DOI: 10.4149/BLL_2021_140

Bratisl Med J 2021; 122 (12)

866 – 870

CLINICAL STUDY

Bilateral evacuation of bilateral non-acute subdural hematomas – evaluation of postoperative outcomes and complications

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ABSTRACT

INTRODUCTION: Bilateral finding of non-acute subdural hematomas (NASH) is less common compared to unilateral occurrence. The aim of this study was to evaluate results of surgical treatment of bilaterally treated bilateral NASH.

METHODS: Retrospective analysis of patients, who underwent bilateral surgical evacuation of NASH (2014–2020). This study was conducted to determine the association between the incidence of postoperative complications and outcome, hematoma recurrence and selected risk factors (including volumetric parameters). Correlations between variables were assessed by using Spearman´s correlation. Chi-squared test, Student´s t-test (unpaired and paired) and one-way ANOVA were used for univariate analysis.

RESULTS: Our study included 29 patients with bilateral NASH who underwent bilateral surgical hematoma evacuation. The laminar hematoma type was associated with higher hematoma recurrence rate ($p = 0.032$) and worse clinical outcome ($p = 0.043$). Larger PHV was significantly associated with larger PV after surgery and worse neurological outcome. Larger PHV, PHCV and PV were significantly associated with higher incidence of NASH recurrence ($p = 0.0008$, $p = 0.0007$ and $p = 0.00006$).

CONCLUSION: The laminar hematoma type and larger PHV were significant risk factors for the recurrence of bilateral NASH and worse neurological outcome. Larger PHCV and PV were significantly associated with hematoma recurrence *(Tab. 7, Fig. 3, Ref. 24)*. Text in PDF *www.elis.sk*

KEY WORDS: chronic subdural hematoma, recurrence, outcome, surgical treatment, bilateral.

Abbreviations: NASH – non-acute subdural hematoma, PHV – preoperative hematoma volume, PHCV – post-evacuation hematoma cavity volume, PV – pneumocephalus volume, EHE – extent of hematoma evacuation

Introduction

Non-acute subdural hematomas (NASH) are one of the most common diseases in the practice of a neurosurgeon. This disease is commonly referred to as chronic subdural hematoma, which is not appropriate. This term expresses only a certain stage of NASH development with respect to the hematoma age. Bilateral NASH occur less frequently than unilateral lesions, but they are often associated with worse neurological outcomes and mental status (1, 2). Patients with bilateral NASH have a lower rate of head injury history compared to patients with unilateral hematomas (3). Patients after unilateral evacuation of bilateral NASH have a higher reoperation rate compared to bilateral evacuation of bilateral hematomas (4). Bilateral lesions are associated with lower incidence of hemiparesis, but with higher occurrence of consciousness disorders (1, 2, 5). The aim of this study is to evaluate the results of surgical treatment of bilaterally evacuated bilateral NASH.

Methods

The aim of our study was a retrospective evaluation of patients with bilateral NASH who underwent surgical treatment – evacuation of NASH on both sides at the Clinic of Neurosurgery (University Hospital Martin) from January 2014 to December 2020. Patients with bilateral NASH who underwent one-side evacuation of hematoma were excluded from this study. NASH were surgically treated by evacuation via burr holes or through craniotomy with membranectomy. In all cases, irrigation of the subdural space was performed, and drainage was applied – subdural drainage after trepanation and subgaleal drainage after craniotomy. We evaluated the morphological type of NASH on preoperative CT scans (Fig. 1). We also divided hematomas according to their age. The incidence of recurrence, clinical outcome and complications were monitored after surgery.

