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Original Research Article

RISK FACTORS OF RECURRENCE IN CHRONIC SUBDURAL HEMATOMA AND A PROPOSED EXTENDED CLASSIFICATION OF INTERNAL ARCHITECTURE AS A PREDICTOR OF RECURRENCE

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ABSTRACT

Background: Chronic subdural hematoma (CSDH) is prevalent in the elderly and the recurrence rate is greater, therefore, determining risk factors for CSDH recurrence is essential. This study proposes the extended classification of architecture of CSDH and investigate potential risk factors for recurrence.

Materials and Methods: The study includes 80 adult patients aged 18 and above who had CSDH and underwent surgery. The risk factor of reappearance was assessed with GOS, age, diabetes, sex, hypotension, CT appearance of hematoma. All patients underwent burr-hole and hematoma evacuation. Classification scheme based on internal architecture was used.

Results: Eighty patients (60 men and 20 women) underwent burr-hole surgery. A recurrence incidence of 31.25% and non-recurrence of 68.75% was seen in them. The recurrence was greater in the older patients, having diabetes mellitus (24%), hypertension (32%), and antiplatelet use (46%). There were patients with GOS of 5. The recurrence of CDSH as per the hematoma location and density: Right (40%), left (48%), bilateral (12%), High density (36%), low density (8%), iso (24%) and mixed (32%). In midline shift of <10mm there was high recurrence rate of 72% as compared to the ≥10mm midline shift. As per the Nakaguchi classification of different types, the "Homogenous" type was the most prevalent representing 47.5% of cases, with a recurrence rate of 42.11%. In our proposed extended classification, the homogenous Isodense type was the most prevalent representing 22.5 % of cases with a recurrence rate of 44.44%.

Conclusion: Age, gender, DM, hematoma density, midline shift, GOS score and internal architecture are all linked with CSDH recurrence. The probability of postoperative recurrence may be predicted by classifying CSDHs based on their internal architecture.

Keywords: Recurrence, Chronic subdural hematoma, risk factors, internal architecture.

INTRODUCTION

One of the most frequent neurosurgical disorders is chronic subdural hematoma (CSDH).[1] It is nevertheless linked to a considerable morbidity and usually manifests at an older age.[2] About 1-5.3 incidences of CSDH occur annually per 100,000 people. The aging population and related medical conditions including haemodialysis, anticoagulant medication, and/or antiplatelet therapy are contributing to the rising prevalence.[1] A second rise in hematoma volume in the ipsilateral subdural space accompanied by neurological impairments and further operation is referred to as a "recurrence" of CSDH.[3] The risk of recurrence following surgery and necessary operations ranges from 5 to 30%. The surgical technique appears to have an impact on the recurrence rate.[4] Recurrences of cerebral subdural haemorrhage (CSDH) may be caused by intracranial hypotension, thick outer

membrane, primary or metastatic Dural pathology, brain remaining at a depth at the end of hematoma evacuation, lower GCS, pneumocephalus, elevated amount of tissue plasminogen activator in the subdural fluid and outer membrane, greater amounts of IL-6 in the fluid, high or mixed-density hematoma, elevated expression of vascular endothelial growth factor and basic fibroblast growth factor in the outer membrane, more linoleic acid concentration in the fluid, antiplatelet medications, and infection,[1] surgical method, whether a single burr hole or multiple burr holes, or even a craniotomy,[4] chronic alcoholism, epilepsy, earlier shunt surgery, and underlying illness exhibiting bleeding tendencies.[5] Recurrences may be prevented by treating intracranial hypotension, replacing the hematoma with oxygen or saline, maintaining postoperative drainage, embolizing the vascular capsule, irrigating the cavity with tissue plasminogen activator and thrombin solution, and, when necessary, correcting defective coagulation.[1] CSDH was categorized as homogenous, laminar, separated, or trabecular type by Nakaguchi et al.[8] An attribute of this homogeneous subtype was found to be a fine, high-density coating that permeated the internal membrane of the laminar type. Hematoma of the separated type was described as having two distinct densities within it, one component with a lower density than the other, and a distinct boundary between them. The "gradation" type, which was regarded as a subtype of the separated kind, was identified when the boundary was hazy and the high and low densities mixed together at the border. The term "trabecular type" refers to a hematoma with non-uniform and a high-density septum joining the internal and external membrane on a low-density to isodense.[6] Unfortunately, not all CSDHs encountered in clinical practice can be allocated by the current classification, which divides hematomas into four categories. Moreover, the hypothesis that these categories correspond to phases in the disease's natural progression has never been tested.[9] To inform treatment choices and stop a recurrence through more involved treatments, it is essential to identify individual who are at risk of recurrence. Recurrences are still a barrier in therapy, despite the simplicity of the surgical procedures.[1] Thus, In order to determine the risk factors for recurrence in chronic subdural hematomas, we carried out research and presented an expanded classification of internal architecture as a recurrence predictor.

