the drain did not work, the patient underwent surgery again, and the subdural hematoma was drained by craniotomy.

In all included patients, subdural hematoma volume was measured preoperatively and postoperatively (7th–10th day). In all evaluated patients, the mean ± standard deviation of preoperative subdural hematoma volume was 78.46 ± 38.49 cm^3. Additionally, the mean ± standard deviation of postoperative subdural hematoma volume was 14.52 ± 12.96 cm^3. In the comparison of preoperative subdural hematoma volumes with the postoperative subdural hematoma volumes, we found a statistically significant difference ($p<0.001$). In all patients included in this study, postoperative subdural hematoma volumes were significantly lower than preoperative subdural hematoma volumes (Table I).

Table I: Distribution of Repeated Measurements by Group

Measurements	Total	Group		p_1
		Group 1	Group 2	
Preoperative Subdural Hematoma Volume (cm^3)	78.46 ± 38.49 (a)	76.64 ± 28.34 (a)	80.29 ± 47.61 (a)	0.807
Postoperative 1-3th Days Subdural Air Volume (cm^3)	13.27 ± 14.08 (b)	25.65 ± 8.96 (b)	0.89 ± 1.15 (b)	**<0.001**
Postoperative 7-10th Subdural Collection Volume (cm^3)	14.52 ± 12.96 (b)	12.41 ± 10.19 (c)	16.62 ± 15.35 (c)	0.401
p_2	< 0.001	< 0.001	< 0.001	

Data are shown as mean±standard deviation. ***p_1**: Between-Subjects,* ***p_2**: Within-subjects (ab): In same colomn, common letters indicate statistical insignificance. Repeated measures ANOVA was used.*

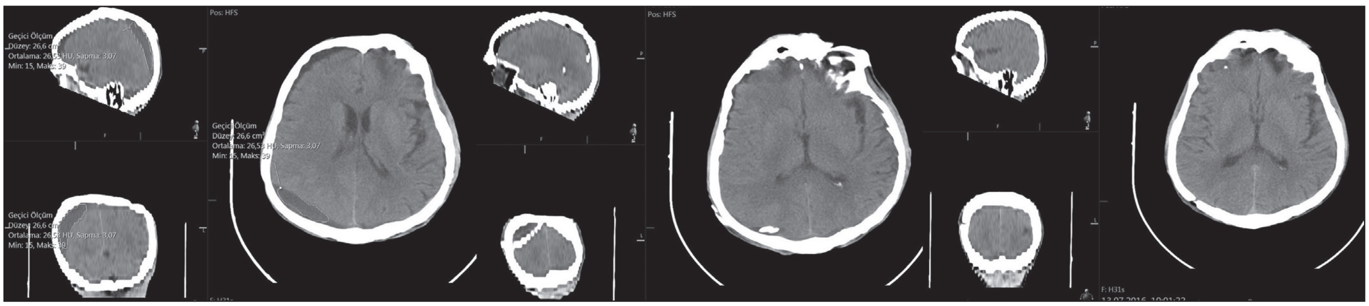

Figure 1: Measurements of preoperative and postoperative intracranial subdural collection volumes with automatic volume measurement of software program of the imaging workstation system.

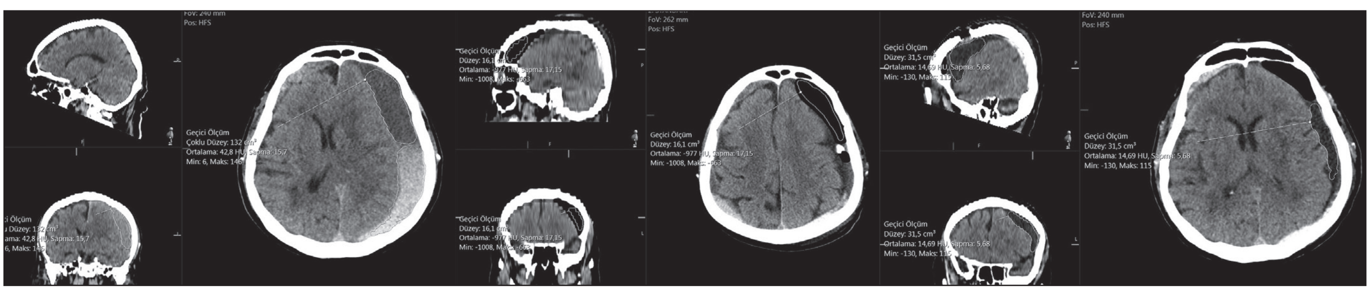

Figure 2: Measurements of postoperative intracranial subdural air volumes with automatic volume measurement of software program of the imaging workstation system.