Volumetric parameters were measured on preoperative and early postoperative CT examination as follows: preoperative he-

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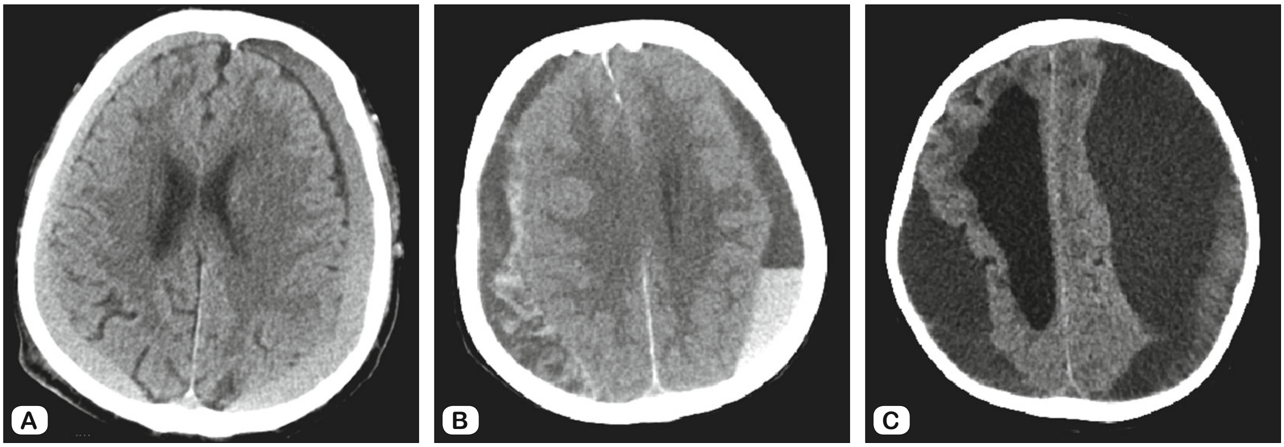

Fig. 1. Morphological types of NASH [19]. A – bilateral homogeneous isodense, B – trabecular (right) and separated (left), C – homogeneous hypodense (right) and laminar (left).

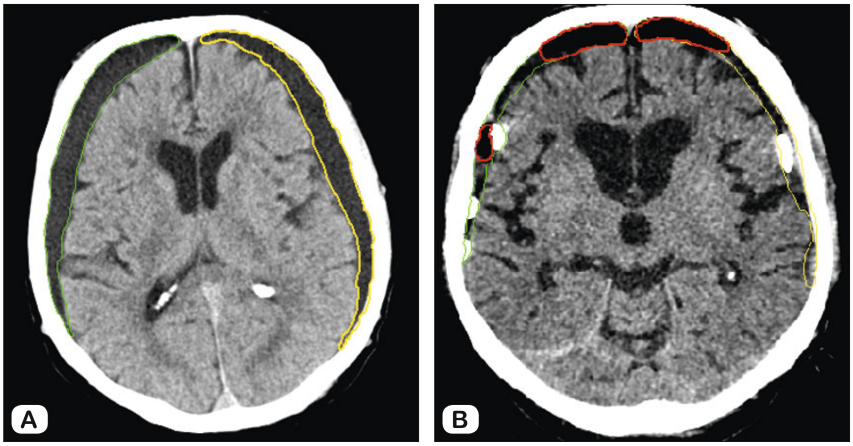

Fig. 2. Method of measuring volumetric parameters (A– before evacuation, B– after evacuation, green – PHV and PHCV on right side, yellow – PHV and PHCV on left side, red – PV after surgery).

matoma volume (PHV), post-evacuation hematoma cavity volume (PHCV) and pneumocephalus volume (PV) (Fig. 2). PHCV was defined as a space containing residual NASH, fluid air irrigation and acute blood admixture. Measurements were performed using TomoCon Viewer, version 24.0.4507 (TatraMed Software s.r.o.). Another evaluated parameter was the extent of hematoma evacuation (EHE). This was calculated as a percentage difference between PHV and PHCV. EHE also expresses the extent of brain hemisphere re-expansion.