MATERIALS AND METHODS

The study will include 90 adult patients aged 18 years or older who have been diagnosed with CSDH confirmed by computed tomography (CT) and will underwent surgery. Patients with traumatic brain injury as the primary diagnosis, acute subdural hematoma, insufficient radiological or clinical data, or those who underwent non-surgical therapy for CSDH, who have additional concurrent cerebral diseases (such as tumours or aneurysms) that may complicate the evaluation would be excluded. The study assessed the relationship between recurrence and clinical and personal characteristics, including gender, age, diabetes, hypotension, and GOS score, as well as CT abnormalities such hematoma density and degree of midline shift.[10] A complete medical history was obtained, covering any trauma that had happened during the previous three months or longer, as well as any anticoagulant or antiplatelet prescription use. The patients underwent a neurological evaluation that included the GOS score in addition to a comprehensive clinical examination.
Under local anaesthetic and subdural distance irrigation, all patients had hematoma draining using the burr-hole technique as a surgical procedure. Following irrigation, a subdural drainage system was installed. Within 24 hours following surgery, control cranial CT was available in every case. Within two to four days, drainage systems were shut off. On the day, the week, and the month following the procedure, each patient was treated in compliance with the cranial CT clinic protocol.[11] A CT scan was used to measure the hematoma's thickness, revealing its maximum thickness. On a CT scan, the degree of midline shift was measured close to the septum pellucidum, or third ventricle.[12] According to CT imaging results, several cytoarchitecture types of CSDH were identified and published by Nakaguchi et al.[13] In order to account for all hematomas seen in this study, the Nakaguchi categorization was expanded, and six unique subtypes were identified based on internal architecture and hematoma density.

Statistical analysis: The SPSS software was used for this analysis. For nominal values, the Chi-square test was used, whereas the "independent sample T" test was utilized for numerical values. Independent predisposing factors were investigated. The significance value was chosen as $p<0.05$ for statistical evaluations.[11]

RESULTS

We prospectively studied all 90 consecutive patients with CSDH who were enrolled, where they underwent burr-hole surgery for the haematoma. 10 patients were excluded as 4 did not underwent surgery and 6 was unable to be under observation for 3 months after the operation. Therefore, the final sample size in this study was 80 (60 men and 20 women) with majority of the patients less than 80 years of age. In total, operations were successful in 68.75 % of the cases (55 of 80 patients) after the first surgery. In 25 cases (31.25%) second operation was required.

Table 1: Recurrence criteria that have been reported for chronic subdural hematomas

Author	Year	Criteria of Recurrence
Nakaguchi et al [6]	2001	There was a rise in the level of CSDH on the operative side and reduction of the brain surface when compared to data from CT scans performed 3 months after surgery.
Gelabert-Gonalez et al [7]	2005	CT scans taken before and after surgery showed a rise in the amount of the CSDH on the operated side as well as compression of the brain surface.
Santarius et al [4]	2009	Within six months following the initial drainage treatment, the appearance of symptoms and indicators associated with an ipsilateral hematoma as detected by a CT scan.

Table 2: The clinical characteristics of recurrence and non-recurrence of groups

Factors	Recurrence (n=25)	No recurrence (n=55)	P-value
Sex			
Male	18 (72%)	42 (76.4%)	0.926
Female	7 (28%)	13 (23.6%)	
Age			
≥80 years	10 (40%)	12 (21.8%)	0.035
<80 years	15 (60%)	43 (78.2%)	
History of head trauma			
Yes	16 (64%)	25 (45.5%)	0.039
No	9 (36%)	30 (54.5%)	
Antiplatelet use			
Yes	10 (40%)	9 (16.4%)	0.020
No	15 (60%)	46 (83.6%)	
Hypertension			
Yes	8 (32%)	17 (30.9%)	0.031
No	17 (68%)	38 (69.1%)	
Diabetes Mellitus			
Yes	6 (24%)	8 (14.5%)	0.041
No	19 (76%)	47 (85.5%)	
GOS			
3	9 (36%)	8 (14.5%)	0.002
4	8 (32%)	18 (32.7%)	
5	8 (32%)	29 (52.8%)	