Subdural hematoma volume was preoperatively and postoperatively (7th–10th day) in groups 1 and 2. In groups 1 and 2, the means ± standard deviations of preoperative subdural hematoma volumes were 76.64 ± 28.34 cm^3 and 80.29 ± 47.61 cm^3, respectively. Additionally, the means ± standard deviations of postoperative subdural hematoma volumes were 12.41 ± 10.19 cm^3 and 16.62 ± 15.35 cm^3, respectively. In the comparison of preoperative and postoperative subdural hematoma volumes in groups 1 and 2, we found a statistically significant difference (p<0.001). In groups 1 and 2, postoperative subdural hematoma volumes were found to be significantly lower than preoperative subdural hematoma volumes (Table I).

We compared the preoperative and postoperative subdural hematoma volumes in groups 1 and group 2. There were no significant differences between groups 1 and 2 (p=0.807, p=0.401) (Table I) (Figure 3).

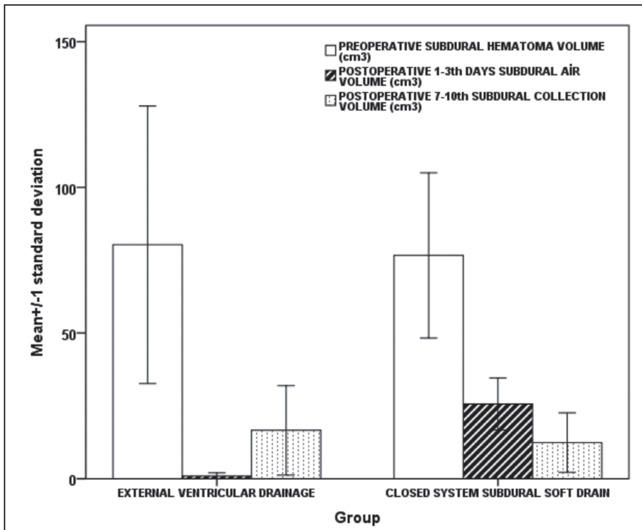

Figure 3. Bar graph of measurments by groups

Figure 3: Bar graph of measurements by groups.

We measured the postoperative (1st–3rd day) intracranial air volume of all patients included in this study. In all evaluated patients, the mean ± standard deviation of postoperative intracranial air volume was 13.27 ± 14.08 cm^3. We measured the postoperative (1st–3rd day) intracranial air volume of all patients in groups 1 and 2. In all patients in groups 1 and 2, the means ± standard deviations of preoperative subdural hematoma volumes were 25.65 ± 8.96 cm^3 and 0.89 ± 1.15 cm^3, respectively. In the comparison of postoperative intracranial air volumes in group 1 and postoperative intracranial air volumes in group 2, we found a statistically significant difference ($p<0.001$). Postoperative intracranial air volumes in group 2 were significantly lower than those in group 1 (Table I) (Figure 3).

DISCUSSION

CSH is one of the most common diseases in neurosurgical practice (1). Although different types of surgery have been described in the literature, there is no consensus on the method of surgical treatment (6,8,14). In previous years, classic surgical treatment often involved drainage with wide craniotomy. Subsequently, it was found that the subdural fluids were also successfully drained by small craniostomies called burr holes. Drainage with burr holes became a classic method for CSH treatment. In the literature, burr hole craniostomy was compared to craniotomy and found to be more effective (4,10,13).

