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Article

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Predictors for outcome after surgery for traumatic acute subdural hematoma

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Abstract: *Introduction:* Acute traumatic subdural hematoma (ASDH) is one of the most frequent conditions in neurosurgery demanding emergency surgery. The aim of the study was to identify factors influencing outcome in patients who had surgery for evacuation of ASDH. *Methods:* From 2005 to 2012 eighty-five patients at age above 18 years had surgery for evacuation of ASDH. Outcome was measured according GOS at discharge and was dichotomized as "favorable outcome" (GOS 4 to 5) and "unfavorable outcome" (GOS 1 to 3). These factors were evaluated with univariate and logistic regression analysis for significance with outcome. *Results:* The mean age of the 85 patients was 62.7 years (SD±18.5). 45.9% patients were with favorable outcome and 54.1% had unfavorable outcome. Patients with GCS score 3-8 (54.1%) had 80.4% unfavorable outcome whereas 78.6% of patients with GCS score 13-15 (32.9%) had favorable outcome. All patients with nonreactive pupils (bilaterally or unilaterally - 31.8%) had unfavorable outcome whereas patients (36.5%) with both reactive pupils (36.5%) had in 80.6% favorable outcome. All patients (40%) with Rotterdam CT scores 5 and 6 had unfavorable outcome. The factors determining outcome were admission GSC score, Rotterdam CT scores, and prothrombin time. *Conclusion:* Patients who have GSC score of 3, unresponsive pupil(s) or have Rotterdam CT scores 5 and 6 have little chance of survival. Patients with coagulopathy have two times more unfavorable outcome. The patients with ASDH should have surgery as soon as possible after correction of vital parameters in order to avoid deterioration which can be very rapid and irreversible.

Key words: Acute traumatic subdural hematoma, factors, outcome, surgery

Introduction

Traumatic subdural hematoma is one of the most frequent neurosurgical condition, demanding emergency surgery (Figure 1 and Figure 2). The mortality is still high – between 40 and 90% (4, 10, 11, 15, 23, 29, 33) despite the progress in the care of the patients – early in-field resuscitation and rapid transfer to the hospital, staffed with experienced trauma surgeons and neurosurgeons. A numerous factors has been reported to have influence on the outcome after surgery in these patients and include age (4, 10, 12, 15, 22, 28), comorbidities (7, 16), injuries in other body

areas (17), GCS score (1, 4, 8 - 12, 15,19, 23, 28, 31, 33), pupils reactivity (4, 8, 10, 11, 15, 33, 34), different CT characteristics of the ASDH (1, 19, 25, 33), time of surgery (1, 4, 8 - 10, 12, 24, 26, 28, 31, 34). The goal of the study was to evaluate factors that had influence on the outcome after surgical management of ASDH and to allow prediction for functional outcome in such patients.

Figure 1 - Acute subdural hematoma

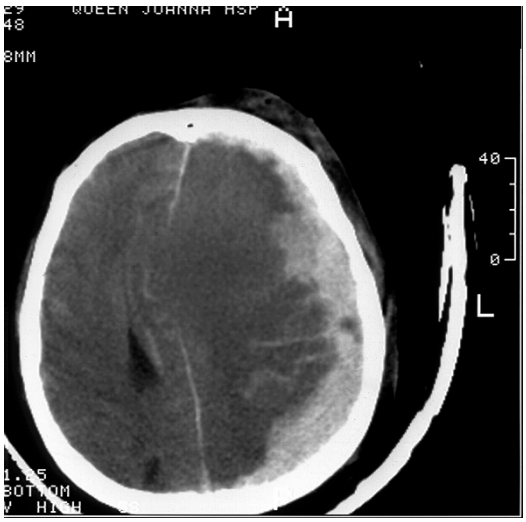

Figure 2 - Acute subdural hematoma with traumatic subarachnoid hemorrhage

Materials and methods

This is a retrospective study on 85 patients who had surgery between 2005 and 2012 at the Department of Neurosurgery in Queen Joanna Hospital ISUL – Sofia. Criteria for inclusion were age over 18 years and patients subjected to surgery for ASDH where informed consent was given by the patient or patients' relatives or caregivers. Criteria for exclusion were patients with penetrating injury, ASDH due to aneurismal rupture, ASDH in posterior fossa, secondary bleeding in chronic subdural hematoma, and refusal of surgery by the patient or by his/her relatives. Surgery was performed in a standardized manner using a trauma flap. Patients were further managed in the intensive care unit using a standard protocol.

