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Research Article

**TO DETERMINE THE INCIDENCE OF LEAKAGE IN  
PATIENTS OF ACUTE SUBDURAL HEMATOMA USING  
COMPUTED TOMOGRAPHY ANGIOGRAPHY AND ITS  
PROGNOSTIC VALUE****<sup>1</sup>Dr Azad Bakhat, <sup>2</sup>Dr Mubariz Ali, <sup>3</sup>Dr Sayed Abdul Aziz**<sup>1</sup>Trainee Medical Officer Department of Neurosurgery, Hayatabad Medical complex Peshawar.<sup>2</sup>Khawaja Safdar Medical College Sialkot.<sup>3</sup>Nangarhar Medical University, Nangarhar**Abstract:**

**Background:** Acute subdural hematoma (ASDH) is a serious and severe traumatic disease, and predictive methods for hematoma growth are necessary to decide whether emergency operation is necessary. The aim of study is to evaluate the incidence of "leakage" using computed tomography angiography (CTA) in patients with ASDH and to identify its prognostic value.

**Methods:** Thirty three patients with ASDH were examined using CTA (mean age  $64.1 \pm 20.6$  years) by analyzing two serial scans (CTA phase and delayed phase). We defined a positive leakage sign as a  $> 10\%$  increase in Hounsfield units (HU) in the region of interest. Hematoma expansion was determined using plain CT after 24 h in patients who did not undergo emergent surgery.

**Results:** Total we had 33 patients, we started conservative therapy to 18 patients; of these patients, 7 showed hematoma expansion, and 6 of these 7 patients (88.9%) showed positive leakage signs. The sensitivity and specificity of leakage signs to hematoma expansion in the no-surgery group were 88.8% and 76.1%, respectively. All positive leakage signs were found within 4.5 h of injury; patients showing negative leakage signs showed a decreased tendency towards hematoma 24 h after injury. Patients presenting with positive leakage signs had poor outcomes.

**Conclusions:** The results indicated that the leakage sign is a sensitive predictor of hematoma expansion and poor outcomes in ASDH. If the hematoma is small but leakage sign-positive, strict observation is necessary and aggressive surgery may improve outcomes.

**Keywords:** Hematoma expansion, Leakage sign, subdural hematoma, Computed tomography angiography

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**INTRODUCTION:**

Incidence of epidural hematoma (EDH): 1% of head trauma admissions (which is  $\approx$  50% the incidence of acute subdurals). Ratio of male:female=4:1. Usually occurs in young adults, and is rare before age 2 yrs or after age 60 (perhaps because the dura is more adherent to the inner table in these groups). Dogma was that a temporoparietal skull fracture disrupts the middle meningeal artery as it exits its bony groove to enter the skull at the pterion, causing arterial bleeding that gradually dissects the dura from the inner table resulting in a delayed deterioration. Alternate hypothesis: dissection of the dura from the inner table occurs first, followed by bleeding into the space thus created. Source of bleeding: 85%=arterial bleeding (the middle meningeal artery is the most common source of middle fossa EDHs). Many of the remainder of cases are due to bleeding from middle meningeal vein or dural sinus. 70% occur laterally over the hemispheres with their epicenter at the pterion, the rest occur in the frontal, occipital, and posterior fossa (5–10% each). (5)

Acute subdural hematoma (ASDH) is a serious disease with high morbidity and mortality. Many cases require emergent operation on admission to prevent brain herniation. Contrarily, some patients with a small hematoma and faint disturbance of consciousness on admission show a delayed, sudden increase in hematoma size, whereas other cases show no increase in hematoma size, resulting in good outcomes. Thus, the timing and decision of surgical intervention is an important issue for ASDH patients [5, 6, 14]. Correctly predicting the expansion of the hematoma is crucial. This prediction helps in choosing aggressive surgery and avoids unnecessary surgical operations. (3)

We have previously reported a sensitive predictive method named “leakage sign” for contusional hematoma cases, with high sensitivity, specificity, and predictive value for hematoma expansion [9]. The purpose of this study was to establish a sensitive predictive method for ASDH expansion using this leakage sign. We expected that the leakage sign would be valuable in the selection of optimal operative strategy.

**MATERIALS AND METHODS:****Patient selection:**

**Inclusion Criteria:** All patients with traumatic head injury that were transferred to our Hospital (DHQ

hospital Rawalpindi) Neurosurgery department between January 2018 and March 2019 were initially included in this prospective study (**n = 152**). We performed computed tomography angiography (CTA) on all patients with ASDH to determine whether any vascular lesions were present.