Subsequently, the influence of factors such as patient age, gender, hematoma side, hematoma age, morphological types of NASH, surgical technique (burr holes vs. craniotomy), number of burr holes (1 vs 2 burr holes), timing of surgery (emergent vs delayed), hematoma homogeneity (homogeneous vs. heterogeneous) and the use of antiplatelet agents were evaluated relative to the incidence of NASH recurrence and GOS. Similarly, the influence of volumetric parameters (PHV, PHCV, PV and EHE) on the incidence of recurrence of NASH and their correlation with GOS were evaluated. The correlation between PHCV and PV was also assessed. Differences of all volumetric parameters according to internal architecture of NASH and hematoma laterality were evaluated. Side prevalence with respect to morphological type of NASH and hematoma age was also assessed.

Correlations between variables were assessed by using Spearman´s correlation. The strength of correlation was interpreted with respect to R (rho) value as follows: R = 0.00–0.19 (very weak), R = 0.20–0.39 (weak), R = 0.40–0.59 (moderate), R = 0.60–0.79 (strong) or R = 0.80–1.00 (very strong). Chi-squared test and Student´s t-test (unpaired and paired) and one-way ANOVA were used for the univariate analysis.

Results

Our study cohort consisted of 29 patients with bilateral NASH (Tab. 1). Clinical outcome (GOS) after surgery is shown in Table 3. The incidence of the subdural hematoma recurrence requiring reoperation was 8.2 % (17.2 % of patients). The recurrence of subdural hematoma was the most common postoperative complication. Postoperative complications included surgically significant acute extracerebral hematomas (epidural and subdural), epidural abscess, subdural empyema, secondary epilepsy and hy-

Tab. 1. Basic cohort parameters.

Number of patients: 29		Number of NASH: 58	
Male:	21/72.4 %	Female:	8/27.6 %
Emergency surgery:	16/27.6 %	Delayed surgery:	42/72.4 %
Antiplatelet drugs:	9/31.0 %	Anticoagulants:	0/0 %
Burr holes:	50/86.2 %	Craniotomy:	8/13.6 %
1 burr hole:	43/86.0 %	2 burr holes:	7/14.0 %

Tab. 2. Incidence of postoperative complications.

Complications after surgery	Incidence
Recurrence of NASH	5/8.6 % of NASH, 17.2 % of patients
Death	3/10.3 % of patients
Acute extracerebral hematoma	3/10.3 % of patients
Epidural abscess/subdural empyema	2/6.9 % of patients
Epilepsy	1/1.7 % of patients
Hydrocephalus	2/6.9 % of patients

Tab. 3. Glasgow outcome scale in the cohort group.

GOS 5	6/20.7 %
GOS 4	16/55.2 %
GOS 3	4/13.8 %
GOS 2	0/0.0 %
GOS 1	3/10.3 %

drocephalus (Tab. 2). Hydrocephalus was treated in two patients by implantation of a ventriculo-peritoneal shunt (Tab. 2). Acute extracerebral hematoma, epidural abscess and subdural empyema were evacuated through craniotomy. Due to hematoma age, the most common type of NASH was chronic (58.6 %). Hematoma age had no significant impact on the recurrence rate of NASH and GOS. Subacute, subchronic and chronic NASH did not have a side prevalence (Tab. 4). The homogeneous hypodense type of NASH was found to be the most common morphology (39.7 %). The homogeneous hyperdense type of NASH did not appear in our study cohort. The laminar type of hematoma had a significantly higher incidence of recurrence compared to other morphological types of NASH ($p = 0.032$, $Chi^2 = 4.5892$). Patients with the laminar type of NASH had a significantly worse clinical outcome compared to patients with other morphological types (Tab. 5). No side prevalence of individual morphological types of NASH was confirmed. Factors such as surgical technique, timing of surgery, the use of antiplatelet drugs, hematoma homogeneity, gender and patient age had no significant impact on hematoma recurrence and GOS (Tab. 6). Also, the hematoma side (left vs. right) did not have a significant influence on the recurrence of NASH. Patient age correlated weakly negative with GOS, but the result was not statistically significant ($R = –0.33096$, $p = 0.07949$).

