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Comparisons of Radiological and Clinical Characteristics between Traumatic and Non-traumatic Subdural Hematoma Patients

Jun Gue Seo, Joochul Yang, Ji Hye Lee, Inho Oh, Tae Wan Kim, and Kwan Ho Park

Department of Neurosurgery, VHS Medical Center, Seoul, Korea

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Address for correspondence:
Tae Wan Kim
Department of Neurosurgery, VHS Medical Center, 53 Jinhwangdo-ro, 61-gil, Gangdong-gu, Seoul 05368, Korea.
E-mail: euro3399@naver.com

ORCID iDs
Jun Gue Seo
https://orcid.org/0000-0001-7587-4579
Joochul Yang
https://orcid.org/0000-0002-4496-937X
Ji Hye Lee
https://orcid.org/0000-0001-6689-2169
Inho Oh
https://orcid.org/0000-0003-4440-4130
Tae Wan Kim
https://orcid.org/0000-0001-7650-3331
Kwan Ho Park
https://orcid.org/0000-0001-5489-9830

Conflict of Interest
The authors have no financial conflicts of interest.

ABSTRACT

Objective: Subdural hematoma (SDH) primarily occurs in elderly patients. While most patients have good prognosis, some do not. Hematoma recurrence is one of the factors influencing prognosis. Moreover, some characteristic radiological factors may increase the recurrence rate. The aim of this study was to investigate whether the presence of trauma influenced radiological characteristics and hematoma recurrence in SDH patients treated with burr hole trephination.

Methods: From January 2012 to December 2014, we selected 83 patients diagnosed with unilateral SDH using computed tomography and/or magnetic resonance imaging. We divided the patients into 2 groups based on the presence of trauma. We compared the 2 groups with multiple parameters, such as patient factors, radiological characteristics, and recurrence rate.

Results: Patients who had a prolonged international normalized ratio (INR) were significantly more common in the non-traumatic SDH group (22.2%:55.2%, p=0.002). There was no statistical difference in radiological parameters between the 2 groups. The recurrence rate was marginally higher in the non-traumatic SDH group (14.8%:17.2%, p=0.502), but this difference was not statistically significant.

Conclusion: There were no statistically significant differences in the radiological findings, including brain atrophy, hematoma density, thickness of hematoma, and degree of midline shifting between the 2 groups. The associated trauma history may not influence recurrence. Anticoagulants medication influence INR prolongation, and commonly shown in non-traumatic group, but not statistically. INR prolongation was statistically more common in non-traumatic SDH patients than in traumatic SDH patients. INR prolongation is only a different characteristic between 2 groups.

Keywords: Subdural hematoma; Trauma; International normalized ratio; Recurrence

INTRODUCTION

Subdural hematoma (SDH) occurs mainly in elderly patients. Most elderly patients who exhibit midline shifting have shown poor outcomes without surgery.[5] Most symptomatic patients are treated surgically using burr hole trephination and closed-system drainage. The majority of patients have a good prognosis, but hematoma recurrence is observed in some

patients, which may influence outcomes. Definitive operative methods remain controversial. Computed tomography (CT) remains the most important diagnostic tool.

While some patients had experienced head trauma, others did not. We retrospectively analyzed patient factors and radiological differences by CT and/or magnetic resonance (MR) imaging, and subsequently investigated whether the presence of trauma influenced the radiological characteristics and recurrence of SDH.

MATERIALS AND METHODS

Patient selection

From January 2012 to December 2014, we selected 83 patients diagnosed with unilateral SDH using CT and/or MR imaging. Sometimes, the presence or absence of trauma history was ambiguous. We therefore questioned patients regarding their trauma history, including minor trauma, or questioned family members if the patients were not alert and no external wound was observed at admission. We defined non-traumatic hematomas as the absence of memory of trauma and external wounds. Among them, 24 patients underwent CT only before surgery, and 52 underwent both CT and MR imaging. Only MR imaging was performed in 7 patients. All patients underwent surgical treatment using burr hole trephination and closed-system drainage. The patients comprised 75 men and 8 women, with a mean age of 75.72 years (range; 50–88 years). We divided the patients into 2 groups based on the presence or absence of trauma history (group A, traumatic SDH; group B, non-traumatic SDH). Fifty-four patients were assigned to group A and 29 patients to group B.

Analytic parameters

We compared the 2 groups using multiple parameters: hypertension history, use of antiplatelet and/or anticoagulant medication, prolongation of international normalized ratio (INR), side of hematoma, presence of brain atrophy, hematoma density (mixed or single density), hematoma thickness, and degree of midline shifting. INR is the ratio of a patient's prothrombin time to a normal sample. The normal range of INR was 0.93 to 1.14 in our hospital. Therefore, prolongation of INR was defined more than 1.15. Brain atrophy was classified using the Pasquier cortical atrophy scale.[16] Presence of brain atrophy was defined scale 2 and 3 in this study. Mixed hematoma density was classified as either separated, laminar, or trabecular type. Hematoma thickness was measured as the maximal thickness of the hematoma. All radiological data were measured using CT scan, except for 7 patients who did not undergo CT scans, in which case, we used MR imaging. Two authors double-checked all radiological data and used the average value of degree of midline shifting and hematoma thickness to calculate the maximal thickness.