Table 2: Provides a summary of the clinical information for 80 patients. The following patient-specific variables were noted: antiplatelet medication use, gender, age, history of head trauma, and preoperative comorbidities (such as hypertension and diabetes). Total Twenty-five patients (31.25%) experienced recurrences, out of these 18 were men (72%) and 7 were women (28%).A considerable difference was observed, with a higher recurrence in patients aged ≥80 years (P=0.035). While 41 of the individual had a history of head trauma. The patients with history of head trauma (64%) had more chances of recurrence of subdural hematoma (p=0.039). In a patient who does not have a history of head trauma in them there was 36 % of chances of recurrence of subdural hematoma. Among the patients who take the antiplatelet in them the recurrence rate of CSDH was 40% while who does not take antiplatelet in them 60% of the patients had the chances of recurrence of CSDH. Subdural hematoma recurred after the operation in 8 of the patients with hypertension (32%) and in 6 of the patients with diabetes (24%). Subdural hematomas returned in 19 (76%) and 17 (68%) of the cases without diabetes or hypertension, respectively. A higher percentage of patients in the non-recurrence group had better GOS scores (score of 5: 52.8%) compared to those in the recurrence group (score of 5: 32%). This suggests that the recurrence group had poorer outcomes.

Table 3: Preoperative computed tomography results and recurrence rates

Factor	Recurrence (n=25)	No recurrence (n=55)	Total (n=80)	P-value
Hematoma Locations				
Right	10 (40%)	22 (40%)	32 (40%)	0.656
Left	12 (48%)	28 (51%)	40 (50%)	
Bilateral	3 (12%)	5 (9%)	8 (10%)	
Hematoma Density				
Low	2 (8%)	8 (14.5%)	10 (12.5%)	<0.001*
Iso	6 (24%)	27 (49%)	33 (41.25%)	
High	9 (36%)	7 (12.7%)	16 (20%)	
Mixed	8 (32%)	13 (23.6%)	21 (26.25%)	

Table 3: Provided a summary of the preoperative CT results. Ten patients (40%) experienced a CSDH recurrence on the right side, three (12%) experienced a bilateral recurrence and twelve (48%), on the left side. There was not any statistical significant variation in location between both cohorts (p<0.656). Hematoma density, however, varied considerably (p<0.001) between the two

groups. Compared to all other groups, the high-density cohorts (36.3%) and the mixed-density cohorts (32%) had greater recurrence rates. In the Iso group, the incidence of CSDH reappearance was 24%, whereas in the low hematoma density it was 8%; there was a p-value of 0.001 between the two cohorts.

Table 4: Midline shift and incidences of recurrence

Midline Shift	Recurrence (n=25)	No recurrence (n=55)	Total (n=80)	P-value
<10 mm	18 (72%)	47 (85.5%)	65 (81.25%)	0.087
≥10 mm	7 (28%)	8 (14.5%)	15 (18.75%)	

Table 4 displays the degree of midline shift from the preoperative CT scan. Compared to individuals with a midline displacement of more than 10 mm (28%), those with a shift of less than 10 mm (72%) had a lower likelihood of reappearance. Nevertheless, the difference (p=0.087) between the two groups was not statistically relevant. Thus, midline shift by itself could not be a reliable indicator of recurrence in CSDH patients, according to the data.

Table 5: Recurrence rates and time to develop both internal architectural classification system for chronic subdural hematoma.

Type	N=80	No Recurrence (n=55)	Recurrence (n=25)	Recurrence Rate (%)	P-value
Nakaguchi classification—no. (%)					
Homogenous	38 (47.5%)	22 (27.5%)	16 (40.0%)	42.11%	<0.001
Laminar	12 (15.0%)	8 (10.0%)	4 (10.0%)	33.33%	
Separated	6 (7.5%)	2 (2.5%)	4 (10.0%)	66.67%	
Trabecular	24 (30.0%)	16 (20.0%)	8 (30.0%)	33.33%	
Extended classification—no. (%)					
Homogenous Hypodense	16 (20.0%)	8 (10.0%)	8 (10.0%)	50.00%	<0.001
Homogenous Isodense	18 (22.5%)	10 (12.5%)	8 (10.0%)	44.44%	
Homogenous Hyperdense	8 (10.0%)	6 (7.5%)	2 (2.5%)	25.00%	
Sedimented	10 (12.5%)	6 (7.5%)	4 (5.0%)	40.00%	
Laminar	12 (15.0%)	10 (12.5%)	2 (2.5%)	16.67%	
Bridging	16 (20.0%)	16 (20.0%)	0 (0.0%)	0.00%	

