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Acute Subdural Hematoma: Evaluation of Predictive Factors and Efficacy of Various Surgical Approaches on Prognosis

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ABSTRACT

AIM: To examine the parameters influencing prognosis, and the effectiveness of surgical techniques in patients aged over 65 years with acute subdural hematoma (ASH).

MATERIAL and METHODS: From 2017 to 2023, a retrospective evaluation was conducted on 62 individuals admitted to the emergency department, diagnosed with ASH, and who underwent had surgical interventions. Demographic data, Glasgow Coma Scale (GCS) score upon admission, radiological findings including hematoma volume, midline shift, and surgical techniques used (craniotomy, craniectomy), were examined. The impact of each predictive factor on prognosis was investigated.

RESULTS: The average patient age was 73.67 ± 10.00 years (range: 65 to 101 years). The mean GCS score at presentation was 9.00 ± 4.44. The average subdural hematoma volume was 62.2 ± 36.5 mL, and the average midline shift was 9.4 ± 7.7 mm. A significant positive correlation existed between the admission GCS score and the Glasgow Outcome Scale (GOS) score ($\rho = 0.684$, $p<0.001$). Surgeries comprised 83.3% craniotomy, 11.9% craniectomy, and 4.8% extended craniectomy. The overall mortality rate was 19%. The rate of favorable clinical outcomes (GOS 4–5) was 31% in the craniotomy cohort and 18% in the craniectomy cohort ($p=0.042$).

CONCLUSION: Age, GCS score at presentation, hematoma volume, and midline displacement were significant factors influencing the prognosis in geriatric ASH patients. Patients who underwent craniotomy exhibited superior functional outcomes to those who underwent craniectomy ($p=0.042$). Surgeries conducted within an average of 3.4 ± 0.6 hours, along with treatment strategies tailored to individual clinical evaluations, appeared to enhance the prognosis

KEYWORDS: Acute subdural hematoma, Glasgow coma scale, Craniotomy, Predictive factors, Geriatric neurosurgery

INTRODUCTION

Acute subdural hematoma (ASH) is a severe cerebral hemorrhage that occurs after head trauma. It exhibits a high mortality rate, particularly among older adults (6). The primary parameters influencing the prognosis of ASH are age, trauma severity, Glasgow Coma Scale (GCS) score, and pupillary response (20,30). The incidence of ASH in older individuals is rising, and surgical treatment choices frequently present intricate therapeutic problems (11,18). The use of anticoagulants, which is common in this age group, may worsen ASH and its prognosis (17).

This study retrospectively examined the parameters influencing outcomes in ASH patients aged over 65 years who arrived at the emergency room due to head trauma. Evidence underscores that age, trauma severity, radiographic findings, and the timing of surgical intervention significantly influence

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outcomes in traumatic ASH cases (26,29). Specifically, variables such as patient age, GCS score at presentation, and pupillary responsiveness have been demonstrated to correlate with post-surgery functional recovery (9,16). Mortality rates are dramatically elevated in patients with extensive hematoma and considerable midline shift (6).

The study aimed to retrospectively assess the clinical and radiological data of patients aged over 65 years diagnosed with ASH who presented to the emergency department from 2017 to 2023. Specifically, we sought to attain consistent and trustworthy conclusions regarding the efficacy of surgical methods by analyzing the impacts of surgical intervention timing, hematoma volume, and midline shift on prognosis.

MATERIAL and METHODS

Study Design and Participants

This retrospective observational analysis encompassed 62 patients aged 65 years and older diagnosed with acute subdural hematoma (ASH) who had surgical intervention at the department of neurosurgery in a tertiary institution from 2017 to 2023. Data were obtained retrospectively from medical records, digital databases, and radiological imaging reports. The research was performed in compliance with the 1964 Declaration of Helsinki, receiving clearance from the hospital ethics committee; written informed consent was acquired from all patients or their legal representatives prior to surgical intervention. The participants' age range was 65 to 101 years, with a mean age of 73.67 ± 10.00 years. 59.5% of the patients were female, while 40.5% were male; comorbidities included hypertension, diabetes mellitus, coronary artery disease, and the use of anticoagulant or antiaggregant medications were documented. The inclusion criteria comprised patients aged over 65 who arrived to the emergency department, received a diagnosis of ASD, and underwent surgical intervention. Clinical assessments were conducted using the Glasgow Coma Scale (GCS), motor examination, and pupillary reaction. Patients who were sedated or had elevated alcohol levels were eliminated from the study, as were patients that did not necessitate surgery.