No significant differences in volumetric parameters with respect to laterality and morphological type of NASH were found in the cohort group (Tab. 7). PHV correlated weakly positive with PV after surgery, but the result was statistically significant ($R = 0.32518$, $p = 0.01275$). PHV, PHCV and PV had a significant impact on the recurrence rate of NASH, but EHE did not. Larger PHV ($p = 0.0008$), PHCV ($p = 0.0007$) and PV ($p = 0.00006$) were associated with a higher recurrence rate of NASH (Tab. 7, Fig. 3). PHV significantly (weakly negative) correlated with GOS ($R = –0.29758$ $p = 0.023$). Correlations of PHCV, EHE and PV with GOS were very weak and not significant.

Discussion

The overall incidence of bilateral NASH is reported to be in range from 10.9 % to 25.5 % (1, 3, 5, 6). Patients after unilateral evacuation of bilateral NASH were not included in our cohort. Thus, the hematomas on both sides had to be surgically significant. Andersen-Ranberg et al found out that bilateral surgical intervention in bilateral NASH is associated with a significantly lower risk of retreatment compared with unilateral intervention and should be the method of choice (7). Contralateral hematoma volume after unilateral evacuation of bilateral NASH is an independent risk factor for its progression, especially if its volume increases one day after surgery. Thus, an increase in hematoma volume on a non-operated side is a risk factor for additional surgery. The critical value of the volume of the contralateral hematoma is 38 ml and more (8, 9).

Subdural hematoma recurrence was the most common complication after surgery in our group of patients. In this study, the laminar morphological type of hematoma and larger PHV, PHCV and PV were associated with higher hematoma recurrence rate. The laminar type of NASH and PHV had a significant impact on the clinical outcome. Shen et al developed a prognostic grafting system for recurrence of bilateral NASH af-

Tab. 4. Distribution NASH according to hematoma age.

NASH	Incidence	Side prevalence	Impact on GOS	Impact on recurrence
Subacute	14/24.2 %	4 vs 10 p=0.149 Chi²=2.0859	4 vs 3.7 p=0.356 95 % CI (3.3065, 4.0572)	1 vs 4 p=0.835 Chi²=0.043448
Subchronic	10/17.2 %	6 vs 4 p=0.559 Chi²=0.34147	4.1 vs 3.7 p=0.290 95 % CI (–0.36165, 1.1866)	1 vs 4 p=0.876 Chi²=0.024307
Chronic	34/58.6 %	19 vs 15 p=0.586 Chi²= 0.29724	3.6 vs 4.0 p=0.104 95 % CI (–0.10282, 1.0685)	3 vs 2 p=0.952 Chi²=0.0036132

Tab. 5. Impact of morphological types of NASH on hematoma recurrence and GOS.

Morphological type	Incidence	Side prevalence	Impact on GOS	Impact on recurrence
Separated	11/19.0 %	6 vs 5 p=0.782 Chi²=0.076432	3.6 vs 3.8 p=0.689 95 % CI (–0.60153, 0.90327)	p=0.28379 Chi²=1.1489
Trabecular	6/10.3 %	4 vs 2 p=0.437 Chi²=0.60476	4.3 vs 3.7 p=0.184 95 % CI (–0.31361, 1.5957)	p=0.450 Chi²=0.57169
Laminar	5/8.6 %	2 vs 3 p=0.668 Chi²=0.18417	2.8 vs 3.8 p=0.043 95 % CI (0.034778, 2.0633) significant	p=0.032 Chi²=4.5892 significant
Homogeneous isodense	13/22.4 %	5 vs 8 p=0.452 Chi²=0.56656	4.1 vs 3.7 p=0.245 95 % CI (–0.28952, 1.11)	p=0.376 Chi²=0.78478
Homogeneous hypodense	23/39.7 %	12 vs 11 p=0.860 Chi²=0.031137	3.7 vs 3.8 p=0.730 95 % CI (–0.49884, 0.70754)	p=0.385 Chi²=0.75408

Tab. 6. Impact of selected risk factors on NASH recurrence and GOS.

