Article published online: 2022-11-15

Prognostic Value of Swirl Sign in Acute Epidural Hemorrhage

Hemant Kumar Beniwal[1] Musali Siddartha Reddy[2] Golapudi Prakash Rao[1] Manne Srikrishnaditya[1] Anisha Beniwal[3]

[1] Department of Neurosurgery, Gandhi Medical College and Hospital, Mahbubnagar, Telangana
[2] Department of Neurosurgery, SVS Medical College and Hospital, Mahbubnagar, Telangana
[3] Department of Critical Care Medicine, Max Hospital, Saket, New Delhi India

Address for correspondence Hemant Kumar Beniwal, Department of Neurosurgery, 4th Floor, Gandhi Medical College and Hospital, Padma Rao Nagar, Secunderabad, 500003, Telangana, India (e-mail: sujanhemant@gmail.com).

AJNS 2022;17:584–587.

Abstract

Objective The purpose of this study is to analyze and evaluate the incidence, prognostic value, and impact of swirl sign on the outcome of patients who underwent surgical treatment for epidural hematoma.

Materials and Methods A retrospective analytical study on 307 acute epidural hematoma (AEDH) patients with and without swirl sign was conducted at our hospital between 2015 and 2019. All the patients in this study were treated initially as per the protocols of advanced trauma life support and surgically treated by craniotomy and evacuation of epidural hematoma. Patients with other concomitant intracerebral injuries such as subdural hematoma and contusion and those who were managed conservatively were excluded from the study. Various factors such as age, sex, mechanism of injury, Glasgow Coma Scale (GCS) score at admission, time from injury to surgery, preoperative mydriasis, location of bleed, midline shift, location of fracture, volume of hematoma, duration of stay in the hospital, and GCS score at discharge were taken into consideration and compared in between patients with and without swirl sign. Outcomes were assessed at the end of 6 months using the Glasgow Outcome Scale.

Results Of the 307 patients who were operated for epidural hemorrhage, 92 had swirl sign (29.96%) and the rest had no swirl sign. Univariate analysis revealed a significant correlation between the presence of swirl sign and age, preoperative mydriasis, and time from injury to surgery. The patients with the swirl sign had an unfavorable outcome at the end of 6 months which was statistically significant.

Conclusion It can be concluded that those patients with swirl sign in AEDH had an unfavorable outcome compared to those without swirl sign. Therefore, aggressive treatment and early surgery play an important role in the outcomes of the patients.

Keywords
- Acute
- epidural hematoma
- outcome
- prognosis
- surgery
- swirl sign

article published online
November 16, 2022

DOI https://doi.org/10.4103/ajns.AJNS_68_21.
ISSN 2248-9614.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

Introduction

Acute epidural hematoma (AEDH) is one of the most common intracranial injuries following trauma. Swirl sign is a relatively uncommon sign and refers to acute extravasation of blood on noncontrast computed tomography scan of the brain. It represents unclotted blood which is of lower attenuation compared to the clotted blood which surrounds it. The most common source of bleeding in patients with AEDH is the middle meningeal artery. As the swirl sign represents active bleeding, it causes rapid expansion of hematoma and therefore a rapid increase in intracranial pressure followed by brain herniation resulting in death. Therefore, timely diagnosis and neurosurgical intervention may reduce the mortality and morbidity associated with it. The aim of this study is to evaluate the incidence, correlation between the presence of swirl sign and various risk factors, prognostic value, and outcomes.

Materials and Methods

A retrospective analysis was conducted on patients with traumatic AEDH (with and without swirl sign) who were diagnosed based on computed tomography (CT) scan and surgically treated at the department of neurosurgery in our hospital between 2015 and 2019.

Inclusion Criteria

Patients with isolated AEDH were included in the study.

Exclusion Criteria

- Patients with concomitant subdural hematomas and intracranial hemorrhages
- Patients with abnormal coagulation profile
- Patients who were managed conservatively were excluded from the study.

All the patients admitted were initially evaluated and treated according to the advanced life trauma support protocol. Initially patient was managed and stabilised and neurological and other systemic examination done in emergency department, after that, patient was sent for CT scan of the head for radiological examination. Patients were operated upon if they met the criteria/indications for surgery such as hematoma of 30 mL or higher, clot thickness greater than 10 mm, midline shift greater than 5 mm, compressed/absent basal cisterns, and neurological deterioration.

Surgery done was craniotomy and evacuation of an AEDH. Outcomes were assessed using Glasgow Outcome Scale (GOS) score 6 months after the surgery. The favorable outcome was defined as GOS greater than 4 and the unfavorable outcome was defined as GOS of 4 or lower. The volume of the hematoma was calculated by the formula A*B*C/2 where A represents the greatest diameter in the axial plane, B represents diameter at 90° to A, and C represents the number of CT slices multiplied by the slice thickness. Swirl sign was identified by the presence of small swirling hypoattenuated region in a large hyperattenuated epidural clot.

