Evaluation of Radiological and Clinical Findings in Recurrence of Chronic Subdural Hematoma

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Research Article

Keywords: recurrence, chronic subdural hematoma, risk factor

Posted Date: May 4th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-1542988/v1

Abstract

Chronic subdural hematoma (CSH) is one of the most encountered types of intracranial hemorrhage in elderly patients. However reoperation rates are still high, therefore predicting of risk factors for recurrence is essential. In the current study, we aim to identify as many clinical and radiological factors as possible that can predict to the recurrence of CSH.

A retrospective review of 291 CSH patients admitted to our department was performed. Clinical and radiological factors predictive for CSH recurrence were identified on univariable analyses at first, and variables with a p-value of <0.05 were entered into the multivariate logistic regression analyses.Univariate analyses revealed that preoperative midline shift (p=0.025), mix-density hematoma (p=0.023), internal architecture of hematoma (p=0.044), membranectomy (p=0.001), and ambient cistern compression (p=0.001) correlated with a significantly higher rate of recurrence. Multivariate analyses showed that seperated architecture, membranectomy and ambient cistern compression were independent risk factors for CSH recurrence. Among many factors, membranectomy, seperated architecture and ambients cistern compression were the strongest predictors for recurrence.

Introduction

Chronic subdural hematoma (CSH) is one of the most frequently encountered disorder in neurosurgery departments worldwide, especially prevalent among the elderly. Incidence is 8.2–17.6 per 100.000 individuals annually and increases with population ages (21). The burr hole craniostomy with closed-system drainage is the usual treatment of CSH with a good outcome and prognosis. However, between 9.2% and 26.5% of patients suffer recurrence after initial surgery and the rate of recurrence significantly higher in elderly patients (22).

Factors predicting the recurrence of CSH have been shown in many studies, including age, sex, antiplatelet and/or anticoagulant use, bilateral or unilateral hematoma, preoperative midline shift, computed tomography (CT) density, preoperative hematoma thickness, method of hematoma evacuation, patients with diabetes mellitus (DM) and hypertension (6, 12, 13).

Most studies have discussed one or few factors related to the recurrence risk of CSH and the results were conflicting. In the current study, we analyze the data of patients with CSH in our department and included as many parameters as possible to identify risk factors for CSH recurrence.

Materials And Methods

We retrospectively evaluated 291 patients who underwent surgical evacuation in the Department of Neurosurgery, Faculty of Medicine, Ataturk University, between 2015 and 2020 with the approval of the local institutional research ethics committee. This analysis study was conducted following the Declaration of Helsinki.

All medical records were stored in an electronic database at Yakutiye Research Hospital. Age, sex, hypertension, DM, antiplatelet therapy, anticoagulant therapy, Markwalder grading scale (Table 1), midline shift (mm), the initial maximal thickness of the subdural hematoma (mm), cisterna ambiens compression, the density of hematoma (Hounsfield units, HU), surgical procedure (single burr hole, double burr hole or cranitomy), membranectomy and laboratory findings (levels of white blood cell (WBC), hemoglobin, platelet, international normalized ratio (INR), albumin) were assessed. The density of subdural hematoma was classified into 3 groups based on CT findings: hypo-density (< 25 HU), iso-density (25–35 HU), and mixed-density. Additionally, CSH was classified as described by Nakaguchi according to its internal architecture; homogeneous architecture, laminar architecture, separated architecture, and trabecular architecture (11) (Fig. 1). Patients with bilateral hematomas were not included in the study.

Surgery was decided if there were focal symptoms and/or significant changes in neurological status. The surgical procedure was decided according to the characteristics of the hematoma. Patients were operated by single or double burr hole craniostomy with irrigation and closed-system drainage under general anesthesia. However, a small (< 4 cm) craniotomy was performed in cases in which organized hematoma was implied by CT scans and intra-operative observation by the surgeon. In these cases, after dural opening, the outer membrane was opened and the subdural space irrigated with isotonic solution. A small opening was created in the inner membrane and the space below the inner membrane was also irrigated. In some cases, a membranectomy was performed if the hematoma was encapsulated. Membranectomy was performed as all capsular membrane components (both outer and inner membranes) were resected.

An external closed drainage system was maintained for 2 to 3 days and removed after a CT. However, CT was performed immediately in patients who had worsening symptoms such as decreases in the level of consciousness, weakness and severe headache. When new bleeding was observed in the early CT scan, a craniotomy was performed to evacuated hematoma.

The medical records of patients who were admitted to this study were reviewed up to 6 months after the initial surgery. Recurrence was defined as the increase volume of hematoma on the same side and compression of the brain surface observed on CT scans within 3 months. The surgical technique for recurrent CSH was determined according to hematoma characteristic.