Monitored factors	Impact on NASH recurrence	Impact on GOS
Burr holes vs craniotomy	5 vs 0 p=0.374 Chi²=0.78997 none	3.7 vs 4.1 p=0.320 95 % CI (–0.42403, 1.274) none
Number of burr holes (1 vs 2)	4 vs 1 p=0.717 Chi²=0.13165 none	3.8 vs 3.1 p=0.182 95 % CI (–0.31288, 1.6086) none
Timing of surgery (emergency vs delayed)	1 vs 4 p=0.718 Chi²=0.13446 none	3.8 vs 3.8 p=0.971 95 % CI (–0.64899, 0.6728) none
Antiplatelet drugs	1 vs 4 p=0.606 Chi²=0.26609 none	4 vs 3.7 p=0.448 95 % CI (–0.58164, 1.2816) none
Homogeneity of NASH (homogeneous vs heterogeneous)	3 vs 2 p=0.927 Chi²=0.00836 none	3.8 vs 3.6 p=0.518 95 % CI (–0.40952, 0.80346) none
Hematoma side (left vs right)	2 vs 3 p=0.668 Chi²=0.18417 none	not applicable
Gender (male vs female)	3 vs 2 p=0.574 Chi²=0.31655 none	3.6 vs 4.3 p=0.149 95 % CI (–0.25877, 1.6159) none
Age of patients	66.8 vs 70.9 p=0.515 95 % CI (–0.8603, 16.753) none	R = –0.33096, p = 0.07949 weakly negative correlation

Tab. 7. Influence of volumetric parameters on NASH recurrence and GOS.

Volumetric parameters	Side differrence (left vs right)	Impact of recurrence	Correlation with GOS	Difference between morphological types
Preoperative hematoma volume	93.7 vs 80.7 ml p=0.440 95 % CI (–21.1, 47.01)	169,6 vs 79,5 ml p=0.0008 95 % CI (–13.611, 352.81) **significant**	R = –0.29758 p=0.023 weakly negative significant	p=0.330 F=1.181
Post-evacuation hematoma cavity volume	46.6 vs 46.3 ml p=0.973 95 % CI (–16.232, 16.783)	89,2 vs 42,4 ml p=0,0007 95 % CI (20.625, 72.945) **significant**	R= –0.11488 p=0.391 very weakly negative	p=0.558 F=0.7565
Extent of hematoma evacuation	–42.8 vs –38.3 % p=0.639 95 % CI (–14.9, 23.9)	–38.2 vs –40.8 % p=0.895 95 % CI (–36.097, 41.238)	R=0.074072 p=0.581 very weakly positive	p=0.9419 F=0.1914
Pneumocephalus volume	11.5 vs 8.9 ml p=0.398 95 % CI (–3.5842, 8.7566)	29.3 vs 8.4 ml p=0,00006 95 CI (11.199, 30.687) **significant**	R= –0.053757 p=0.689 very weakly negative	p=0.064 F=2.372

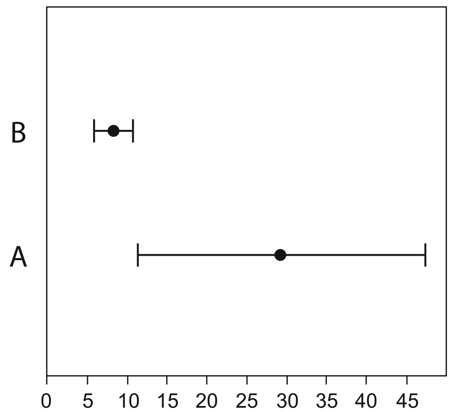

Fig. 3. Impact of pneumocephalus volume on recurrence rate of NASH, p = 0.00006 (A – recurrence group: 29.3 ml, B – non-recurrence group: 8.4 ml).