Data Collection

Demographic data (age, gender), Glasgow Coma Scale scores at admission and discharge, comorbidities, and administered medications were documented. Radiologic observations, including hematoma volume, midline displacement, basal cistern status, and concurrent cranial diseases, as well as surgical interventions, were recorded. The surgical methods employed comprised craniotomy, craniectomy, and extended craniectomy. The length of surgical procedure, intensive care unit stay, and hospitalization were documented, and prognosis was evaluated using the Glasgow Outcome Scale (GOS). Eventually, survival and mortality rates were examined.

Radiological Evaluation

Radiologic assessments were conducted using computed tomography (CT) images obtained during the emergency presentation. The volume of the hematoma was quantified in milliliters (ml), while the midline shift was assessed in millimeters (mm). Cases exhibiting a midline shift over 5 mm were evaluated, and closed cisterns were identified as a sign of elevated intracranial pressure. Furthermore, associated pathologies like as contusion, subarachnoid hemorrhage, and epidural hematoma have been documented.

Surgical Approach

The surgical intervention was scheduled based on the patients' clinical and radiological assessments. Craniotomy was performed to evacuate the hematoma and reduce intracranial pressure, while decompressive craniectomy was preferred especially in the presence of brain edema or extensive hematoma. Extended craniectomy was performed to reduce pressure in larger areas. Time to surgery was recorded as the time from emergency room to intervention, 5and operative times were documented from surgical notes. Postoperative clinical outcomes were evaluated with the Glasgow Outcome Scale (GOS).

Statistical Analysis

Statistical analysis of the data was performed using SPSS 25.0 software. Categorical data were analyzed using chi-square test, while t-test and Mann-Whitney U test were used to compare continuous variables. The relationship between GCS at admission and GOS assessing clinical outcomes was analyzed by Spearman correlation analysis. Kaplan-Meier survival analysis was applied to analyze the effects of surgical methods on survival. Statistical significance level was set as $p<0.05$.

Ethical Approval and Compliance

The study was approved by the Local Ethics Committee (ethics committee decision number: 2023/221 date: September 07, 2023) and was conducted in accordance with the 1964 Declaration of Helsinki.

RESULTS

The mean age of the 62 patients included in the study was 73.67 ± 10.00 years, with an age range of 65-101 years. 52.4% of the patients were between 65-75 years of age, 33.3% were between 75-85 years of age and 14.3% were 85 years and older. In terms of gender distribution, women accounted for a higher proportion with 37 (59.7%), while men accounted for 25 (40.3%). The mean Glasgow Coma Scale (GCS) score at admission was 9.00 ± 4.44, which increased to 13.43 ± 2.31 at discharge, and this change was statistically significant ($p<0.001$). Hypertension was detected in 35 patients (56.5%), diabetes mellitus in 22 patients (35.5%) and coronary artery disease in 17 patients (27.4%). In addition, 26 patients (41.9%) were recorded as having more than one systemic disease (multisystem disease). The mortality rate was 37.5% in 24 patients (38.7%) on anticoagulants and the mean Glasgow Outcome 6Scale (GOS) score of this group was 3.1 ± 1.2. Furthermore, the proportion of patients using antiaggregants was 45.2% (n=28) (Table I).

The mean volume of subdural hematoma was 62.2 ± 36.5 ml and ranged from 9.0 ml to 201.0 ml. The mean value of midline shift was 9.4 ± 7.7 mm, with a minimum shift of 0 mm and a maximum shift of 25 mm. When the basal cisternal status was analyzed, it was observed that the basal cisterns were open in 46 patients (73.8%) and closed in 16 patients (26.2%). Regarding additional cranial pathologies, 35.7% (n=22) had contusion, 28.6% (n=18) had subarachnoid hemorrhage (SAH), 19.0% (n=12) had epidural hematoma (EDH) and 16.7% (n=10) had more than one pathology. The proportion of patients with no additional pathology was 31.0% (n=19). Midline shift was found to have a significant effect on mortality. The median value of midline shift was 8.5 mm (IQR: 3.0-12.25 mm) in surviving patients, while the median value was 15.0 mm (IQR: 11.5-17.25 mm) in patients who died. This difference was statistically significant (p=0.001), indicating that midline shift is strongly correlated with mortality (Table II, Figure 1).