Data for age, gender, and mechanism of trauma were collected from Emergency Medical Service records, patients, accompanied persons, and from referral hospital documentation. All patients underwent evaluation of the vital signs (pulse oximetry, blood pressure, heart rate, GCS score, pupils reactivity) and neurological examination at admission. Comorbidities were evaluated according Charlson Comorbidity Index (3). Consultations were made with other specialists (general surgeons, trauma surgeons, cardiologists, ear, nose and throat surgeons) in cases with concomitant injuries (evaluated with Injury Severity Score, ISS) or health problems. Standard computerized tomography (CT) protocol was used. For classification of the CT 6-point Rotterdam CT score (16) was used. Routine

laboratory tests were done. Patients with traumatic shock or with impaired consciousness were stabilized in the resuscitation room at the Emergency Department and intubated and ventilated prior to transfer to CT suite. Outcome was measured according GOS (5) and was dichotomized in "favorable" (GOS 4 and 5) and "unfavorable" (GOS 1-3). Statistical analysis was performed using IBM SPSS software ver. 20.0 (SPSS Inc. Chicago, Il, USA) for Windows. Significance was defined at $p < 0.05$.

Results

Full data sets were available for 85 patients. These data are presented in Table 1. The mean age of the patients was 62.7 years (standard deviation, SD±18.5), the patients over the 65 years were 50.6% and they had more frequently unfavorable outcome (62.8%) than patients in younger group (45.2%) but this was not of significance.significant effect (p=0.519).

TABLE I

Demographic data, mechanism of injury, and comorbidities in 85 patients

Parameter	**No of patients**	**%**	**Favorable outcome**	**%**	**Unfavorable outcome**	**%**	**p**	**Sig**
Age							0.519	no
≤64	42	49.4	23	54.8	19	45.2		
≥65	43	50.6	16	37.2	27	62.8		
Sex							0.149	no
Males	61	71.8	31	50.8	30	49.2		
Females	24	28.2	8	33.3	16	66.7		
Mech.of Injury							0.128	no
Fall	72	84.7	36	50	36	50		
MVA	13	15.3	3	23.1	10	76.9		
Charlson Comorbidity Index							0.059	no
0 - 2	30	35.3	16	53.3	14	46.7		
≥3	55	64.7	23	41.8	32	58.2		
Outcome								
Favorable	39	45.9						
Unfavorable	46	54.1						

TABLE II

Characteristics of overall severity of injury and severity of brain injury, CT characteristics and time from injury to admission and to surgery

+	No of patients	%	Favorable outcome	%	Unfavorable outcome	%	p	Sig
ISS							0.013	yes
≤25	70		36	51.4	34	48.6		
≥26	15		3	20	12	80		
≤33	73	85.9	37	50.7	36	49.3		
≥34	12	14.1	2	16.7	10	83.3		
GCS							<0.0005	yes
3-8	46	54.1	9	19.6	37	80.4		
9-12	11	12.9	8	72.7	3	27.3		
13-15	28	32.9	22	78.6	6	21.4		
Pupillary abnormalities							<0.0005	yes
Nonreactive	14	16.5	-	-	14	100		
Unilat. reactive	13	15.3	-	-	13	100		
Sluggish	27	31.8	14	51.9	13	48.1		
Both reactive	31	36.5	25	80.6	6	19.4		
MAP[1]							0.891	no
≤70 mmHg	1	1.2	-	-	1	100		
≥70 mmHg	84	98.8	39	46.4	45	53.6		
Rotterdam CT Score							<0.0005	yes
2	19	22.4	17	89.5	2	10.5		
3	14	16.5	11	78.6	3	21.4		
4	18	21.2	11	61.1	7	38.9		
5	14	16.5	-	-	14	100		
6	20	23.5	-	-	20	100		
Time injury to surgery							0.002	yes
≤ 240 min	17	20	4	23.5	13	76.5		
≥ 240 min	68	80	35	51.5	33	48.5		
Time admission to injury							0.028	yes
≤60 min	22	25.9	7	31.8	15	68.2		
≥61 min	63	74.1	32	50.8	31	49.2		
Outcome								
Favorable	39	45.9						
Unfavorable	46	54.1						