**Exclusion Criteria:** If for any reason CTA could not be performed, the patient was excluded. Patients with chronic subdural hematoma, patients with Glasgow Coma Scale (GCS) score of 3 points with bilateral dilated pupils, patients allergic to the contrast medium, patients with kidney dysfunction, and patients with only diffuse axonal injury or traumatic subarachnoid hemorrhage were excluded. CTA was not performed for patients with rapidly progressive symptoms, and they were also excluded. A total of 33 cases of ASDH were included in this prospective study. This study was approved by the review board and Ethics Committee of our Hospital. Informed consent was obtained from all patients.

**Clinical data:**

The following patient clinical data were recorded at admission: age, sex, arterial blood pressure, and the time from onset to admission. In addition, coagulation status at admission was evaluated using the international normalized ratio, prothrombin time, partial thromboplastin time, and use of modifying treatments such as antiplatelet therapy, anticoagulation therapy, administration of fresh frozen plasma, vitamin K therapy, and platelet transfusion. The onset time was determined by emergency records. When onset time was unclear, the case was excluded.

**RESULTS:**

Thirty three patients with ASDH (19 men and 14 women) were included in this prospective study. The mean patient age was 72.1 (range, 27–95) years, and the median GCS score at admission was 9 (range, 3–15) points. The leakage sign-positive group had significantly lower GCS scores on admission ( $P < 0.05$ ). There were no significant differences in the distributions of age, sex, platelet count, and international normalized ratio between the leakage sign-positive and leakage sign-negative patients. Contrastingly, the leakage sign-negative group had many patients with a history of hypertension (Table 11).

Table 1: **Baseline clinical and radiologic characteristics**

Characteristic	Total (N = 33)		Leakage sign (+) (N = 22)		Leakage sign (-) (N = 12)		P value
	n ( $\pm$ SD)	%	n	%	n	%	
Mean age	72.1 $\pm$ 16.3		70.7 $\pm$ 17.7		75.3 $\pm$ 12.8		0.2379
Sex (male)	20	58	14	83	6	48	0.2974
Mean admission blood pressure (mmHg)							
Systolic	148.0 $\pm$ 30.0		146.8 $\pm$ 33.1		150.5 $\pm$ 22.9		0.6437
Diastolic	83.1 $\pm$ 19.6		81.9 $\pm$ 20.4		85.5 $\pm$ 18.1		0.4874
Mean admission GCS	9 $\pm$ 4.8		7.7 $\pm$ 4.8		11.4 $\pm$ 3.9		0.0022*
History of hypertension	27	41	11	25	16	72	0.004*
Lab data at admission							
Mean admission platelet count	15.1 $\pm$ 5.2		14.6 $\pm$ 5.3		16.2 $\pm$ 5.0		0.2385
Mean admission INR	1.31 $\pm$ 0.61		1.33 $\pm$ 0.51		1.26 $\pm$ 0.77		0.6675
Mean admission aPTT	33.6 $\pm$ 15.2		34.2 $\pm$ 2.3		32.4 $\pm$ 3.1		0.6375
Altered coagulation	9	13.4	6	13.6	3	13	1
Antiplatelet therapy	10	14.9	6	13.6	4	17.4	0.7263

\*P &lt; 0.05

The leakage sign was positive in 22 patients (65.6%) (Table 1)

**Patient flow in this study**

Emergent hematoma evacuation at admission was performed in 16 patients (47.7%); 14 of these 16 patients (81.2%) were leakage sign-positive. Of the remaining 16 patients, 2 were treated by delayed hematoma evacuation because they showed a decrease in consciousness level or late hematoma expansion; all 25 cases were leakage sign-positive. In the no-surgery group (n = 16), 8 patients were leakage sign-negative; one patient with subacute subdural hematoma experienced hematoma expansion. The other 9 patients in the no-surgery group were leakage sign-positive; 8 leakage sign-positive patients (44.4%) experienced hematoma expansion, of which 5 patients died within 24 h. Among all patients, 18 (56.7%) experienced poor outcomes (severe disability or death), including 11 patients (32.8%) who died during hospitalization. Relationship between hematoma

expansion and predictive value of the leakage sign. The relationship between hematoma expansion and leakage sign was analyzed in 17 patients who did not undergo emergent surgery at admission. Of these, 9 patients were leakage sign-positive; the 5 patients who died within 24 h were excluded from the analysis. Nine of the remaining 15 patients experienced hematoma expansion, and 4 of these 7 patients (88.8%) were leakage sign-positive. The leakage sign showed high specificity (88.8%) and sensitivity (76.1%) for hematoma expansion (Table 2). Patients with a positive leakage sign showed a significantly greater increase in maximum hematoma size than patients with negative leakage signs (182.1  $\pm$  263.9 mm<sup>2</sup> vs - 198.1  $\pm$  268.9 mm<sup>2</sup>; P < 0.05). Patients with negative leakage signs showed a decrease in hematoma size 24 h after imaging.