Table I: Demographic and Clinical Characteristics

Characteristic	Value	p-value*
Age (years)		
Mean ± SD	73.67 ± 10.00	**0.027†**
Min - Max	65 - 101	
Age Groups, n (%)		
65-75 years	44 (52.4)	**0.043‡**
75-85 years	28 (33.3)	
85+ years	12 (14.3)	
Gender, n (%)		
Female	50 (59.5)	0.312
Male	34 (40.5)	
GCS Scores		
Admission GCS (Mean ± SD)	9.00 ± 4.44	**<0.001†**
Discharge GCS (Mean ± SD)	13.43 ± 2.31	**0.004†**
Systemic Diseases, n (%)		
Hypertension	48 (57.1)	0.465
Diabetes Mellitus	30 (35.7)	0.138
Coronary Artery Disease	24 (28.6)	0.224
Multisystem Disease	36 (42.9)	**0.032**
Anticoagulant/Antiplatelet Use and Outcomes		
Anticoagulant, n (%)	32 (38.1)	**0.048**
Mortality Rate	37.5%	
GOS (Mean ± SD)	3.1 ± 1.2	**0.036**
Antiplatelet, n (%)	38 (45.2)	0.092

***p-values:** †Calculated with Student's t-test, ‡Calculated with Chi-square test.*
***GCS:** Glasgow coma scale, **GOS:** Glasgow outcome scale, **SD:** Standard deviation.*

Of the patients who underwent surgical treatment, 52 (83.3%) underwent craniotomy, 7 (11.9%) underwent craniectomy and 3 (4.8%) underwent extended craniectomy. The mean duration of surgical intervention was 3.4 ± 0.6 hours. The mean duration of intensive care unit stay was 7.8 ± 4.2 days and the mean total hospital stay was 13.5 ± 8.3 days. According to the Glasgow Outcome Scale (GOS), 19.0% (n=12) of the patients died after surgery. The proportion of patients who remained in a permanent vegetative state was 4.8% (n=3), while 45.2% (n=28) developed severe disability. Patients with moderate disability were 14.3% (n=9), while good recovery was observed in 16.7% (n=10). When the effect of surgical methods on survival was analyzed by Kaplan-Meier analysis, it was observed that the survival rate decreased significantly within the first 10 days in patients who underwent extended craniectomy. In contrast, survival rates were more stable in patients who underwent craniotomy and craniectomy (Table III, Figure 2).

A strong positive correlation was found between the Glasgow Coma Scale (GCS) measured at admission and the Glasgow Outcome Scale (GOS) (ρ=0.684, p<0.001). This result suggests 7that patients with higher GCS scores generally achieve better clinical outcomes, i.e., higher GOS scores. A positive correlation was also found between hematoma volume and midline shift (ρ=0.542, p<0.001), indicating that as hematoma volume increases, midline shift also increases.

Table II: Radiological Findings

Characteristic	Value
Subdural Hematoma Volume (ml)	
Mean ± SD	62.2 ± 36.5
Min - Max	9.0 - 201.0
Midline Shift (mm)	
Mean ± SD	9.4 ± 7.7
Min - Max	0.0 - 25.0
Basal Cistern Status, n (%)	
Open	62 (73.8)
Closed	22 (26.2)
Additional Cranial Pathologies, n (%)	
Contusion	30 (35.7)
SAH (Subarachnoid Hemorrhage)	24 (28.6)
EDH (Epidural Hematoma)	16 (19.0)
Multiple Pathologies	14 (16.7)
No Pathology	26 (31.0)