The patients were divided into two groups: recurrent and non-recurrent.

SPSS software (version 20.0, SPSS Inc., Chicago, USA) was used for data analysis. Independent sample t-test and chi-squared test were used for univariate statistical analyses. A logistic regression model was used for multivariate statistical analyses. The relationship between each predictive factor and recurrence of CSH is expressed as odds ratio (OR) and 95% confidence interval (CI). A p value < 0.05 was considered significant.

Result

A total of 291 patients (216 men and 75 women, mean age 70,4 ± 11,3, range 38–90) with CSH were included. Tables II and III show demographics and the clinical presentation. The total CSH recurrence rate was 28.8% (84 out of 291). Males showed a 31,9% recurrence rate (69 out of 216), while females showed a 20% recurrence rate (15 out of 75). The difference was not statistically significant (p = 0.256). 234 patients had a history of head trauma before initial surgery in both groups (80,4%), 63 patients in the recurrence group (26,9%), and 171 patients in non-recurrence group (73%) (p = 0.392). However, 57 patients did not have an obvious trauma history (19,6%).

Hypertension, DM, preoperative laboratory findings, use of antiplatelet and anticoagulation drugs were analyzed. All variables were not significant in the CSH recurrence.

CT findings on admission are presented in Table III; 66 patients with hypo-density (22,6%), 84 patients with iso-density (28,9%), 141 patients with mix-density (48,5%) (p = 0.023). Basal cisterns were compressed in 105 patients (36,8%), and 66 of them were in recurrence group (p = 0.001). Midline shift was 4,39 ± 3,54 mm in non-recurrence group, 6,33 ± 4,38 mm in recurrence group (p = 0.025). In recurrence group, CSH was homogeneous architecture in 8 patients (10%), was laminar architecture in 32 patients (38%), was seperated architecture in 42 patients (50%), was trabecular architecture in 2 patients (2%), and CSH recurrence was associated with hematoma layers (p = 0.044).

Surgical procedures was not related to recurrence (p = 0.144). However, membranectomy was significantly associated with more recurrence (p = 0.001).

Univariate analyses showed that the recurrence of CSH was significantly associated with midline shift, mix-density hematoma, internal architecture of hematoma, ambient cistern compression and membranectomy. Multivariate logistic regression analyses identified that seperated architecture, membranectomy and ambient cistern compression as the only independent risk factors for the recurrence of CSH. The results of multivariate analyses for the identification of factors predictive of CSH recurrence are shown in Table IV.

Discussion

CSH is a common type of intracranial hemorrhage and many factors related to recurrence have been reported (5, 8, 20).

Motoie et al. reported that age and sex associated with recurrence hemorrhage, however in our study, we found that age and sex were not associated with hematoma recurrence (13).Our study population was younger than theirs, their mean age was 79 years, ours was 70 years old. Less brain atrophy in younger patients, which didn’t examine in this study, may make the difference. Also, Kim et al. reported that male gender was associated with recurrence hemorrhage and they explained: estrogen is related to the repair of damaged vessels (6). However, estrogen levels are higher in older men than in postmenopausal women (10).

Many publications stated that history of head trauma was not related to hemorrhage recurrence (2, 7). We also found similar results. In this study; DM, hypertension, using anticoagulant and/or antiaggregant drugs were not predictive factors for hematoma recurrence. Yamato et al. suggested that hyperviscosity of the blood induced by hyperglycemia could play a role in decreasing recurrence rate in diabetic patients (22). Motoie et al claimed that using antiaggregant and/or anticoagulant drugs do not increase the recurrence rate, because these prevent the formation of clots in subdural space, but further studies are required to accept such a claim (13).

Similar to the results of the study conducted by Song et al., we found that preoperative midline shift was associated with hemorrhage recurrence (19). Kim et al. suggested that preoperative midline shift causes impaired adhesion between inner and outer membrane, therefore recurrence risk increases due to insufficient postoperative brain expansion (7). As a more objective indicator of brain compression, ambient cistern compression was found to be highly correlated with recurrence. To our knowledge, there is only one study examining the relationship between ambient cistern compression and recurrence of CSH in the English literature (13).

The density of hematoma reflects the amount of fresh blood clot in the hematoma cavity, and shows that blood vessels are actively growing into the membrane of CSH, therefore high hematoma density reflects active capillary network formation (9). Similarly, we established a relationship between mixed-density hematoma (hyperdense area were present) and recurrence. Also, the recurrence rate was found associated with multiple layer hematoma in which the excessive neo-membrane structures and blood vessel formation is active. However, contradictory results have been reported, Ohba et al. reported that the recurrence rate is not related to hematoma density (15).