Statistical Analysis

Statistical analysis was done using SPSS version 20 (SPSS Inc., IBM) and MS Excel. Descriptive statistics are mentioned in percentages. Data were expressed as mean ± standard deviations and proportions. Association between swirl sign and various parameters and outcomes was evaluated on basis of the Chi-square test, Fisher's test and unpaired *t*-test. Multivariate regression analysis was used for variables such as age, gender, preoperative Glasgow Coma Scale (GCS) score, preoperative mydriasis, and time from injury to surgery. Independent *t*-test was used to compare two groups. All tests are two-tailed, and *p*-value less than 0.05 was considered statistically significant.

Results

Demographic Distribution of Study Population

A total of 307 people who met the inclusion criteria were included in this study. In the patients with swirl sign, the patient's age ranged from 12 to 75 years with a mean age of 30.15 ± 15.25 years. Majority of the patients with swirl sign were below 30 years (62%). Eighty-five (92.3%) patients were male and 7 (7.7%) were female. The mechanism of injury was road traffic accidents in 66 (71.7%) patients, fall from height in 15 (16.3%) patients, and assault in 11 (12%) patients.

In the patients without swirl sign, the age ranged from 12 to 70 years with a mean age of 35.6 ± 12.78. Majority of the patients were above 30 years (54.8%). One hundred and eighty-six (86.5%) patients were male and 29 (13.5%) were female. The mechanism of injury was road traffic accidents in 145 (67.4%), fall from height in 54 (25.1%), and assault in 16 (7.5%) patients.

The mean difference of age between study participants with and without swirl sign group was found to be statistically significant (unpaired *t*-test of significance was used: $p < 0.05$).

Clinical and Imaging Characteristics of the Study Population

Univariate analysis revealed a significant correlation between the occurrence of swirl sign and mean age, preoperative mydriasis, and time from injury to surgery. There was no significant correlation between the occurrence of swirl sign and gender, mechanism of injury, mean GCS score at admission, presence of skull fracture, midline shift, mean hematoma volume on computed tomography, and mean number of days in intensive care unit.

In patients with swirl sign in epidural hematoma, 86 (95.6%) had preoperative mydriasis and 4 (4.34%) did not have any preoperative mydriasis ($p < 0.05$). Of the 23 patients in whom surgery was performed within 4 h after accident, 12 (52.1%) had swirl sign, and in those 284 patients in whom surgery was performed 4 h after accident, 80 (28.1%) had swirl sign ($p = 0.0303$). The most common site for skull fracture in patients with swirl sign was temporoparietal (62.5%), and it is also the most common site for hematoma collection in patients with (50%) and without swirl sign (54.4%).

The midline shift among swirl sign group was found among 51.8% of study subjects and 48.2% of nonswirl sign

group study subjects. The difference was found to be statistically highly significant ($p < 0.001$). The odds were found to be 3.7 (2.2–6.49) suggesting positive association between midline shift and swirl sign.

The mean duration of stay in the intensive care unit (ICU) was 3.96 ± 4.8 in patients with swirl sign and 3.8 ± 4.2 in patients without swirl sign. The mean difference of ICU stay was found to be statistically significant ($p < 0.05$).

The mean GCS at the time of admission was 9.5 ± 4.1 in patients with swirl sign and 8.5 ± 3.9 in patients without swirl sign. The mean difference between GCS score was found to be statistically significant ($p < 0.05$).

Similarly, in this study, it was also found that the mean GCS score at discharge was 14.6 ± 0.83 among swirl sign-positive patients and 8 ± 2 among nonswirl sign patients. The difference in mean GCS score at discharge was found to be statistically highly significant ($p < 0.001$).

The mean hematoma volume on CT scan among swirl sign-positive study subjects was found to be 49.8 ± 19 and 42 ± 16.3 among swirl sign-negative subjects. The difference was found to be statistically highly significant ($p < 0.001$).

Outcomes

In this study, it was observed that only 52.2% of study subjects had a favorable outcome among swirl sign-positive group and 80.9% of study subjects among nonswirl sign group had favorable outcome. Around 30.4% of study subjects had mortality in swirl sign group and only 8.4% of study subjects had mortality in nonswirl sign group. The difference in outcome was found to be statistically highly significant ($p < 0.001$). The mean GOS score among swirl sign group was found to be 3.58 ± 1.77 and 4.43 ± 1.25 among nonswirl sign group. The mean difference was also found to be statistically highly significant ($p < 0.001$).

The mortality rate of patients was higher in patients with swirl sign (30.4%) compared to the patients without swirl sign (8.4%).