***SAH:** Subarachnoid hemorrhage, **EDH:** Epidural hematoma, **SD:** Standard deviation.*

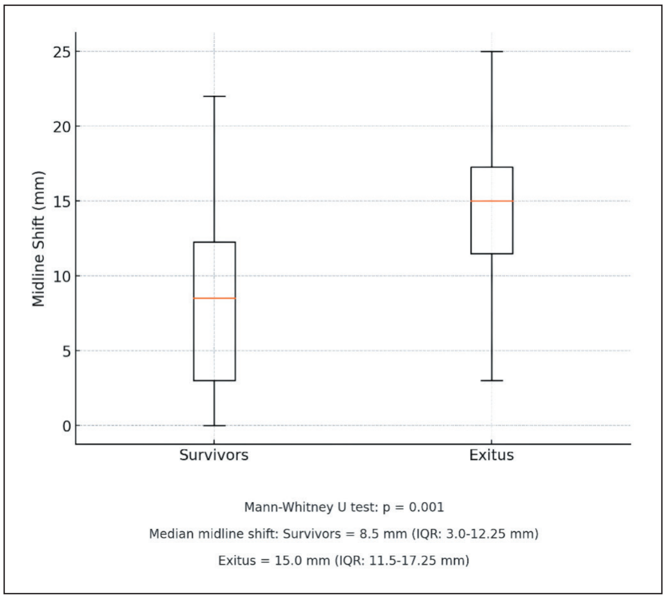

Figure 1: Midline shift distribution by Mortality Status.

Table III: Surgical Characteristics and Outcomes

Characteristic	Value
Type of Surgery, n (%)	
Craniotomy	70 (83.3)
Craniectomy	10 (11.9)
Extended Craniectomy	4 (4.8)
Surgical Duration (hours)	
Time to Surgery (Mean ± SD)	3.4 ± 0.6
Min - Max	2.5 - 5.0
Length of Stay (days)	
ICU Stay Duration (Mean ± SD)	7.8 ± 4.2
Total Hospital Stay (Mean ± SD)	13.5 ± 8.3
Glasgow Outcome Scale (GOS), n (%)	
GOS 1 (Death)	16 (19.0)
GOS 2 (Persistent Vegetative State)	4 (4.8)
GOS 3 (Severe Disability)	38 (45.2)
GOS 4 (Moderate Disability)	12 (14.3)
GOS 5 (Good Recovery)	14 (16.7)
Mortality	
Exitus, n (%)	16 (19.0)

GOS: *Glasgow outcome scale,* ***ICU:*** *Intensive care unit,* ***SD:*** *Standard deviation.*

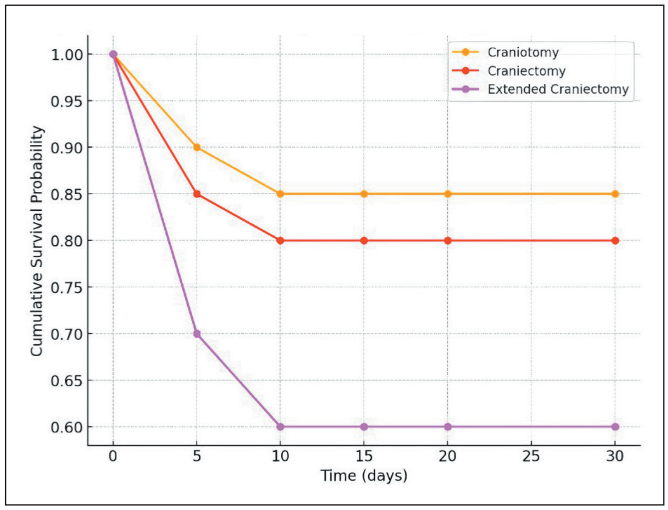

Figure 2: Kaplan-Meier survival analysis by surgical type (doubled patients).

A strong negative correlation was found between admission GCS score and mortality (ρ=-0.612, p<0.001). This suggests that lower GOS scores are associated with a higher mortality risk. A weak negative correlation was found between age and GOS (ρ=-0.384, p=0.012), indicating that the likelihood of poor clinical outcomes increases with increasing age (Table IV, Figure 3).

There was a significant negative correlation between subdural hematoma volume and Glasgow Outcome Scale (GOS) (r = -0.62, p=0.001). This finding indicates that the clinical outcomes of the patients tended to worsen as the hematoma volume increased. As seen in the graphical analysis, patients with smaller hematoma volumes generally achieved higher GOS scores (good recovery), whereas a significant decrease in GOS scores was observed as hematoma volume increased. Especially in cases with a hematoma volume of more than 100 ml, GOS scores were mostly 2 or lower, and these patients were observed to have severe neurological impairment or death (Figure 4).