Nakaguchi and et al. classified CSD into the four stage, based on the internal architecture and density of hematomas (14). They reported that CSD initiate as the homogeneous type and sometimes beginning into the laminar type, and then matures as the separated type and is finally absorbed as the trabecular type (14). Experimental studies have shown that blood in the subdural space causes an inflammatory response and increases the amount of cytokines. Separated stage is the most active period of inflammation because the amount of cytokine is measured the most (4). In the publications, they reported that the recurrence is high in separated architecture, like the results we obtained (3, 17).

Surgical technique (single/double burr-hole/craniotomy) were not found associated with recurrence. However, the recurrence rate was found to be significantly higher in patients who underwent membranectomy. The optimal surgical technique for CSH is unclear, but it has been reported that postoperative mortality and morbidity rates do not differ between burr-hole craniostomy, and craniotomy with or without membranectomy (16). We know that the outer membrane is highly vascularized and the exudation is critical for CSH accumulation (18). Although a wide membranectomy may be performed, it will not be total, bleeding may occur from residual membrane. On the other hand, fenestration or partial resection of the outer membrane may prevent blood/excuda accumulation in the long term (1). In our study, the procedures performed in patients with recurrence were: 10,7% with double burr hole craniostomy, 28,6% with single burr hole craniostomy and 60,7% with craniotomy. According to our experience, the double burr hole craniostomy method has been found to be the most reliable method, in which the integrity of the outer membrane was sufficiently impaired but widely membranectomy was not performed.

Conclusion

Double burrhole craniostomy with closed-system drainage is an effective method for the surgical treatment of CSH. Membranectomy, seperated architecture and ambients cistern compression are independent predictors of recurrence hemorrhage. Although classifying the characteristics of hematoma is controversial, ambient system compression appears to be an objective and good indicator of recurrence of CSH.

Declarations

Ethical Approval and Consent to participate; This study was approved by our local ethics committee (19/05/20) and carried out according to the 1964 Helsinki declaration. Due to the retrospective nature of the study, no explicit informed consent was obtained from subjects.

Human and Animal Ethics; We carried out according to the 1964 Helsinki declaration. No animal subjects were used.

Consent for publication; The authors affirm that human research participants provided informed consent for publication of the images in Figure(s) 1a, 1b, 1c and 1d.

Availability of supporting data; Pertinent data are presented in the manuscript. Raw data can be made available at request pseudonymized.

Competing interests; The authors have no competing interests to declare that are relevant to the content of this article.

Funding; No funding was received to assist with the preparation of this manuscript.

Authors' contributions; All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Mehmet Emin Akyüz and Hakan Hadi Kadıoğlu. The first draft of the manuscript was written by Mehmet Emin Akyüz, evaluation and supervision of the article was done by Hakan Hadi Kadıoğlu and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Acknowledgements; not applicable

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Tables

Table 1. The classification system of patients according to their initial clinical status

Markwalder Grading Scale	
Grade 0	Neurologically normal
Grade 1	Alert and orientated: absence of mild symptoms such as headache, or mild neurologic deficit such as reflex asymmetry
Grade 2	Drowsy or disorientated, or variable neurologic deficit such as hemiparesis
Grade 3	Stuporous but responding appropriately to noxious stimuli, several focal signs such as hemiplegia
Grade 4	Comatose with absent motor responses to painful stimuli, decerebrate or decorticate posturing

Table 2; Continuous variables were assessed using the Student's t-test, *statistically significant;p<0,05, cranitomyWOM; withoutmembranectomy

Factors	**Non-recurrent group (n=207)**	**Recurrent group (n=84)**	**p value**
Age (years)	70.4 ± 10.8	70.6 ± 12.7	0.304
Midline shift* (mm)	4.39 ± 3.5	6.33 ± 4.38	0.025
Maximum thickness of hematoma (mm)	19.82 ± 6.57	22.17 ± 9.31	0.163
Hemoglobin (g/dl)	13.9 ± 1.8	13.9 ± 2.07	0.935
WBC (x10^3/µL)	8.3 ± 2.5	8.4 ± 2.8	0.979
Platelet (x10^3/µL)	256.50 ± 82.88	222.82 ± 78.75	0.069
INR	1.29 ± 0.91	1.15 ± 0.56	0.449
Albumin (g/dl)	3.85 ± 0.47	3.64 ± 0.77	0.120

Table 3; Categorical variables were assessed using the Chi-Square Test, *statistically significant;p<0,05

