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Outcome of traumatic extradural haematoma in Hong Kong

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Summary

Aim: Traumatic extradural haematoma (EDH) is a neurosurgical emergency and timely surgical intervention for significant EDH is the gold standard. This study aims to determine the incidence and mortality of consecutive patients with traumatic EDH admitted to the Emergency Department (ED) of Prince of Wales Hospital (PWH), a University Hospital Trauma Centre in Hong Kong.
Patients and methods: Retrospective analysis of prospectively collected data for all consecutive trauma cases admitted through the ED during 2001—2004. EDH was diagnosed by CT in all cases. Both primary and delayed onset EDH were included, as were patients with combined EDH and other intracranial lesions (e.g. subdural haematoma). Age, sex, cause of injury, associated intracranial lesions, skull fracture, Glasgow Coma Scale, pupil reactivity, treatment, length of stay and clinical outcome were determined.
Results: Two thousand and two hundred and eight patients were in the trauma registry for 2001—2004. Total 1080 head injured patients; 89 patients had traumatic EDH, mean of 1.9 patients per month. Seventy (79%) patients were male, with a mean age of 37.7 years. Fifty (56%) patients were from road traffic crashes, 27 (30%) sustained falls, 10 (11%) had direct head trauma. On admission, 62 (70%) patients were GCS 13—15, 9 (10%) GCS 9—12 and 18 (20%) GCS 3—8. Sixty-six (74%) patients had a skull fracture. Thirty (34%) patients underwent neurosurgical operation. Overall, nine patients (10%) died; eight patients were GCS < 8; five had bilateral fixed and dilated pupils; one had a single fixed and dilated pupil. Four patients died after neurosurgical operation, three of whom had fixed dilated pupils

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and were GCS 3 prior to surgery. Median length of hospital stay for survivors was 10.4 days.
Conclusion: Survival from traumatic EDH was 90% (80/89) and 91% (73/80) of survivors had a Glasgow Outcome Score of 4 or 5 (good or moderate). The combination of bilateral fixed dilated pupils and GCS 3 suggests severe primary brain injury. Emergency evacuation of intracranial haematomas is unlikely to improve the outcome for these patients. Even in an urban environment with short prehospital times and rapid access to neurosurgery, outcome in patients who are GCS 3 following EDH is likely to be poor.

Introduction

Traumatic extradural haematoma (EDH) has been recognised for more than 140 years.[5] 100 years ago, the mortality rate of EDH was as much as 86%[6] and traumatic EDH remains a true neurosurgical emergency. Until the late 1970s, when angiography was used for diagnosis [the era before computed tomography (CT)], the mortality rate was 30% or higher.[3]

With the introduction and wide availability of cranial CT, early diagnosis and timely surgical intervention for EDH is an attainable gold standard. Indeed, the treatable nature of EDH has led some authors to suggest that "toward zero mortality" is an achievable target with respect to this condition.[1] Studies examining the incidence and outcome of EDH have been performed around the world[11] including previous reports from Hong Kong.[1,9,11]

The aim of this prospective observational study was to determine the incidence, mortality and functional outcome [measured by Glasgow Outcome Scale (GOS)][7] of all consecutive patients with traumatic EDH who were admitted to the Emergency Department (ED) of Prince of Wales Hospital (PWH) in Hong Kong over the 4 year period from 2001 to 2004 inclusive.

Patients and methods

The setting for this study was the ED of Prince of Wales Hospital, which has 150,000 new patient attendances per annum. Five hundred and twenty patients are triaged to the trauma resuscitation rooms every year. The trauma centre provides emergency neurosurgical care for a population of around 1.5 million people in the eastern New Territories. There is one trauma nurse coordinator who prospectively records details of all trauma cases admitted via the ED trauma rooms on a dedicated trauma database.

Data collected includes, but is not limited to, demographic data, injury descriptions, physiological data, details of operative interventions and intensive care unit admissions, length of stay on the general wards, specialties involved, length of inpatient stay and final patient disposition. Patient disposition could include death, discharge home or discharge to a local rehabilitation unit associated with the hospital.

Details for all trauma patients listed on the database with a diagnostic code for extradural haematoma for 2001—2004 were retrieved. The diagnosis of EDH was made by CT in all cases (the presence of any extradural blood was considered to be an EDH) and confirmed during operation in those undergoing surgery. Cases selected for conservative management were included, as were both primary EDH and EDH of delayed onset (no EDH on the first CT scan, followed by clinical deterioration, second CT shows development of EDH).