DISCUSSION

The purpose of this research was to examine how various surgical methods impact the prognosis for individuals aged 65 years and above diagnosed with ASH. Predictive factors such as age, trauma severity, GCS score at presentation, pupillary response, and radiologic findings were retrospectively evaluated, with a particular emphasis on GCS score, hematoma volume, and midline shift as key determinants of clinical outcomes. Our data demonstrated that ASH in older adults was associated with elevated rates of mortality and morbidity, as well as that the selection of treatment significantly influenced outcomes in this demographic. The timing of surgical intervention and the precise surgical technique employed substantially impact patient prognosis, with more positive clinical results noted, particularly in patients who had craniotomies.

Table IV: Correlation Analyses

Variables	Spearman's rho	p-value
GCS-GOS	0.684	**<0.001**
Hematoma Volume-Midline Shift	0.542	**<0.001**
GCS-Mortality	-0.612	**<0.001**
Age-GOS	-0.384	**0.012**

***GCS:** Glasgow Coma Scale; **GOS:** Glasgow Outcome Scale*

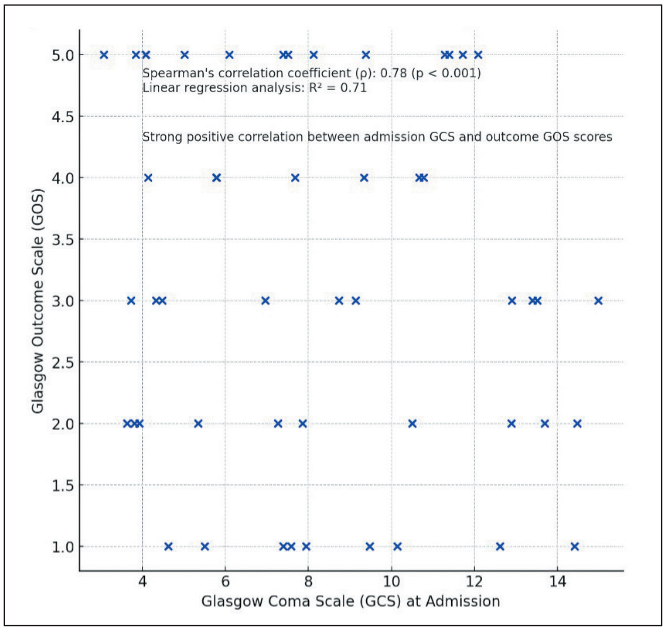

Figure 3: Glasgow Coma Scale (GCS) at admission vs Glasgow Outcome Scale (GOS).

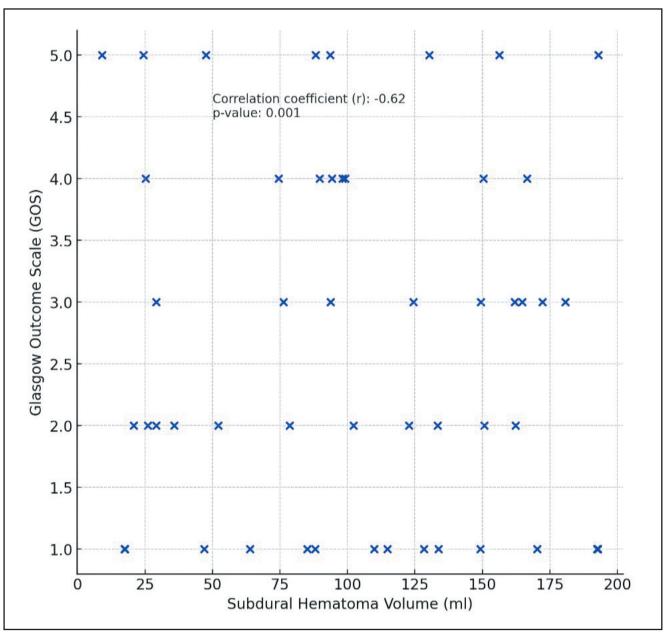

Figure 4: Subdural hematoma volume vs Glasgow Outcome Scale (GOS).