Discussion

Swirl sign is acute extravasation of blood in formed hematoma on noncontrast CT. Radiologically, swirl sign was defined as an area of low density (30–50 HU, hypo- or isodense to brain parenchyma) surrounded by hyperdensity (65–95 HU) of clotted blood.

Greenberg et al reported that the presence of swirl sign in an AEDH is associated with significantly higher mortality and morbidity. Our study also demonstrated that the presence of swirl sign in AEDH is associated with unfavorable outcome and higher mortality at the end of 3 months after surgery, thus reinstating the findings of Greenberg et al.[1]

A retrospective analytical study by Ono et al reported that GCS score was the only significant prognostic factor in the epidural group.[2] Lee et al reported that functional outcome exhibited a significant correlation with the preoperative conscious state, GCS score, and pupillary size.[3] Guo et al reported that the presence of preoperative lower GCS score and mydriasis were responsible for the poorer outcome.[4] In our study, the mean GCS at the time of admission was 9.5 ± 4.1 in patients with swirl sign and 8.5 ± 3.9 in patients without swirl sign. The mean difference between GCS score was found to be statistically significant ($p < 0.05$). Low mean GCS score in patients without swirl sign may be due to increased association with other associated hemorrhages such as subdural hematoma, contusion, intracerebral hematoma, and diffuse axonal injuries.

Age and preoperative mydriasis have a significant correlation with patients demonstrating swirl sign. Increased frequency of swirl sign in age group 11–20 years may be due to its association with large number of temporal bone fractures, which in turn is responsible for middle meningeal artery rupture. The presence of swirl sign is an indication of active bleeding on CT scan of the brain and may be associated with the rapid expansion of intracranial hematoma which is responsible for the rapid preoperative mydriasis.

The time from the trauma to surgery also plays an important role in predicting the outcomes. Tian et al demonstrated that time from trauma to surgical demonstration was associated with mortality.[5] Our study demonstrates that a patient who was operated within 4 h of trauma had a statistically significant better outcome than those without swirl sign. As swirl sign indicates the active bleeding, it may cause rapid increase in size of hematoma which can lead to further neurological deterioration, therefore, early surgery and evacuation of hematoma makes the better outcome. We can suggest that patients with swirl sign should be subjected to early decompression and evacuation to achieve better outcomes.

Consistent with previous studies,[6–9] temporoparietal AEDH associated with fractures tearing through the middle meningeal was the most common location in patients with and without swirl sign.

Conclusion

Swirl sign in acute epidural hematoma represents the sign of active bleeding. Presence of swirl sign has an unfavourable outcome, as it can expand the hematoma in size. Early surgery after trauma makes the favourable outcome in acute EDH with swirl sign.

Limitations

The limitation of this study was the retrospective design of the study.

Funding
None.

Conflict of interest
None declared.

References

1 Greenberg J, Cohen WA, Cooper PR. The “hyperacute” extraaxial intracranial hematoma: Computed tomographic findings and clinical significance. Neurosurgery 1985;17:48–56

2 Ono J, Yamaura A, Kubota M, Okimura Y, Isobe K. Outcome prediction in severe head injury: Analyses of clinical prognostic factors. J Clin Neurosci 2001;8:120–123
3 Lee EJ, Hung YC, Wang LC, Chung KC, Chen HH. Factors influencing the functional outcome of patients with acute epidural hematomas: Analysis of 200 patients undergoing surgery. J Trauma 1998; 45:946–952
4 Guo C, Liu L, Wang B, Wang Z. Swirl sign in traumatic acute epidural hematoma: Prognostic value and surgical management. Neurol Sci 2017;38:2111–2116
5 Tian HL, Chen SW, Xu T, Hu J, Rong BY, Wang G, et al. Risk factors related to hospital mortality in patients with isolated traumatic acute subdural haematoma: Analysis of 308 patients undergone surgery. Chin Med J (Engl) 2008;121:1080–1084
6 Araujo JL, Aguiar Udo P, Todeschini AB, Saade N, Veiga JC. Epidemiological analysis of 210 cases of surgically treated traumatic extradural hematoma. Rev Col Bras Cir 2012;39:268–271
7 Bullock MR, Chesnut R, Ghajar J, Gordon D, Hartl R, Newell DW, et al. Surgical management of acute epidural hematomas. Neurosurgery 2006;58:S7–15
8 Paiva WS, Andrade AF, Mathias L Jr., Guirado VM, Amorim RL, Magrini NN, et al. Management of supratentorial epidural hematoma in children: Report on 49 patients. Arq Neuropsiquiatr 2010; 68:888–892
9 Yilmazlar S, Kocaeli H, Dogan S, Abas F, Aksoy K, Korfali E, et al. Traumatic epidural haematomas of nonarterial origin: Analysis of 30 consecutive cases. Acta Neurochir (Wien) 2005;147: 1241–1248