Patients with other associated intra-cranial lesions (e.g. acute subdural haematoma, cerebral contusion) were also included. As the trauma database only includes patients who present after injury, any EDH which was not related to head trauma (e.g. post-craniotomy complications) was excluded by definition.

The following data was retrieved from the trauma database for analysis: patient characteristics (age, sex); cause of injury; associated intracranial lesions; skull fracture (and anatomical location); Glasgow Coma Scale (as assessed in the ED);[13] pupil reactivity; treatment; time to the operating theatre from injury and from ED admission; length of hospital stay; injury severity score (ISS); clinical outcome (measured by the Glasgow Outcome Scale (GOS) on discharge or death).[7] Data was analysed using SPSS v13.0. Kruskal—Wallis tests were used to compare three subgroups of GCS score for median times and ISS scores.

As this was a retrospective analysis, no changes were made to patient's treatment. The decision to operate was at the discretion of the specialist neurosurgeon caring for the patient, and no objective criteria were set for study purposes.

Ethical approval was obtained from the hospital institutional review board.

Results

Two thousand two hundred and eight patients were entered into the PWH trauma registry from 2001—2004, of whom 1080 patients had head injuries. Among them, 89 patients, alive at the time of ED admission, had a diagnosis of traumatic EDH, a mean of 1.9 patients per calendar month. For the population served, this is equivalent to an incidence of 1.5 extradural haematomas per 100,000 persons per year. Seventy (79%) were male, with a mean age of 37.7 years (range 1 month to 87 years). Fifty (56%) patients sustained their injuries as a result of road traffic crashes, 27 (30%) had suffered a fall and 10 (11%) patients had sustained direct head trauma as a result of assault.

On admission, 62 (70%) patients had a GCS of 13—15, 9 (10%) patients had a GCS of 9—12, and 18 (20%) patients had a GCS of 3—8. The mean pupil size at the time of admission was 3.5 mm. Sixty-six (74%) patients had a skull fracture. One (1%) patient had a delayed onset EDH. In total, 30 (34%) patients underwent a neurosurgical operation (Table 1).

Including all neurosurgical procedures, the median time from injury to ED was 39 min (range 19 min to 7 h, 9 min); median time from injury to the operating theatre was 5 h (range 1 h 50 min to 17 h); and median time from ED to theatre was 3 h, 5 min (range 1 h to 14 h, 5 min). There were no significant differences for any of the times comparing survivors to non-survivors.

When the first operation was a craniotomy ($n = 27$), the median time from ED to theatre was 3 h, 20 min (range 1 h to 14 h, 5 min) but there were no significant differences for any of the times between survivors and non-survivors. When the median ED to theatre times for the craniotomy group were compared by GCS grouping (13—15, 9—12, and ≤ 8), there were no statistically significant differences in the times between the groups (4 h 55 min for GCS 13—15; 1 h 18 min for GCS 9—12 group; 2 h 35 min for GCS ≤ 8 group, $p = 0.247$, Kruskal—Wallis test).

Median ISS for patients who were GCS 13—15 was 25; for those who were GCS 9—12, median ISS was 38; and for GCS ≤ 8, median ISS was 35. These differences were statistically significantly different ($p = 0.026$, Kruskal—Wallis test).

In the patients with a severe head injury (defined as an admission GCS ≤ 8), four patients did not have a neurosurgical procedure performed. Two of these patients were GCS 3, one with a massively depressed skull fracture and one with a very small EDH. A third patient was very elderly with a combined EDH and subdural haematoma. All of these three patients died. One patient who was GCS 8 had a small EDH and made a good recovery.

Table 1 Patient characteristics

	Number	%
Sex		
Male	70	78.7
Female	19	21.3
Cause of injury		
Road traffic accident—driver	4	4.5
Road traffic accident—car passenger	9	10.1
Road traffic accident—motorcyclist	10	11.2
Road traffic accident—other	6	6.7
Fall >2 m	14	15.7
Fall <2 m	13	14.6
Direct trauma to the head (assault)	10	11.2
Pedestrian	21	23.6
Other	2	2.2
Glasgow Coma Score on admission		
GCS 13—15	62	69.7
GCS 9—12	9	10.1
GCS 3—8	18	20.2
Pupil reactivity		
Both normal	78	87.6
One fixed, one reactive	4	4.5
Both fixed and non-reactive	7	7.9
Isolated EDH	84	94.4
Complex EDH		
Other intracranial lesions	5	5.6
Subdural haematoma	1	1.1
Intracerebral haematoma	1	1.1
Cerebral contusion	3	3.4
Location of EDH		
Frontal	15	16.9
Temporal	24	27.0
Parietal	12	13.5
Occipital	5	5.6
Multiple	34	38.2
Delayed onset EDH	1	1.1
Surgery—craniotomy	27	30.3
Surgery—ICP monitor insertion	3	3.4

EDH: extradural haematoma; ICP: intracranial pressure.