[1]MAP - Mean arterial pressure

TABLE III

Laboratory parameters in 85 patients

Parameter	No of patients	Favorable outcome	%	Unfavorable outcome	%	p	Sig
Hb[1]						0.519	no
Males < 130	21	8	38.1	13	61.9		
Females < 115	9	2	22.2	7	77.8		
Both	55	29	52.7	26	47.3		
WBC[2]						0.231	no
<3.5	1	-	-	1	100		
3.5-10.5	38	21	55.3	17	44.7		
>10.5	46	18	39.1	28	60.9		
PLT[3]						0.097	no
<130	14	3	21.4	11	78.6		
130-440	70	36	51.4	34	48.6		
>440	1	-	-	1	100		
Glucose						<0.0005	yes
3.3-6.0	12	10	83.3	2	16.7		
>6.0	73	29	39.7	44	60.3		
Sodium						0.232	no
<135	14	8	57.1	6	42.9		
135-145	65	30	46.2	35	53.8		
>145	6	1	16.7	5	83.3		
PT[4]						<0.0005	yes
<70	45	12	26.7	33	73.3		
70-120	37	24	64.9	13	35.1		
>120	3	3	100	-	-		

[1]hemoglobine; [2]white blood cells; [3]platelets; [4]prothrombine time

Predominant gender was male (71.8%) but this had no effect on outcome. Predominant mechanism of trauma was fall (84.7%) and motor vehicle accident (MVA) carried more unfavorable outcome (76.9%) but mechanism had no effect on outcome. Fifty-five patients had Charlson Comorbidity Index more than 2 but this was not of significance. More than half of the patients were with GCS score group 3 to 8 and they had unfavorable outcome in 80.4% contrary to the group with highest scores (GCS 13-15), where 21.4% of patients were with unfavorable outcome (Table 2).

63.6% of patients had abnormalities in pupillary reaction, 16.5% with bilaterally unresponsive and 15.3% with unilaterally responsive pupils and all patients in these two groups were with unfavorable outcome. About half of the patients in the group with sluggish reaction had unfavorable outcome and pupillary reaction was a significant factor in univariate analysis.

There was only one patient with hypotension on admission so mean arterial pressure (MAP) had no significant effect on outcome. In the only patient hypotension was lethal, possibly due to irreversible brain damage. The patient was with bilaterally nonresponsive pupils and GCS score 3.

CT abnormalities were of significance for outcome and there were no patients with favorable outcome among patients (40%) with highest score of 5 and 6 whereas 89.5% of patients with Rotterdam CT scores 2 had favorable outcome.

Time injury to surgery up to 240 min had 20% of patients and 23.5% of them had favorable outcome. Time admission to injury up to 60 min had 25.9% of patients and 31.8% of them had favorable outcome.

Results for laboratory data analysis are shown in Table 3. There was no effect on outcome except for blood glucose ($p<0.0005$) and prothrombin time ($p<0.0005$). Amongst all patients 8 were with diabetes and 2 were with use of acenocumarol (both with unfavorable outcome).

Discussion

Our results show a favorable outcome in 45,9% and unfavorable one in 54,1%. The main factors, influencing outcome in this study were GCS score on admission, Rotterdam CT score and PT. Patients with lowest scores had the worst outcome and in (4) all patients with GCS score of 3 had unfavorable outcome whereas all patients with GCS 7 to 14 made functional recovery. In (10) patients with GCS scores less than 8 had 55.4% mortality and with scores 9 to 15 had 11.1%. In our study all but one patients with GCS 3 had unfavorable outcome and in the group with GCS scores 3 to 8 (54.1% of all patients) only 19.6% had favorable outcome. In the group with GCS scores 9-12, favorable outcome was achieved in 72.7% and in the group with GCS 13 to 15 - in 78.6% of cases.