This research sought to elucidate the radiologic parameters that should inform surgical treatment decisions for older individuals with ASH. Research on the influence of the GCS on prognosis unequivocally indicates that it possesses significant predictive validity for both mortality and overall clinical outcomes. Our investigation identified a strong association between the GCS and the GOS scores (ρ=0.684); this result corroborates existing literature, reaffirming that the GCS is a reliable prognostic indicator. Akbik et al. indicated that a low GCS score correlated with unfavorable clinical outcomes and that preoperative GCS serves as a significant predictor of postoperative mortality (2). Brazinova et al. similarly indicated that older patients with a low GCS score typically exhibited a poor prognosis, and factors such as closed basal cisterns or significant midline shift heightened the risk of death (7). Our investigation revealed a mortality rate of 19% in patients with a low GCS score. This corroborates the systematic analysis by Evans et al., which indicated that a low GCS score was associated with an elevated mortality risk in older individuals (11). In addition, Salottolo et al. emphasized that older adult patients mostly had lower GCS scores and that these may predict poor prognosis (25). The results of our study, in parallel with these findings, show that the GCS score has a strong predictive value for mortality and poor clinical outcomes in the older population. The association of a low GCS score with poor prognosis is consistent with previous studies.

In our study, the mean hematoma volume was 62.2 mL, and this volume significantly affected prognosis. Jacobs et al. reported that the risk of poor prognosis increased with increasing hematoma volume, and mortality increased significantly, especially in cases exceeding 50 ml (13). Our findings showed a similar correlation between hematoma volume and mortality, consistent with the literature. Additionally, midline shift was evaluated as an important indicator of prognosis. In our study, the median midline shift was 8.5 mm in survivors, whereas this value reached 15 mm in patients who died. This finding aligns with research conducted by Yılmaz et al., which indicated that a midline displacement of 10 mm or greater was strongly associated with elevated mortality rates (31). The condition of the basal cisternae was also evaluated as a significant prognostic variable. Closed basal cisternae were found in 26.2% of our patients, and this was associated with poor prognosis. This result coincides with the findings of de Rodrigues de Souza et al., who reported that closed basal cisternae were more common in patients with high mortality risk (24). We also evaluated the effects of additional pathologies, on prognosis; additional pathologies such as contusion (35.7%) and subarachnoid hemorrhage (28.6%), negatively affected it. Moussa et al. also reported that contusion and other brain pathologies, especially with midline shift, worsened the prognosis (19). These findings support the results of our study and show that additional pathologies negative affect prognosis.

In our study, no statistical difference in prognosis existed between patients who underwent craniotomy (83.3%) and decompressive craniectomy (11.9%). However, the literature has reported that craniectomy is generally preferred in more severe cases and is thus associated with higher mortality rates. For example, Ahmed et al. reported that craniectomy resulted in worse clinical outcomes and a high mortality rate of 42.7% (1). Similarly, Chen et al. reported a mortality rate of 23.3% in the craniectomy group and 7.1% in the craniotomy group (8). Despite the lack of significant difference between clinical outcomes in our study, it the literature thus that craniotomy may be a more advantageous option regarding prognosis.

The effect of surgery timing on prognosis is also important. In our study, the mean time to surgery 3.4 hours, and this was critical in terms of prognosis. Pinggera et al. emphasized that rapid surgical intervention is of greatly important in decreasing mortality and, especially, performing surgery within 4 hours is effective in decreasing mortality rates (15,21). The surgical time frame in our study is close to that recommended in the literatüre, supporting the importance of timely surgical intervention.

In our study, the mean duration of intensive care unit stay was 7.8 days and the mean total hospital stay was 13.5 days. In the study by Anis et al., the mean duration of intensive care unit stay was 4.6 days in the decompressive craniectomy group and 3.4 days in the craniotomy group (3). The length of stay may vary depending on the clinical status of the patient and complications that develop. Zhang et al. reported that postoperative complications were lower in the craniotomy group and intracranial pressure control was more difficult in the craniectomy group. In particular, complications such as brain edema were more common after craniectomy (34). Similar complications were observed in our study, strengthening the idea that craniectomy may increase the risk of complications.

