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# Acute subdural hematoma: outcome and outcome prediction

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## Abstract

Patients with traumatic acute subdural hematoma were studied to determine the factors influencing outcome.

Between January 1986 and August 1995, we collected 113 patients who underwent craniotomy for traumatic acute subdural hematoma. The relationship between initial clinical signs and the outcome 3 months after admission was studied retrospectively.

Functional recovery was achieved in 38 % of patients and the mortality was 60 %. 91 % of patients with a high Glasgow Coma Scale (GCS) score (9–15) and 23 % of patients with a low GCS score (3–8) achieved functional recovery. All of 14 patients with a GCS score of 3 died. The mortality of patients with GCS scores of 4 and 5 was 95 % to 75 %, respectively. Patients over 61 years old had a mortality of 73 % compared to 64 % mortality for those aged 21–40 years. 97 % of patients with bilateral unreactive pupil and 81 % of patients with unilateral unreactive pupil died. The mortality rates of associated intracranial lesions were 91 % in intracerebral hematoma, 87 % in subarachnoid hemorrhage, 75 % in contusion.

Time from injury to surgical evacuation and type of surgical intervention did not affect mortality. Age and associated intracranial lesions were related to outcome. Severity of injury and pupillary response were the most important factors for predicting outcome.

**Keywords:** Acute subdural hematoma, outcome, outcome prediction.

## 1 Introduction

Traumatic acute subdural hematoma (ASDH) remains one of the most lethal of all head injuries; the mortality rate is reported to be between 40 and 90 % in most large series [6, 8, 11, 12, 22, 24, 25]. Mortality from ASDH is influenced by many variables such as age, diagnosis, mechanism and severity of injury, associated craniocerebral injury, prompt surgical evacuation, surgical technique, and postoperative care [2, 5, 7, 17, 23]. Although mortality has been reported to markedly decrease in patients with ASDH who undergo craniotomy and hematoma evacuation within 4 hours of injury [23], some reports show no significant difference in mortality from ASDH whether craniotomy and hematoma evacuation occurred less or more than 4 hours after injury [18, 28]. Recently HATASHITA et al [11] suggested that mortality is only influenced by age, type of surgical intervention among patients with GCS scores of 4–6, and absence of pupillary light reflex.

We retrospectively reviewed 113 consecutive patients with ASDH to demonstrate the outcome of the management of ASDH and to find out which parameters are significant in predicting the outcome.

## 2 Materials and methods

The records of 113 patients admitted to the emergency room of Erciyes University Medical School Hospital between January 1986 and August 1995 who underwent surgical intervention for traumatic ASDH were reviewed. Unconscious patients underwent a standardized treatment protocol including entubation with assisted ventilation and hemodynamic stabilization. Patients with serious extracranial injuries and ASDH of the posterior fossa were excluded.

**Table I.** Summary of variables affecting outcome

| Variable | | Good recovery | Moderately disabled | Severely disabled | Death | Total |
|---|---|---|---|---|---|---|
| Age (yrs) | < 20 | 19 | 2 | 1 | 23 | 45 |
| | 21–40 | 10 | 2 | 1 | 24 | 37 |
| | 41–60 | 6 | – | – | 10 | 16 |
| | 61 < | 3 | 1 | – | 11 | 15 |
| Sex | Male | 33 | 2 | 2 | 56 | 93 |
| | Female | 5 | 3 | – | 12 | 20 |
| Mechanism of injury | MVA | 21 | 2 | 1 | 48 | 72 |
| | Fall | 13 | 2 | 1 | 16 | 32 |
| | Assault | 4 | 1 | – | 4 | 9 |
| Presenting GCS | 3–4 | 2 | – | – | 35* | 37 |
| | 5–6 | 4 | 2 | – | 22* | 28 |
| | 7–8 | 11 | 2 | 1 | 11 | 25 |
| | 9–12 | 10 | 1 | – | – | 11 |
| | 13–15 | 11 | – | 1 | – | 12 |
| Total | | 38 | 5 | 2 | 68 | 113 |