ter initial bilateral evacuation based on the following parameters: use of anticoagulants, severe brain atrophy and postoperative PV (10). In our study, the volume of pneumocephalus after surgery as a risk factor for hematoma recurrence positively correlated with preoperative hematoma volume (R = 0.32518, p = 0.01275). Thus, a significant development of postoperative pneumocephalus is expected after evacuation of a large volume hematoma. In the study by Huang et al, PHV also positively correlated with 1-day postoperative PV (p < 0.01). In this study, PV did not have a significant effect on the hematoma recurrence rate (11). However, many studies have confirmed a significant association between pneumocephalus and NASH recurrence (12–14). Postoperative pneumocephalus not only prolongs the hospital stay and healing time, but also leads to neurological deterioration (14). The ratio of PV to PCHV was identified as an independent risk factor for predicting hematoma recurrence (12). Intraoperative aspiration of post-evacuation hematoma cavity enhances brain re-expansion and reduces hematoma recurrence (15). As in the study by Huang et al, there was no correlation in our cohort between PV and neurological outcome of patients (11). Uda et al confirmed the effect of PHV on the recurrence rate of NASH, which is in line with our study (16). Molina et al reported that PHV > 80 ml is significantly more frequent in the hematoma recurrence group of patients after evacuation (17). In compliance with our study, Chon et al found a link between the laminar hematoma type and incidence of hematoma recurrence. However, in their study, the morphological type of separated hematoma was also associated with an increased risk (18). In the cohort of Miah et al, the laminar and separated architecture types were associated with higher hematoma recurrence rate (21). The newly separated morphological type according to Nakaguchi et al is most often associated with a high incidence of recurrence of NASH (7, 9, 13, 18–21). In our study, the laminar type of hematoma had an effect not only on recurrence but also on the neurological outcome. It should be noted that in our study group of bilateral hematomas, no homogeneous hyperdense morphological type of hematoma occurred.

Other various factors are referred to as conditions carrying the risk of hematoma recurrence and worse neurological outcome, namely arterial hypertension, absence of postoperative drainage, early removal of drainage tube, hematoma evacuation via burr holes, antithrombotic agents, midline shift, admixture of acute blood in post-evacuation hematoma cavity, phatic disorder, preoperative seizures, disorder of consciousness, thrombocytopenia, diabetes mellitus, brain atrophy, non-hyperintensity on T1-weighted magnetic resonance, general anesthesia and heterogeneous density of hematoma (6, 7, 10, 12, 16–18, 20–23). Further studies focusing on the results of surgical treatment of bilateral NASH are needed. The limit of our study is the low number of patients with bilateral NASH included in the cohort. However, bilateral NASH have a lower incidence as compared to unilateral findings. Finally, it should be borne in mind that hematoma bilaterality is often associated with a higher risk of hematoma recurrence and worse neurological outcome (1, 2, 4, 5, 7, 21–24).

References

1. Lee J, Park JH. Clinical Characteristics of Bilateral versus Unilateral Chronic Subdural Hematoma. Korean J Neurotrauma 2014; 10 (2): 49–54.

2. Agawa Y, Mineharu Y, Tani S, Adachi H, Imamura H, Sakai N. Bilateral Chronic Subdural Hematoma is Associated with Rapid Progression and Poor Clinical Outcome. Neurol Med Chir (Tokyo) 2016; 56 (4): 198–203.

3. Park HS, Park ES, Park JB et al. Chronic Subdural Hematomas: Comparison between Unilateral and Bilateral Involvement. Korean J Neurotrauma 2014; 10 (2): 55–59.

4. Zolfaghari S, Bartek J Jr, Djärf F et al. Risk factors for need of reoperation in bilateral chronic subdural haematomas. Acta Neurochir (Wien) 2021 Apr 2. DOI: 10.1007/s00701-021-04811-5. Epub ahead of print. PMID: 33796888.

5. Huang YH, Yang KY, Lee TC, Liao CC. Bilateral chronic subdural hematoma: what is the clinical significance? Int J Surg 2013; 11 (7): 544–548.

6. Opšenák R, Hanko M, Snopko P, Varga K, Fejerčák T, Kolarovszki B. Factors influencing the results of surgical therapy of non-acute subdural haematomas. Eur J Trauma Emerg Surg 2019 Nov 18. DOI: 10.1007/s00068-019-01268-1. Epub ahead of print. PMID: 31740995.