The studies on less invasive approaches continued recently. Different minimally invasive methods are reported in the literature. It was concluded that less invasive approaches were at least as effective as classic methods (4,10). When minimally invasive procedures are examined in the literature, the general purpose is observed as fewer incisions, smaller burr holes, more effective drainage, and fewer complications. For this purpose, a single small incision and burr hole instead of two large incisions and burr holes are frequently used in minimally invasive methods (4,10).

Various types of drain that was used in subdural collection drainage was also reported in the literature. The subdural evacuating port system (Medtronic, Inc., Minneapolis, USA), EVDS, and CDS are some of the types of the drains that were used in minimally invasive procedures (3,7).

Our study evaluated two groups: groups 1 and 2. Group 1 underwent the surgical method that is considered a classic method, which consisted of two large burr holes (2 cm diameter), saline irrigation (until the collection liquid became clear), and placement of CSD. Group 2 underwent the surgical method that is considered as a minimally invasive method, which consisted of one small burr hole (1 cm diameter), no saline irrigation, and placement of EVDS.

When the literature is examined, hematoma thickness, shift measurement, and neurological level of patients are frequently used in determining the effectiveness of surgeries and comparing them with other surgeries (2,9,11). In this study, we used the measurement of intracranial total volume of the hematoma as a criterion for determining and comparing the effectiveness of surgery. In this sense, there is no similar study in the literature using intracranial volume measurement. We believe that intracranial volume measurement of hematoma is superior to other criteria used in the literature. We think that hematoma thickness does not show the amount of hematoma and shift effect, and neurological status depends on the duration of the cerebral edema effect. In our study, we found a statistically significant difference between preoperative and postoperative hematoma volumes in both groups 1 and 2 ($p<0.001$ and $p<0.001$, respectively). This result supports that the surgical methods applied in both groups are effective. In the comparison of preoperative and postoperative hematoma volumes between the groups, we could not detect a statistically significant difference between groups 1 and 2 ($p=0.807$ and $p=0.401$, respectively). This result supports that the surgeries performed in both groups are not superior to each other in providing hematoma drainage. Our study showed that minimally invasive surgeries are as effective as classical surgeries. Our result is compatible with the literature. Although there are some studies in the literature showing that minimally invasive subdural hematoma drainage using EVDS is an effective method, no study showed this result with comparative intracranial hematoma volume.

The significant advantages of minimal invasive surgery include less normal tissue damage, less postoperative pain, fewer operative and postoperative major complications, shortened hospital stay, faster recovery times, less scarring, less stress on the immune system, smaller incision, reduced operative time, and reduced infection risk (12). It is already known that large incisions, long surgery time, and long hospitalization increase the infection risk. It is also a well-known antithesis that the presence of intracranial air carries risks, such as meningitis, cerebral abscess, seizure, and herniation (5,15).

There is an opinion in recent studies that less intracranial air is formed after minimally invasive surgeries compared to classical CSH surgeries and that this may reduce the risk of infection (5,12,15), but no study proved this thesis. To prove the accuracy of this thesis, we measured the postoperative intracranial air volumes of patients in groups 1 and 2 and compared them between the groups. As a result of our statistical analysis, we determined that there was a significant difference in postoperative air volumes between the groups. The postoperative air volumes of patients in group 1 were significantly higher than the postoperative air volumes of patients in group 2 ($p<0.001$). This result may support the thesis that the surgical method that we used in group 2 can reduce the risk of infection by also reducing postoperative intracranial air formation.

We believe that the minimally invasive surgical method is at least as effective as the classical method. EVDS also appears to provide effective drainage using a fluid column gravity siphon for continuous negative pressure. We detected a patient in group 2 who was excluded in this study developed an early catheter occlusion. This condition increases the suspicion that the patient with a high hematoma density may be more easily occluded due to the small diameter of the catheter of EVDS. We also detected two patients in group 1 who were excluded from this study developed early cerebral infection. No infection was detected in any patient in groups 2 . In this case, together with the other advantages of minimally invasive surgery, it supports the possibility that the low amount of postoperative intracranial air may reduce the risk of infection.