Six patients presented with a GCS of 3. Two patients were described above. Of the remaining four, one was discharged following a craniotomy and evacuation of EDH, one was discharged to rehabilitation following a craniotomy and evacuation of EDH and contusionectomy, and two patients died, one following craniotomy and one with a small EDH.

Overall, nine patients (10%) died. Of these patients, eight had a GCS of <8 on admission; five

Table 2 Patient outcome ($n = 89$)

Glasgow Outcome Score	Outcome	Surgical	Conservative	Overall
5	Good	18 (20%)	48 (53.3%)	66 (73.3%)
4	Moderate	5 (5.6%)	2 (2.2%)	7 (7.8%)
3	Poor	3 (3.3%)	3 (3.3%)	6 (6.7%)
2	Vegetative	0	1 (1.1%)	1 (1.1%)
1	Death	4 (4.4%)	5 (5.6%)	9 (10.1%)

GOS: Glasgow Outcome Score.[8]

Table 3 Outcome and GCS on admission ($n = 89$)

GOS	Outcome	GCS 3–8 ($n = 18$)	GCS 9–12 ($n = 9$)	GCS 13–15 ($n = 62$)
5	Good	7 (7.8%)	6 (6.7%)	53 (58.9%)
4	Moderate	0	1 (1.1%)	6 (6.7%)
3	Poor	3 (3.3%)	2 (2.2%)	1 (1.1%)
2	Vegetative	0	0	1 (1.1%)
1	Death	8 (9.0%)	0	1 (1.1%)

GOS: Glasgow Outcome Score[8]; GCS: Glasgow Coma Score.[13]

Table 4 Outcome in patients undergoing neurosurgical procedures ($n = 30$)

GOS	Outcome	GCS 3–8 ($n = 7$)	GCS 9–12 ($n = 2$)	GCS 13–15 ($n = 21$)
5	Good	2 (2.2%)	2 (2.2%)	14 (15.6%)
4	Moderate	0	0	5 (5.6%)
3	Poor	2 (2.2%)	0	1 (1.1%)
2	Vegetative	0	0	0
1	Death	3 (3.3%)	0	1 (1.1%)

GOS: Glasgow Outcome Score[8]; GCS: Glasgow Coma Score.[13]

of these patients had bilateral fixed and dilated pupils and one further patient had a single fixed and dilated pupil.

Four patients died after neurosurgical operation, 3 of whom had fixed dilated pupils and had a GCS of 3 prior to surgery. Median length of inpatient hospital stay for survivors was 10.4 days overall; 8.4 days for those discharged home and 19.2 days for those going on to rehabilitation. Overall patient outcome, using the GOS, is listed in Table 2. Table 3 details the outcome according to the admission GCS. Table 4 details the outcome of those patients who had a neurosurgical procedure performed as part of their management. Median length of inpatient stay for patients who died was 2.4 days. Table 5 lists clinical details of patients who died.

Discussion

In this single centre study in a Hong Kong trauma centre, survival from traumatic extradural haema-

Table 5 Details of patients who died

Age	Sex	Mechanism of injury	ED GCS	Pupils on admission	Other injuries	Craniotomy	Reason for death
18	F	Pedestrian	3	BFD	None	No	Brain injury
18	F	Passenger	5	N	Pelvic fracture	No	Brain injury
22	M	Pedestrian	5	BFD	SDH	Yes	Brain injury
31	M	Fall <2 m	14	N	None	Yes	DIC
48	M	Fall >2 m	3	BFD	None	Yes	Brain injury
52	F	Pedestrian	6	BFD	Pelvic fracture	No	Multiple injuries
55	F	Fall >2 m	3	BFD	None	Yes	Brain injury
62	F	Fall <2 m	3	N	None	No	Brain injury
87	M	Fall <2 m	6	1 fixed; 1 normal	None	No	Brain injury

M, male; F, female; N, normal pupils; BFD, bilateral fixed dilated pupils; GCS, Glasgow Coma Score[13]; ED, emergency department; SDH, subdural haematoma; DIC, disseminated intravascular coagulopathy.

toma was 90% (80/89). Ninety-one percent (73/80) of survivors had a Glasgow Outcome Score of 4 or 5, indicating good or moderate outcomes. The incidence of traumatic EDH was approximately 2 patients per month for this centre.