7. Andersen-Ranberg NC, Poulsen FR, Bergholt B, Hundsholt T, Fugleholm K. Bilateral chronic subdural hematoma: unilateral or bilateral drainage? J Neurosurg 2017; 126 (6): 1905–1911.

8. Shen J, Shao X, Gao Y et al. Risk Factors for Contralateral Hematoma Progression after Unilateral Evacuation of Bilateral Chronic Subdural Hematomas. World Neurosurg 2019; 126: e773–e778.

9. Takahashi S, Yamauchi T, Yamamura T, Ogishima T, Arai T. Proposal of Treatment Strategies for Bilateral Chronic Subdural Hematoma Based on Laterality of Treated Hematoma. Asian J Neurosurg 2018; 13 (4): 1134–1139.

10. Shen J, Gao Y, Li Q et al. Risk Factors Predicting Recurrence of Bilateral Chronic Subdural Hematomas after Initial Bilateral Evacuation. World Neurosurg 2019; 130: e133–e139.

11. Huang GH, Li XC, Ren L et al. Take it seriously or not: postoperative pneumocephalus in CSDH patients? Br J Neurosurg 2020; 34 (3): 284–289.

12. Shen J, Xin W, Li Q, Gao Y, Zhang J. A Grading System for The Prediction Of Unilateral Chronic Subdural Hematoma Recurrence After Initial Single Burr Hole Evacuation. Risk Manag Healthc Policy 2019; 12: 179–188.

13. Ohba S, Kinoshita Y, Nakagawa T, Murakami H. The risk factors for recurrence of chronic subdural hematoma. Neurosurg Rev 2013; 36 (1): 145–149.

14. You CG, Zheng XS. Postoperative pneumocephalus increases the recurrence rate of chronic subdural hematoma. Clin Neurol Neurosurg 2018; 166: 56–60.

15. Chavakula V, Yan SC, Huang KT et al. Subdural Pneumocephalus Aspiration Reduces Recurrence of Chronic Subdural Hematoma. Oper Neurosurg (Hagerstown) 2020; 18 (4): 391–397.

16. Uda H, Nagm A, Ichinose T et al. Burr hole drainage without irrigation for chronic subdural hematoma. Surg Neurol Int 2020; 11: 89.

17. Suero Molina E, Borscheid L, Freistühler M, Zawy Alsofy S, Stummer W, Schipmann S. Risk-assessment in chronic subdural hematoma evaluated in 148 patients – A score for predicting recurrence. Clin Neurol Neurosurg 2020 Aug; 195: 106020.

18. Chon KH, Lee JM, Koh EJ, Choi HY. Independent predictors for recurrence of chronic subdural hematoma. Acta Neurochir (Wien) 2012; 154 (9): 1541–1548.

19. Nakaguchi H, Tanishima T, Yoshimasu N. Factors in the natural history of chronic subdural hematomas that influence their postoperative recurrence. J Neurosurg 2001; 95 (2): 256–262.

20. Hammer A, Tregubow A, Kerry G, Schrey M, Hammer C, Steiner HH. Predictors for Recurrence of Chronic Subdural Hematoma. Turk Neurosurg 2017; 27 (5): 756–762.

21. Miah IP, Tank Y, Rosendaal FR et al. Radiological prognostic factors of chronic subdural hematoma recurrence: a systematic review and meta-analysis. Neuroradiology 2021; 63 (1): 27–40.

22. Song DH, Kim YS, Chun HJ et al. The Predicting Factors for Recurrence of Chronic Subdural Hematoma Treated with Burr Hole and Drainage. Korean J Neurotrauma 2014; 10 (2): 41–48.

23. Blaauw J, Jacobs B, den Hertog HM et al. Neurosurgical and Perioperative Management of Chronic Subdural Hematoma. Front Neurol 2020; 11: 550.

24. Chen FM, Wang K, Xu KL et al. Predictors of acute intracranial hemorrhage and recurrence of chronic subdural hematoma following burr hole drainage. BMC Neurol 2020 Mar 13; 20 (1): 92.

Received May 12, 2021.
Accepted May 27, 2021.