Table 5 presents information on the rates of recurrence and the duration required to establish an internal architectural classification system for chronic subdural hematomas. There were two architectural classification system were used: Extended and Nakaguchi classification. As per the Nakaguchi classification different types, the "Homogenous" type was the most prevalent representing 47.5% of cases, with a recurrence rate of 42.11%. The less common type was the separated type with the greatest recurrence rate at 66.67%. The laminar and Trabecular types showed lower recurrence rates which is statically considerable (p = <0.001). In the Extended classification, the Homogenous isodense (22.5%) and homogenous hypodense type (20%) was more frequent with recurrence rate of 44.44% and 50% respectively. While the Homogenous Hyperdense type was the less frequent (10.0%) at lower recurrence rate of 25 %. The Sedimented" type exhibited a recurrence rate of 40.00%, while the "Laminar" type within the Extended classification showed a markedly reduced recurrence rate of 16.67%, suggesting a more stable condition. Notably, the "Bridging" type had a 0% recurrence rate, indicating it may be the most stable form of CSDH in this classification

DISCUSSION

This study determined the recurrence risk variables for chronic subdural hematomas, along with a suggested extended classification of internal architecture as a recurrence predictor. Surgery through a burr hole was done to treat chronic subdural hematomas. After evaluating a number of potential risk variables, an expanded classification of internal architecture was suggested as a recurrence predictor for CSDH. Furthermore, a number of risk variables for the recurrence of CSDH, including gender, midline shift, age, hematoma thickness, diabetes mellitus, and a poor GCS score have been studied.[14] A recurrence incidence of 31.25% was seen in chronic subdural hematomas, while 68.75% did not recur over the research period. This demonstrates that burr-hole surgery is a successful treatment for CDSH, as reported in the literature, where the incidence of recurrence ranges from 5 to 33%.[1] According to Mondorf et al., BHC should be the recommended surgical evacuation technique for the treatment of CSDH since the group of patients who had craniotomies had a recurrence rate of 27.8%, while the group of patients who had burr-hole surgery had a lower rate of 14.3%.[15] According to Ernestus et al, patients with burr holes had a greater recurrence rate of 18.5% as compared to 12.5% in patients with craniotomies.[16]

Age: In this study there was a significant recurrence rate in patients aged ≥80 years. This suggests that an elevated likelihood of recurrence may be linked to an older age. An identical outcome was observed in

the research carried out by Lee and colleagues, wherein the mean age at identification was around 72.16 years. The recurrence group had a greater average age, with 76.72±7.00 years and 71.83±12.12 years for the recurrence and non-recurrence cohorts, respectively.[14] In contrast, Yamamoto et al.'s other investigation revealed that the univariate analysis did not reveal a relationship between patient age or sex and the recurrence of CSDH.[17] Grübel et al. found no evidence of a significant relationship between age and recurrent CSDH in another investigation.[13]

Gender: Gender differences between the recurrence and non-recurrence groups in our study were not statistically relevant. A small number of studies have shown substantial variations in recurrence rates based on gender. Women experienced a greater recurrence rate in a research by Amirjamshidi et al, although the difference was not statistically considerable.[18] A substantial correlation between sex and its recurrence was discovered in a study by Lee et al, with a propensity for males to have greater recurrence rates. Given the small sample size of the recurrence cohort and the possibility of selection bias, additional research is required.[14]

Antiplatelet: The recurrence group in our study uses antiplatelet medicines at a considerably greater rate. This is a strong correlation, implying that antiplatelet treatment patients may be at higher risk of recurrence. Chon et al. proposed a link between antiplatelet/anticoagulants use and CSDH recurrence,[19] while Lindvall et al. found no such correlation.[20] These variations may be explained by the kinds of medications the patients had taken, how much they had taken, resistance to drugs, and how closely they had followed their prescription schedules.[14]

Hypertension:

Compared to the non-recurrence cohorts, the recurrence cohorts in this study exhibited a marginally higher prevalence of hypertension. Patients with CSDH were shown to have arterial hypertension in a research by Grübel et al.[13] In a research by Tuğcu and colleagues, 68.3%.Sixty-eight (61.8%) of the CDSH patients had a history of hypertension.[11] In contrast, a research by Torihashi et al. shown that hypertension has no bearing on recurrence.[3] Additionally, Gupta discovered no statistically relevant link between reappearance and hypertension.[21]