Hypertension (57.1%), diabetes mellitus (DM ; 35.7%), and coronary artery disease (CAD; 28.6%) rates were high in geriatric ASH patients in our study, consistent with the data in the literature. In a study conducted by Atsumi et al. in chronic subdural hematoma (CSDH) patients, the hypertension rate was reported as 20% and the DM rate as 11.4% (5). In a study by Sundblom et al. in 10CSDH patients over 70 years of age, the rate of cardiovascular disease was 43.4% and the rate of DM was 18.4% (27). These data suggest that comorbidities, including hypertension and DM, are prevalent among older patients and must be factored into the prognosis of ASH.

In our study, the rate of anticoagulant use was 38.1%, and the mortality rate was 37.5% in these patients. Younsi et al. stated that anticoagulant use may increase the risk of postoperative complications in patients with subdural hematoma, but the evidence that it increases mortality is limited (33). On the other hand, Raj et al. found higher mortality rates in older adult using anticoagulants (23). In our study, the rate of antiaggregant use was 45.2%. According to the study by Szczygielski et al., no significant negative effect of antiaggregant drugs such as aspirin on prognosis was observed, but anticoagulant use was associated with poor prognosis (28). Additionally, De Bonis et al. found that patients who used antiaggregants had longer hospital stays, consistent with the results of our study (10).

When the mean age (73.67 ± 10.00 years) and the distribution of age groups (52.4%, 65-75 years; 33.3%, 75-85 years) were evaluated in our study, the negative effect of age on prognosis was observed. A negative correlation (ρ=-0.384) was found between age and GOS score, consistent with similar studies in the literature. For example, Younsi et al. reported a postoperative mortality rate of 33% in ASH patients over 80 years of age and associated it with poor prognosis (32). Kerezoudis et al. observed an 18.3% death rate in older patients undergoing surgery for ASH, highlighting a considerable rise in this risk among patients over 85 years of age (14). These data substantiate the influence of age on prognosis and indicate an elevated risk of adverse clinical outcomes in elderly individuals. Hiraizumi et al. also indicated that age was a significant predictive factor in older patients with ASH, with the likelihood of poor prognosis escalating with advancing age (12). Qi et al. conducted a study on elderly patients with subarachnoid hemorrhage, revealing a substantial negative correlation between age and GOS (22). The data substantiate the detrimental impact of older age on the prognosis of acute subdural hematoma, correlating closely with a raised mortality rate. Aromatario et al. reported that mortality rates after subdural hematoma in elderly patients ranged between 17.6% and 55.1%, and age was significantly associated with poor prognosis (4). In our study, the negative effect of age on prognosis was explained by mortality rates varying according to age groups and negative correlation with GOS. Findings consistent with the results in the literature were obtained.

The most critical shortcomings of this study are its retrospective nature and low sample size. Therefore, the data's precision and level of statistical significance may be restricted. These constraints are also applicable to similar studies in the literature due to their retrospective character and small numbers of patients. Multicenter and prospective studies are preferable in the future. Additionally, the use of biochemical markers or clinical measurement methods in assessing prognosis may be improved.

CONCLUSION

We performed a retrospective analysis of the clinical and surgical prognostic factors in ASH patients over the age of 60 years. These parameters included age, GCS score on admission, hematoma size, and midline shift. The time of surgical intervention and the approach were determinative in clinical outcomes. When craniotomy and decompressive craniectomies were contrasted, the impact of these methods was different for frequently attending clinical features and the selected population. To improve ASH patients' prognosis, timely and effective surgical measures and individualized approaches are essential.

Declarations

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Availability of data and materials: The datasets generated and/or analyzed during the current study are available from the corresponding author by reasonable request.

Disclosure: The authors declare no competing interests.

AUTHORSHIP CONTRIBUTION

Study conception and design: HI
Data collection: HI, ASA, MD
Analysis and interpretation of results: EE
Draft manuscript preparation: HI, ASA, MD, NV
Critical revision of the article: HI, ASA, MD, NV
Other (study supervision, fundings, materials, etc...): HCG, HI, ASA
All authors (HI, ASA, MD, NV, HCG, EE) reviewed the results and approved the final version of the manuscript.

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