The main question raised is whether patients with GCS scores 13 to 15 are candidates for surgery. The CT characteristics (Rotterdam CT score takes into consideration midline shift, width of the basal cisterns, other intracranial traumatic lesions) along with the GCS scores play significant role in decision making for conservative management. Some authors (20) proposed criteria for conservative management of such patients but only 3% of the population they had studied were candidates for conservative management and later 6 of 23 patients required surgery. The main indication for conservative management was the thickness of the ASDH. When (32) treated conservatively 31 patients with midline shift less than 10 mm and GCS 15, six of them required urgent surgery after short period of observation. They came to conclusion that a midline shift more than 5 mm heralds failure of the intracranial compensatory mechanisms. Not only a patient with certain CT parameters but with GCS scores (greater than 8) might have good outcomes in carefully selected patients younger than 65 years (2). We did not manage any patient with thickness of the ASDH more than 10 mm conservatively and cannot advise conservative management because such patients deteriorated quickly and all had unfavorable outcome.

The group with most lethal combination of factors was the group of patients with bilaterally unresponsive pupils and GSC scores of 3 and this group comprised 28.2% of all patients. In (21) only 8 out of 92 patients with GCS scores 3 and bilaterally unresponsive pupils had favorable outcome and they found that in this group the only factor having significance was CT characteristics.

In most of the studies age is the factor in the outcome with significantly higher mortality in older patients but in ours it was not. This may be due to the fact that the age of our population was higher than in many others studies because in some studies (4, 7, 8, 23) younger patients were included. (17) did not find statistically significant correlation also. In a carefully selected aged population (27) demonstrated promising results. Older patients had more comorbidities and (7) found that this affected mortality when more than 2 comorbidities were encountered.

Since (24) many studies evaluated the time elapsed from injury and favorable outcome with earlier surgery (up to 240 min after injury). This was supported by (5, 6) but (4, 11, 12, 26, 31) did not. (28) and (34) found a tendency toward lesser mortality and they had more patients with favorable outcome with earlier surgeries but without significance. In our study 25.9% of patients were admitted up to 60 min after injury but only 20% had surgery up to 240 min after injury and time of surgery was of significance in univariate analysis bur not in logistic regression analysis. Some authors (1, 10) suggested that patients with most severe brain injuries were sent to a neurosurgical unit more rapidly. (12) found that patients operated later than 12 hours had the lowest mortality rate due to lesser severity and thought that patients who might have benefit from earlier surgery died in a hospital at remote distance from a hospital capable of dealing trauma patients. Our policy is to operate as early as possible after resuscitation and full evaluation of a trauma patient and we do not suggest any time delay in managing patients with ASDH.

In the laboratory parameters routinely determined on admission we found significance in univariate analysis only in blood sugar ($p<0.0005$), and protrombin time ($p<0.0005$) but in logistic regression analysis the only laboratory parameter of significance was protrombin time ($p=0.013$). A significantly worse outcome was found by (16) in patients with coagulopathy defined as INR more than 1.2 or partial thromboplastin time more than 37 sec. In their group of patients 54.1% were had coagulopathy but only 9.7% were on oral anticoagulation therapy and there were no significant difference in GCS scores between coagulopathic and non-coagulopathic patients. In our group 2 patients were on acenocumarol and both were with unfavorable outcome. In the group with elevated levels of blood sugar 8 were with diabetes with only one with favorable outcome. We did not find any data regarding the influence of laboratory parameters on outcome in patients with ASDH.

Limitations

The major limitation of the study is that it is a retrospective one. This study represents a single institution experience and was done in a

university hospital so the results obtained may differ in other type of institution.

Conclusion

In this study 45.9% of patients had favorable outcome and 54.1% were with unfavorable one. The main factors of significance in determining outcome in patients with ASH who had surgery were GCS score on admission, Rotterdam CT score and PT. Patients with GSC score of 3 had little chance of survival, especially if they had unresponsive pupil. All patients with Rotterdam CT scores 5 and 6 had unfavorable outcome. Patients with PT less than 70 had two times more unfavorable outcome than patients with PT within normal range. The patients with ASDH should have surgery as soon as possible after correction of vital parameters in order to avoid deterioration which can be very rapid and irreversible.

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