MVA = Motor vehicle accident; GCS = Glasgow Coma Scale; * $\chi^2 = 58.06$; $p < 0.05$ significantly less than other groups

The GCS score [26] and pupil abnormalities were determined just before surgery. The mechanisms of injury, time from injury to operation and other prognostic factors were assessed. Most of the patients who underwent late operation had been transferred from another hospital. The diagnosis was based on computed tomography (CT). Patients with ASDH of more than 10 mm of thickness or causing more than 5 mm of midline shift on CT scans were transferred directly from the CT scanning room to the operating room. Mannitol 1 g/kg and furosemide 1 mg/kg were administered during preparation for surgery. Steroids were not given. Once surgical management had been selected, rapid craniotomy with complete clot evacuation and resection of necrotic brain parenchyma were performed. Duraplasty was used for patients showing acute intraoperative brain swelling and massive cerebral contusion.

The neurological outcome was determined according to the Glasgow Outcome Scale (GOS) [15] and the outcome was recorded at death or 3 months after admission. The five GOS categories are: good recovery, moderately disabled, severely disabled, vegetative and died. Functional recovery is defined as a GOS grade of good recovery or moderately disabled.

Statistical analysis used chi-square testing for comparison of various results. A statistically significant difference was indicated by a p value of less than 0.05.

## 3 Results

Ninety-three (82 %) of the 113 patients were males and 20 (18 %) females. The age ranged from 1 to 85 years (the mean age was 31.1 years). The most common cause of injury was a traffic accident in 72 patients (64 %), a fall in 32 (28 %), and an assault in 9 (8 %). Forty-three patients (38 %) made a functional recovery, two (2 %) were severely disabled, and 68 (60 %) died.

Patients over 61 years old had a mortality of 73 % (for GCS scores of 3–5: 87 %) and patients 21–40 years old had 64 % (for GCS scores of 3–5: 82 %). Age made little difference in outcome (Table I).

The mean GCS score before surgery was 7.1 for all patients, 9.8 for patients with functional recovery, and 5.2 for those who died. Table I shows the relationship between GCS score before surgery and outcome. Eleven of 12 patients with GCS scores of 13–15 made a good recovery and one who had cerebral contusion and aspiration pneumonia was severely disabled. One of 11 patients with GCS scores of 9–12 was moderately disabled and the others made good recovery. All 14 patients with a GCS score of 3 died. Twenty-one of the 23 patients with a GCS of 4 died and two made good recovery. These were 2 and 25 years old, had a time to operation of four and two hours, and no absence of pupillary light reflex. The mortality was 100 % and 91 % at the GCS 3 and 4 score levels, respectively. The severity of injury re-

**Table II.** Relationship between pupillary light reflex and outcome

| Outcome | Pupillary light reflex | | | Total |
|---|---|---|---|---|
| | Bilateral absence | Unilateral absence | Bilateral presence | |
| Good recovery | – | 1 | 37 | 38 |
| Moderately disabled | 1 | 1 | 3 | 5 |
| Severely disabled | – | – | 2 | 2 |
| Death | 38* | 9* | 21 | 68 |
| Total | 39 | 11 | 63 | 113 |

* $\chi^2 = 41.97$; $p < 0.01$ compared with present

**Table III.** Relationship between associated craniocerebral injuries and outcome

| Outcome | Associated craniocerebral injury | | | | Total |
|---|---|---|---|---|---|
| | Contusion | EDH | ICH | SAH | |
| Good recovery | 7 | 8 | 1 | 2 | 38 |
| Moderately disabled | 3 | 1 | – | – | 5 |
| Severely disabled | 2 | – | – | – | 2 |
| Death | 37* | 7 | 10* | 14* | 68 |
| Total | 49 | 16 | 11 | 16 | 113 |