Statistical analysis

Fisher's exact test, *t*-test and multivariate analysis of variance were used for statistical analysis using SPSS (version 18.0; SPSS Inc, Chicago, IL, USA). A *p*-value of less than 0.05 was considered statistically significant.

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RESULTS

Patient factor

Fifty-two patients were found to have taken antihypertensive medication, out of which 35 were classified into group A, and 17 were classified into group B (64.8%:58.6%, p=0.373).

Thirty-eight patients had taken antiplatelet and/or anticoagulant medications, of which 22 were in group A, and 16 patients in group B. The number of patients who had taken antiplatelet and/or anticoagulant medication was higher in group B, but this difference was not statistically significant (40.7%:55.2%, p=0.152). Among them, 28 patients were taken antiplatelet medication, and the rest 10 patients were taken anticoagulant. Patients who taken antiplatelet medication were common in group B, but not statistically (9.3%:17.2%, p=0.287). Patients who taken anticoagulants were also common in group B, but also not statistically (29.6%:41.4%, p=0.280).

All patients who taken anticoagulants except one (9/10) were INR prolonged state. The mean INR was 1.343±0.36. Fifteen patients were shown INR prolongation among 28 antiplatelet medication patients and mean INR was 1.105±1.16. Four non-medication patients were also shown INR prolongation and mean INR was 1.056±0.08. INR prolongation was commonly noted in anticoagulants medication patients compare to other patients, statistically (p<0.001).

INR prolongation was noted in 28 patients. Twelve were in group A, and 16 in group B. Patients with a prolonged INR were statistically more common in group B (22.2%:55.2%, p=0.002) (**TABLE 1**).

Radiological finding

A hematoma on the left side was observed in 44 patients, including 29 in group A and 15 in group B (53.7%:51.7%, p=0.523).

Mixed-density within the hematoma was observed in 38 patients. In group A, 23/54 patients had a mixed-density hematoma, while 15/29 patients in group B exhibited the same. Mixed density hematomas were more common in group B (42.6%:51.7%); however, this difference was not statistically significant (p=0.286).

Separated-type hematomas were observed in 9 patients and laminar-type hematomas in 7 patients. The separated type was more common in group A (30.4%:13.3%), whereas the laminar type was more common in group B (13.0%:26.7%), but this observation was not statistically significant (p=0.208 and 0.261, respectively).

In group A, 23 patients were scale 0, 12 were scale 1, 17 were scale 2, and 2 were scale 3. In group B, 12 patients were scale 0, 6 were scale 1, 9 were scale 2, and 2 were scale 3. Associated brain atrophy was observed in 30 patients, with 19 in group A, and 11 in group B. Associated

TABLE 1. Comparison of demographic data between the 2 groups

Characteristics	Traumatic SDH group (n=54)	Non-traumatic SDH group (n=29)	p-value
Antihypertensive medication	35 (64.8)	17 (58.6)	0.373
Antiplatelet and/or anticoagulant medication	22 (40.7)	16 (55.2)	0.152
INR prolongation	12 (22.2)	16 (55.2)	0.002*

Values are presented as number (%).
SDH: subdural hematoma, INR: international normalized ratio.
*Statistically significant differences (p<0.05).

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TABLE 2. Comparison of radiological data between the 2 groups

Characteristics	Traumatic SDH group (n=54)	Non-traumatic SDH group (n=29)	*p*-value
Mixed density hematoma	23 (42.6)	15 (51.7)	0.286
Associated brain atrophy	19 (35.2)	11 (37.9)	0.494
Mean thickness of hematoma (mm)	21.22	20.59	0.921
Mean degree of midline shift (mm)	10.11	9.84	0.818

Values are presented as number (%).
SDH: subdural hematoma.

TABLE 3. Multivariable analysis of traumatic subdural hematoma group

Variables	OR (95% CI)	*p*-value
Antihypertensive medication	1.296 (0.51–0.76)	0.484
Antiplatelet and/or anticoagulant medication	0.561 (0.26–0.53)	0.547
INR prolongation	0.233 (0.07–0.31)	0.000
Mixed density hematoma	0.693 (0.28–0.55)	0.452
Associated brain atrophy	0.889 (0.23–0.49)	0.884
Mean thickness of hematoma (mm)	19.81–22.80	0.922
Mean degree of midline shift (mm)	9.27–11.09	0.665

OR: odds ratio, CI: confidence interval, INR: international normalized ratio.

brain atrophy was more common in group B than in group A (35.2%:37.9%), but the difference was not statistically significant (p=0.494).

The mean thickness of hematoma in group A was slightly thicker than that in group B (21.22 mm:20.59 mm), although the difference was not statistically significant (p=0.921).

The mean degree of midline shift in group A was greater than that in group B (10.11 mm:9.84 mm), which was not statistically significant (p=0.818).