Of the nine patients who died, one patient had severe multiple injuries with consequent hypovolaemia, and seven patients died of severe primary brain injury. All of these patients presented in coma and only one patient had normal pupils at presentation. One patient presented with a higher GCS (14) and reactive pupils, but this patient developed intractable disseminated intravascular coagulopathy during surgery and subsequently died. This was the only patient to suffer from a delayed EDH in the study.

There was no evidence of major variations in practice (surgical versus conservative management) between individual clinicians in this series. The clinical status of the patient (assessed by GCS) and the size of the EDH (small or large) appeared to be the driving variables that influenced decisions about operative management or conservative treatment.

Our results are comparable to those seen in other centres throughout the developed world.[1,4,9,11] The degree of primary brain injury, shown by a low GCS score on admission, seems to be one of the key factors in common with other studies. It would have been ideal to measure the GCS on every patient following resuscitation and use this for prediction, but our trauma database only records admission GCS; this is a limitation of our study.

Survival of patients with EDH is limited by numerous factors; the age of the patient,[10] the speed of haematoma formation, the size and location of the clot, the interval between onset of pupillary changes and surgery,[2,12] the presence of associated intracranial lesions,[4] and pre-operative GCS.[9,11]

In this study, the median time to theatre from ED admission is 3 h, 20 min for patients requiring a craniotomy as their neurosurgical procedure. There were no statistically significant differences in time to theatre between the three GCS groups, although the group who are GCS ≤ 12 were more severely injured than those who were GCS 13–15. This may correspond with the longer period to operation for the GCS 13–15 group, as they were less severely injured and there was perhaps more time for further investigations (e.g. CT of other body regions) prior to surgery.

It has been stated that amongst head-injured patients with GCS of 3 on admission, only those with traumatic EDH have any chance of survival.[8] The results of this study would suggest that even in an urban environment with short prehospital transfer times and rapid access to neurosurgery, outcome in patients who are GCS 3 following EDH is likely to be poor.

In our study, three patients were admitted to the ED with bilateral fixed and dilated pupils and a GCS of 3, and they could not be salvaged despite emergency surgery.

This combination of bilateral fixed dilated pupils and a GCS of 3 suggests severe primary brain injury and brainstem compression.[8,12] Emergency evacuation of intracranial haematomas is unlikely to reverse the damage which has already occurred to the brainstem and this study adds to the evidence that surgery is unhelpful for this group of patients.

References

1. Bricolo AP, Pasut LM. Extradural haematoma: toward zero mortality. A prospective study. Neurosurgery 1984;14:8–12.
2. Cohen JE, Montero A, Israel ZH. Prognosis and clinical relevance of anisocoria-craniotomy latency for epidural haematoma in comatose patients. J Trauma 1996;41:120–2.
3. Cordobes F, Lobato RD, Rivas JJ, et al. Observation of 82 patients with extradural haematoma. Comparison of results before and after the advent of computed tomography. J Neurosurg 1981;54:179–86.
4. Heinzelmann M, Platz A, Imhof HG. Outcome after acute extradural haematoma, influence of additional injuries and neurological complications in the ICU. Injury 1996;27:345–9.
5. Hutchinson J. Effusion of blood between bone and dura matter. Lond Hosp Rep 1867;4:51.
6. Jacobson HA. On middle meningeal haemorrhage. Guys Hosp Rep 1886;43:147–308.
7. Jennett B, Bond M. Assessment of outcome after severe brain damage. A practical scale. Lancet 1975;1:480–4.
8. Kotwica Z, Jakubowski JK. Head-injured adult patients with GCS of 3 on admission—who have a chance to survive? Acta Neurochir (Wien) 1995;133:56–9.
9. Leung GKK, Wong ATY, Kwan EYC, et al. Extradural haematoma—a five year audit at a tertiary trauma centre in Hong Kong. Asian J Surgery 2001;24(3):305–9.
10. Luerssen TG, Klauber MR, Marshall LF. Outcome from head injury related to patient's age. J Neurosurg 1988;68:409–16.
11. Paterniti S, Fiore P, Macri E. Extradural haematoma. Report of 37 consecutive cases with survival. Acta Neurochir (Wien) 1994;131:207–10.
12. Sakas DE, Bullock MR, Teasdale GM. One-year outcome following craniotomy for traumatic hematoma in patients with fixed dilated pupils. J Neurosurg 1995;82:961–5.
13. Teasdale G, Jennett B. Assessment of coma and impaired consciousness. Lancet 1974;2:81–4.