Diabetes Mellitus: Diabetes mellitus was more common in the study's reappearance group, suggesting that it might raise the chance of recurrence. Additionally, Torihashi et al. discovered that DM patients had a greater but marginal recurrence rate.[3] This contrasts with the findings of the Yamamoto et al. study, which showed that patients without diabetes had a greater rate of recurrence than those with the disease.[17] According to Suzuki et al., osmotherapy with 20% mannitol is useful in preventing a CSDH from bleeding repeatedly.[22] Capillary vasculopathy is a well-known condition that is seen in diabetic patients. There is an adequate capillary network on the outer membrane, especially for patients with CSDH, and the vasculopathy here may cause a recurrence in hematoma.[11]

GOS Score: The study also discovered that patients were more likely to have recurrences if they had lower GOS scores, especially if their scores were three or lower. This highlights the necessity for complete post-operative care by suggesting that worse recovery results may be linked with an increased risk of recurrence. The first investigation into the potential contribution of GOS to CSDH recurrence was carried out by Amirjamshidi et al. The findings demonstrated a substantial correlation between GOS and CSDH recurrence.[18] In the Grübel et al. research, every patient had a great clinical outcome, and over 90% of them received a GOS of 4 or 5 points.[13]

Midline shift: Patients who had a midline displacement of ≥10 mm were more likely to develop recurrence (28%) than those who did not (14.5%), although this difference was not statistically considerable. We failed to find a midline deviation threshold even though a bigger midline shift was linked to a recurrent CSDH. A similar outcome was observed in the study of Grübel et al., wherein a midline displacement of 7.3 mm was observed in 81.6% of patients after initial CCT imaging. There was no discernible correlation between a midline displacement and hematoma recurrence on its own.[13] Hematoma breadth and midline displacement were found to significantly positively correlate in a study by Hamou et al.[9]

Hematoma Density and Location: Our findings showed a significant relationship between high, iso, and mixed densities and a subsequent recurrence of CSDH. In comparison to the other cohorts, the recurrence pace was higher in the mixed-density group (32%) and the high-density cohorts (36.3%). The low-density group experienced an 8% recurrence rate, in comparison. Amirjamshidi et al.'s study,[18] revealed that high-density hemoglobas raise the recurrence rate of CSDH. Contrary to popular belief, research by Mori et al. indicates that there is no correlation between haematoma density and recurrence incidence.[23] The percentage of new blood clots in the hematoma cavity is reflected in the density of CSDH. A high percentage of newly formed blood clots indicates that blood vessels are actively growing into the CSDH membrane and rebleeding into the hematoma cavity. Hematoma densities other than low density, therefore, indicate rebleeding into the hematoma cavity and active neovascularization into the CSDH membrane.[24] There was no statistically considerable difference between the cohorts in the reappearance pace depend on the location of the hematoma ($p<0.656$). This implies that recurrence is not significantly predicted by the side or location of the CSDH. People with bilateral chronic subdural hematomas often have a history of brain atrophy, which hinders

brain re-expansion, according to a study by Gupta. Equal CSDH development is not always the outcome of a bilateral subdural hematoma, though.[21] In a research by Hammer et al., there were 4 right-sided and 11 left-side recurrences. Two of the original four cSDH cases that recurred on both sides and two on the left side did so.[2]

Internal Architecture classification: To estimate the likelihood of CSDH occurrence, a thorough examination of the internal architectural classification was conducted in this study. The six subtypes under the expanded classification enable a more precise and comprehensive recurrence risk assessment when compared to the Nakaguchi and more recent reported classification methods. In this study, bridging had the lowest rate of recurrence while the separated "Nakaguchi classification" type & the homogeneous hypodense extended classification type had higher rates, indicating the worst patient outcomes in these types. A similar outcome was seen in the research by Hamou et al., where it was found that hematomas with a bridge architecture had the lowest recurrence rates (8.6%) while homogenous isodense tumors (45.0%) had the greatest rates.[9] The study's findings are at odds with those of a study by Lee et al., which found that the recurrence rate varied depending on the type of hypodense material—it was 2.2% for homogenous hypodense material and 33.3% for gradation type.[14] The “separated” form had the greater reappearance rate of all CSDH kinds, according to research by Fujioka et al and Nomura et al.[25, 26] The separated form had the greater recurrence pace and the trabecular type the lowest in a research by Hammer.[2]

CONCLUSION

The study highlights the several factors that were associated with recurrence of CDSH such as gender, age, DM, GOS score, hypertension, antiplatelet use, hematoma density and internal architecture classification types (Nakaguchi and extended). Understanding these factors can help in identifying patients who are at higher risk of recurrence and may benefit from more comprehensive intervention.

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