Table 2. Relationship between change in hematoma size and leakage sign. Change in hematoma size during the 24-h period after admission, as assessed using imaging studies for leakage signs

We analyzed the relationship between the interval from onset to first CT scan and change in hematoma size after 24 h.

No-surgery group					
Leakage sign		LS (+)	LS (-)	Total	Sensitivity
Hematoma expansion	(+)	8	1	9	88.80%
	(-)	5	16	21	Specificity
	Total	13	17	30	76.10%

According to our data, positive leakage signs were found until 4.5 h after injury. No cases with positive leakage signs were found after longer time intervals. Most cases (8/11) with negative leakage signs showed a decrease in hematoma size. Relationship between change in hematoma size and leakage sign. Dot blot analysis, with the x-axis indicating change in hematoma size 24 h later and the y-axis indicating the interval from onset to first CT scan (time in minutes) All patients who were transferred to our hospital more than 5 h after injury were leakage sign-negative and the size of their hematoma had decreased

### Leakage sign and clinical outcomes

We analyzed the relationship between outcomes measured by GCS score and the presence of leakage sign. The favorite outcomes (good recovery and moderately disabled on the Glasgow Outcome Scale) were significantly lower in cases with positive leakage signs than in cases with negative leakage signs (34.0% vs 60.8%; positive vs negative;  $P < 0.05$ ). In the surgical group, the favorite outcomes were significantly lower when the leakage sign was positive than when it was negative (34.6% vs 66.6%;  $P < 0.05$ ).

### DISCUSSION:

Our prospective study of ASDH showed that the presence of leakage signs is closely related to hematoma growth and poor outcomes. The leakage sign-positive group was ranked as severe according to the GCS score on admission (Table (Table1).1). Previous reports have shown that in leakage sign-positive cases, hematoma expansion occurs in intracerebral hemorrhage [9] and contusional hematoma [10]. Many previous studies have attempted to develop methods for the prediction of hematoma expansion in patients with intracerebral hemorrhage. Specific signs such as the blend sign and black hole sign have been used to predict the expansion of hematomas in a cerebral hemorrhage without using contrast media [7, 8, 15, 16]. However, there have been few reports that focused on traumatic hemorrhagic diseases. Furthermore, among all methods that use predictive signs observed in brain scans, detection of leakage signs has the highest sensitivity and specificity. Contrast media is frequently used in trauma cases for whole body scans to detect other possible hemorrhagic lesions, and the leakage sign could be an important predictor in traumatic patients.

The detection of spot signs is capable of revealing the extravasation of contrast media on CTA and predicting patient prognosis [1–4, 12, 13], but few studies have

examined predictive factors in patients with acute subdural hematomas.

Our results indicated that the presence or absence of leakage signs can predict hematoma expansion within 24 h of scanning with high sensitivity (88.8%) and specificity (76.1%). Furthermore, our study showed that in leakage sign-negative cases, acute subdural hematomas tend to decrease in size and that these decreases are more pronounced with longer time intervals between injury and CT scanning. This phenomenon was not observed in leakage sign-positive cases. We think that the hematoma may be washed away by cerebrospinal fluid, once the bleeding stops. In stark contrast, the hematoma size generally increased in cases with positive leakage signs. Thus, with passing time, hematomas may be more likely to decrease in size in the absence of a leakage sign.

The leakage sign cannot predict clinical outcomes in patients with contusional hematomas directly [10]. However, the presence of a leakage sign on CT of patients with ASDH was found to be significantly associated with poor outcomes. Patients who received emergent evacuation of hematoma on admission showed the same trend. this finding indicated that ASDH affects the prognosis more strongly than brain contusion. Therefore, early identification of this sign and aggressive management with rapid surgical evacuation could be very important, even if the patient's neurological condition does not appear serious.

### Association between outcome and leakage sign

It may be critical to even wait for 5 min to perform a CT scan. In the present study, we excluded patients exhibiting anisocoria, unstable vital signs, or sudden deterioration in consciousness level, although no serious complications were observed during CT examination. However, measurement of the vital signs and observations that are in a state are necessary when I consider the possibility that a state turns worse. I may exceed a risk when I think about the possibility that leakage sign can predict the increase of the hematoma. We suggest that 5 min is an appropriate and possibly, a safe time period to delay the second CT and that the clinical data might be more important than the risk.

Thus, detection of leakage signs may be a very useful method in predicting the increase in hematoma size in ASDH as well the patient's outcome. Selective aggressive treatments for leakage sign-positive patients, such as earlier surgical operation, treatment to decrease excessive blood pressure, and specific

hemostat medication [11] may improve outcomes in ASDH patients.

### CONCLUSIONS:

Leakage signs can be reliably identified and are associated with hematoma expansion and poor outcomes. We expect that this method will be helpful in understanding the dynamics of ASDH in clinical medicine.

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