Mixed density hematoma and associated brain atrophy were more common in group B, while the mean thickness of hematoma and the degree of midline shift were marginally greater in group A. However, none of these results were statistically significant (**TABLE 2**).

INR prolongation was also the only significant difference between 2 groups on multivariate analysis of variance (**TABLE 3**).

Recurrence

Thirteen patients underwent reoperation due to hematoma recurrence. All patients underwent surgery using a previous burr hole. Eight patients in group A and 5 in group B had recurrence. There was no statistically significant difference in the occurrence rate between the 2 groups (14.8%:17.2%, p=0.502). The results indicate that the etiology of SDH may not influence the recurrence rate, either traumatically or non-traumatically.

DISCUSSION

The mechanism underlying SDH formation remains unclear. Increased osmotic pressure between the hematoma and blood vessels, genesis of the neomembrane, and subsequent growth of new vessels are known to be important factors in enlarging the hematoma.

Risk factors for the genesis of spontaneous SDH include hypertension, use of anticoagulants and antiplatelet agents, alcohol addiction, and intracranial hypotension. Cerebral atrophy

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is a significant factor in the development of hematomas at all ages, especially those less than 65 years.[22] A high co-morbidity rate was noted in the non-trauma group, although this was not statistically significant.[3] Anticoagulant therapy is the most significant risk factor, and hypertension may be a statistically significant risk factor for patients older than 70 years. Simultaneous anticoagulant and antiplatelet therapy resulted in significantly high rate of occurrence of chronic SDH.[7] Anticoagulant and/or antiplatelet medications influence hematoma progression and expansion.[23] Anticoagulant and/or antiplatelet agent use are more prevalent in non-traumatic chronic SDH patients, while mean INR levels were significantly higher in the non-traumatic SDH group, but may not have influence the recurrence rate.[3] In this study, anticoagulant and/or antiplatelet agent use was also more common in the non-traumatic SDH patient group, and patients with prolonged INR were significantly more common in the non-traumatic SDH group, however this had no influence on the recurrence rate.

The most important factor in the development of chronic SDH is sufficient subdural space, namely brain atrophy.[8] Other important precipitating factors are trauma and coagulopathy.[9] Severe brain atrophy and larger subdural space volumes are prone to SDH development when head trauma has occurred.[6] In this study, brain atrophy was not common in the traumatic SDH group.

Midline shifting, mixed-density hematomas, and larger hematoma thickness may accelerate hematoma progression, but the existence of trauma and the underlying mechanism did not influence hematoma progression.[18] Any correlations between the progression of hematoma and anticoagulants and/or antiplatelet medication are unclear.[20]

Various factors influencing hematoma recurrence have been mentioned in several studies, but these factors have not been shown to influence recurrence in other studies. The presence of seizure history and absence of diabetes mellitus are closely related to hematoma recurrence.[21] Loculation and unilaterality of hematoma, old age, large hematoma thickness, and midline shift may be correlated with the occurrence of hemiparesis.[11] Hematoma thickness and density, bilaterality of hematoma, presence of brain atrophy, degree of midline shifting, postoperative residual air, and postoperative residual space of hematoma are known predictors of recurrence.[19] Large postoperative residual hematoma volume and anticoagulant therapy are also predisposing factors for recurrence.[10,12] Anticoagulant medication was associated with increased rebleeding risk, but antiplatelet medication was not,[14] and vice versa.[17] Old age, male sex,[13] presence of hematoma loculation on preoperative CT,[12] and high or mixed hematoma density[15] are all independent predictive factors of recurrence. On initial CT, laminar and separated type mixed-density hematomas had a higher recurrence rate, whereas trabecular type hematomas had a lower recurrence rate.[19] In this study, mixed-density hematomas were more commonly noted in the non-traumatic group, while the separated type was more common in the traumatic group, although the latter was not statistically significant. Meanwhile, the laminar type was more common in the non-traumatic group. Mixed density hematoma type did not influence the recurrence rate.

Mixed-density hematomas were significantly thicker than other types of hematomas.[4] Patients with preoperative hematoma volumes <115 mL had a low recurrence rate,[19] while those with preoperative hematomas thicker than 20 mm had a higher recurrence rate.[1] In this study, there was no difference in hematoma thickness between the 2 groups.

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The presence of trauma history was not influenced by the recurrence rate.[2,3] In this study, there was no statistically significant difference in the recurrence rate between the 2 groups.

The limitation of this study was its retrospective nature and relatively small subjective groups. In addition, some patients underwent MR imaging for analysis. In addition, the 2 subjective groups were treated using the same operative method. If the study included all SDH patients, including those who underwent conservative treatment and craniotomy, different results may have been observed.

CONCLUSION

There were no statistically significant differences in the radiological findings, including brain atrophy, hematoma density, thickness of hematoma, and degree of midline shifting between the 2 groups. The associated trauma history may not influence recurrence. Anticoagulants medication influence INR prolongation, and commonly shown in non-traumatic group, but not statistically. INR prolongation was statistically more common in non-traumatic SDH patients than in traumatic SDH patients. INR prolongation is only a different characteristic between 2 groups.

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