AUTHORSHIP CONTRIBUTION

Study conception and design: EO, OD

Data collection: EO, OD

Analysis and interpretation of results: EO, OD

Draft manuscript preparation: EO, OD

Critical revision of the article: EO, OD

Other (study supervision, fundings, materials, etc...): EO, OD

All authors (EO, OD) reviewed the results and approved the final version of the manuscript.

REFERENCES

1. Almenawer SA, Farrokhyar F, Hong C, Alhazzani W, Manoranjan B, Yarascavitch B, Arjmand P, Baronia B, Reddy K, Murty N, Singh S: Chronic subdural hematoma management: A systematic review and meta-analysis of 34,829 patients. Ann Surg 259:449-457, 2014
2. Berhouma M, Jacquesson T, Jouanneau E: The minimally invasive endoscopic management of septated chronic subdural hematomas: Surgical technique. Acta Neurochir (Wien) 156:2359-2362, 2014
3. Certo F, Maione M, Altieri R, Garozzo M, Toccaceli G, Peschillo S, Barbagallo GMV: Pros and cons of a minimally invasive percutaneous subdural drainage system for evacuation of chronic subdural hematoma under local anesthesia. Clin Neurol Neurosurg 187:105559, 2019
4. Dorosh J, Keep MF: Minimally invasive subacute to chronic subdural hematoma evacuation with angled matchstick drill and repurposed antibiotic ventriculostomy catheter augmented with alteplase: A technical case report. Cureus 11: 1-10, 2019
5. Eftekhar B, Ghodsi M, Nejat F, Ketabchi E, Esmaeeli B: Prophylactic administration of ceftriaxone for the prevention of meningitis after traumatic pneumocephalus: Results of a clinical trial. J Neurosurg 101:757-761, 2004
6. Erol FS, Topsakal C, Faik Ozveren M, Kaplan M, Tiftikci MT: Irrigation vs. closed drainage in the treatment of chronic subdural hematoma. J Clin Neurosci 12:261-263, 2005
7. Flint AC, Chan SL, Rao VA, Efron AD, Kalani MA, Sheridan WF: Treatment of chronic subdural hematomas with subdural evacuating port system placement in the intensive care unit: evolution of practice and comparison with bur hole evacuation in the operating room. J Neurosurg 127(6):1443-1448, 2017
8. Gokmen M, Sucu HK, Ergin A, Gokmen A, Bezircioglu H: Randomized comparative study of burr-hole craniostomy versus twist drill craniostomy; surgical management of unilateral hemispheric chronic subdural hematomas. Zentralbl Neurochir 69: 129-133, 2008
9. Kaliaperumal C, Khalil A, Fenton E, Okafo U, Kaar G, O'Sullivan M, Marks C: A prospective randomised study to compare the utility and outcomes of subdural and subperiosteal drains for the treatment of chronic subdural haematoma. Acta Neurochir (Wien) 154:2083-2089, 2012
10. Kuroki T, Katsume M, Harada N, Yamazaki T, Aoki K, Takasu N: Strict closed-system drainage for treating chronic subdural haematoma. Acta Neurochir (Wien) 143:1041-1044, 2001
11. Liu W, Bakker NA, Groen RJM: Chronic subdural hematoma: A systematic review and meta-analysis of surgical procedures. J Neurosurg 121:665-673, 2014
12. Mohiuddin K, Swanson SJ: Maximizing the benefit of minimally invasive surgery. J Surg Oncol 108:315-319, 2013
13. Mori K, Maeda M: Surgical treatment of chronic subdural hematoma in 500 consecutive cases: Clinical characteristics, surgical outcome, complications, and recurrence rate. Neurol Med Chir (Tokyo) 41:371-381, 2001
14. Muzii VF, Bistazzoni S, Zalaffi A, Carangelo B, Mariottini A, Palma L: Chronic subdural hematoma: Comparison of two surgical techniques. Preliminary results of a prospective randomized study. J Neurosurg Sci 49:41-47, 2005
15. Schirmer CM, Heilman CB, Bhardwaj A: Pneumocephalus: Case illustrations and review. Neurocrit Care 13:152-158, 2010