Factors	Non-recurrent group (n=207)	*Recurrent group (n=84)*	p value
Markwalder Grading Scale			*0.410*
Grade 0	*3 (1.4 %)*	*0 (0 %)*	
Grade 1	*162 (78.3 %)*	*57 (67.9 %)*	
Grade 2	*30 (14.5 %)*	*15 (17.9 %)*	
Grade 3	*12 (5.8 %)*	*9 (10.7 %)*	
Grade 4	*0 (0 %)*	*3 (3.6 %)*	
Sex			*0.313*
male/female	*147/60 (71/29 %)*	*69/15 (82.1/17.9 %)*	
Diabetes Mellitus			*0.491*
no/yes	*165/42 (79.7/20.3 %)*	*72/12 (81.4/18.6 %)*	
Hypertension			*0.243*
no/yes	*84/123 (40.6/59.4 %)*	*45/39 (53.6/46.4 %)*	
History of trauma			*0.408*
no/yes	*36/171 (17.4/82.6 %)*	*21/63 (25.0/75.0 %)*	
Drug use			*0.101*
no/anticoagulant/antiagregant	*150/27/30 (72.5/13.0/14.5 %)*	*75/0/9 (89.3/0/10.7 %)*	
Surgery type			

single burrhole/double burrhole/craniotomyWOM	*99/27/81* *(47.8/13/39.1 %)*	*24/9/51* *(28.6/12.4/45.4 %)*	*0.870*
Density of hematoma*			
hypo/iso/mix	*48/75/84* *(23.2/36.2/40.6 %)*	*18/9/57* *(21.4/10.7/67.9 %)*	*0.023*
Membrane layer*			*0.044*
homogeneous/laminar /separated/trabecular	*91/50/50/16* *(43.9/24.1/24.1/7.8 %)*	*8/32/42/2* *(10/38/50/2 %)*	
Side			*0.910*
unilateral/bilateral	*138/69* *(66.7/33.3 %)*	*57/27* *(67.9/32.1 %)*	
Membranectomy*			*0.001*
no/yes	*177/30* *(85.5/14.5 %)*	*42/42* *(50/50 %)*	
Ambient cistern compression*			*0.001*
no/yes	*168/39* *(81.2/18.8 %)*	*18/66* *(21.4/78.6 %)*	

Table 4; The relation of risk factors to CSDH recurrence was assessed using Logistic Regression Analysis, *statistically significant;p<0,05, †reference; homogeneous, ‡reference; hipo-density, OR; odds ratio, CI; confidence interval

Factors	p value	OR	95 % CI
Hematoma type†	0.456		
laminar	0.268	0.343	0.052-2.274
seperated	**0.003***	0.627	0.075-5.221
Hematoma density‡	0.107		
iso-density	0.659	0.640	0.088-4.644
mix-density	0.456	4.625	0.652-32.811
Membranectomy	**0.004***	7.965	1.960-32.367
Ambient cistern compression	**0.000***	27.881	6.482-119.917

Figures

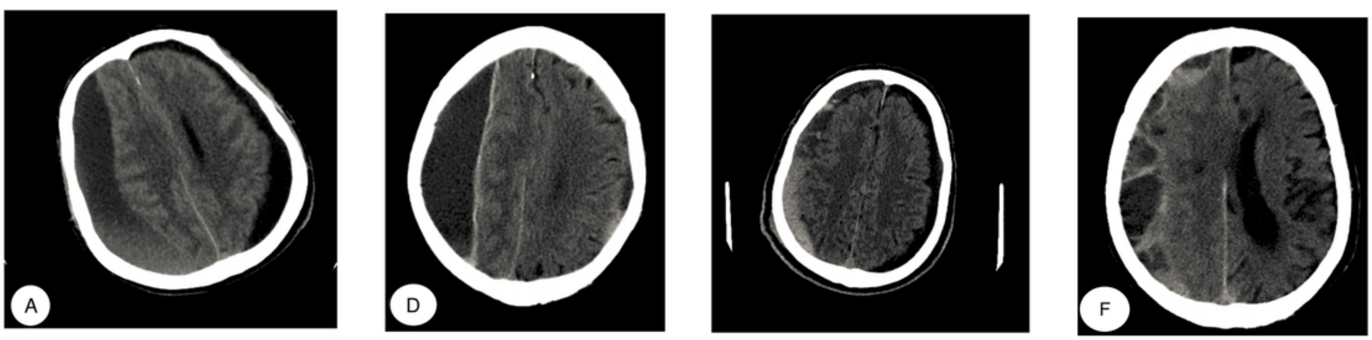

Figure 1

Computed tomography characteristics of CSH; A; homogeneous architecture, B; laminar architecture, C; separated architecture, D; trabecular architecture