EDH = epidural hematoma; ICH = intracerebral hematoma; SAH = subarachnoid hemorrhage; *$\chi^2 = 11.66$; $p < 0.01$ significantly less than

**Table IV.** Relationship between time from injury to operation and outcome

| Outcome | Time from injury to operation | | | | Total |
|---|---|---|---|---|---|
| | < 4 Hours | 5–12 Hours | 13–24 Hours | 25 < Hours | |
| Good recovery | 24 | 8 | 3 | 3 | 38 |
| Moderately disabled | 3 | 2 | – | – | 5 |
| Severely disabled | 2 | – | – | – | 2 |
| Death | 49 | 16 | 2 | 1 | 68 |
| Total | 78 | 26 | 5 | 4 | 113 |

**Table V.** Relationship between type of surgical intervention and outcome

| Outcome | Type of surgical intervention | | | Total |
|---|---|---|---|---|
| | Cranio-tomy | Craniotomy with dural grafting | Decom-pressive craniectomy | |
| Good recovery | 9 | 29 | – | 38 |
| Moderately disabled | 2 | 3 | – | 5 |
| Severely disabled | – | 2 | – | 2 |
| Death | 6 | 43 | 19* | 68 |
| Total | 17 | 77 | 19 | 113 |

* $\chi^2 = 17.33$; $p < 0.01$ significantly less than other groups

flected in the GCS score was a significant predictor of outcome.

Table II shows the correlation between pupillary response and outcome. Fifty of 113 (44 %) patients had pupillary dysfunction.

Thirty-eight of 39 (97 %) patients who had bilateral unreactive pupils died. Nine of 11 (81 %) patients who had unilateral unreactive pupils died. There was a significant relationship between unreactive pupils and outcome.

The most commonly associated intracranial pathology was cerebral contusion (43 %). Ten of 11 (91 %) patients with intracerebral hematoma died. Fourteen of 16 (87 %) patients with subarachnoid hemorrhage died. Thirty-seven of 49 (75 %) patients with cerebral contusion died. Seven of 16 (43 %) patients with epidural hematoma died. Associated intracerebral hematoma, cerebral contusion, and subarachnoid hemorrhage were significantly related to outcome (Table III).

The time from injury to operation ranged from 1–48 hours. The mean time was 5.3 hours for all patients, 4.3 hours for the 68 patients who died and 7.1 hours for the 43 patients with functional recovery. Table IV shows outcome related to operative timing. Mortality for patients operated on within 4 hours of injury was 62.8 %, and that for those operated on between 5–12 hours was 61.5 %, and functional recovery rates for these patients were 34.6 % and 38.5 %, respectively. There was no difference in outcome between patients operated on within 4 hours of trauma and those operated on 4 and more hours after trauma.

The ASDH was evacuated by craniotomy in 17 of 113 (15 %) patients, craniotomy with dural grafting in 77 (68 %) and decompressive craniectomy in 19 (17 %). Thirty-five of 37 patients with a GCS of 3 or 4 died even

after decompressive craniectomies or craniotomies with dural grafting (Table V). Although there was a significant difference between management and outcome, this may have been affected by differences in the patient population.

## 4 Discussion

Mortality from ASDH has remained 40–90 % despite more rapid diagnosis and aggressive neurosurgical intervention [9, 13, 14, 21, 23–25]. HATASHITA et al. [11] recently reported that the overall mortality from ASDH is 55 % and functional recovery 30 %. In our series, the overall mortality from ASDH was 60 % and functional recovery 38 %. It remains a difficult challenge for a neurosurgeon.

The outcome of ASDH is influenced by many variables, such as age, sex, mechanism of injury, associated craniocerebral injuries, severity of injury, timing of surgery, type of operation, and control of intracranial pressure [2, 5, 7, 17, 23]. HATASHITA et al. [11] found that patients with GCS score of 3 had 93 % mortality, while those with a GCS score of 7 or more had 0 %. The mortality of patients with GCS scores of 4–6 ranged from 45 to 67 %. The present study indicates that the mortality varies from 0 to 100 % depending on the GCS score before surgery. The mortality of patients with GCS score of 3 and 4 had 100 % and 91 %, respectively, those with GCS score of 9 or more had 0 %. These findings confirm recent studies indicating that the severity of injury determines the outcome [4, 5, 11, 27]. The GCS is accepted as a method of classification of the severity of injury, and is widely used for determining the likelihood of survival and disability following severe head injury (GCS 3–8).

The outcome after severe head injury is better in younger patients than in older ones [3, 5, 17]. HOWARD et al. [13] reported that the overall mortality from ASDH is more than four times higher in patients aged over 65 years than in those aged 18–40 years. In the present series, the patient's age did not significantly influence outcome. Patients aged over 61 years had a mortality of 73 %, while those aged 0–40 years had 57 % (21–40 years had 64 %). These findings demonstrate that a greater age is associated with increased mortality.

Generally pupillary inequality and reaction to light is a sign of transtentorial herniation, which increases the mortality rate [1, 16, 19, 22]. PHUENPATHOM et al. [20] suggested that both pupillary inequality and one or both pupils not reacting to light were also associated with high mortality. In the group with both pupils not reacting to light, the mortality rate was more than 80 %. In our study 97 % of patients who had bilateral unreactive pupils and 81 % who had unilateral ones died. The results suggest that the presence of an ASDH is the most important predictor of negative outcome in patients with bilateral unreactive pupils.

Associated brain damage can have a greater influence on the outcome than hematoma without brain damage [11]. Phuenpathom et al. [20] reported that mortality rates were 50 % in intracerebral hematoma, 60 % in subarachnoid hemorrhage, 53 % in cerebral contusion and 30 % in epidural hematoma. In our series intracerebral hematoma (91 %), subarachnoid hemorrhage (87 %) and cerebral contusion (75 %) were significantly related to outcome but epidural hematoma (43 %) was not.

Rapid and aggressive surgical evacuation of ASDH is believed to reduce mortality. SEELING et al. [23] reported a mortality of 30 % for comatose patients treated less than four hours from injury versus a 90 % mortality for those treated after four hours. STONE et al. [24] reported no significant difference in outcome between comatose patients undergoing surgery less than four hours after injury and those operated on between 4 and 12 hours after injury, 69 and 75 % mortality respectively, WILDBERGER et al. [28] demonstrated that the mortality in patients with admission GCS score of less than 8 operated on within 4 hours of injury was 59 %, versus 69 % for those operated on after 4 hours. In the present series, the patients operated on within 4 hours of injury had a mortality of 62.8 % which was similar to that for those operated on between 5 and 12 hours (61.5 %). Regardless of time between injury and operation, all patients with a GCS score of 3 died and most patients with a GCS score of 9 or more achieved functional recovery (excluding one). These findings suggest that the time from injury to operation does not primarily affect the mortality. All patients with a head injury in our region are transferred directly to our hospital. The delay associated with transfer is present. Therefore, in this study the timing of operation or delay associated with selection of management showed valuable variation.

Surgical treatment for ASDH is craniotomy, craniotomy with dural grafting or decompressive crani-

ectomy. All patients in our series who underwent decompressive craniectomy died even though they had GCS scores of 4–6. This confirms other clinical and experimental studies showing that decompressive craniectomy did not improve the outcome although this procedure achieved a reduction in ICP [6, 10].

We have demonstrated that all patients with a GCS score of 3 before surgery died, while most patients with GCS scores of 9 or more achieve functional recovery. A shorter time from injury to surgical evacuation did not significantly affect the mortality. Age and associated craniocerebral injuries increased mortality. Pupillary response and GCS score were the most important factors for predicting outcome in ASDH.

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