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Results of Single Burr Hole Drainage for Acute Subdural Hematoma with Non-Reactive Pupil

Non Reaktif Pupili Olan Akut Subdural Hematom Olgularında Tek Delik (Burr Hole) Drenajının Sonuçları

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ABSTRACT

AIM: To investigate the effects of emergency burr hole drainage for acute subdural hematoma (ASDH) with bilateral non-reactive pupils.

MATERIAL and METHODS: A retrospective study was conducted by reviewing medical records from 1998 to 2007. Patients meeting the following criteria were included: 1) head injury with unconsciousness (Glasgow Coma Scale score 8); 2) bilateral non-reactive pupils on arrival; 3) ASDH with disappearance of basal cistern on computed tomography (CT); and 4) performance of emergency single burr hole drainage. Subjects were divided into survival and non-survival groups.

RESULTS: Pupil size on the small side was significantly smaller in the survival group than in the non-survival group. All pupils on the small side in the survival group were 4 mm.

CONCLUSION: Emergency burr hole drainage should still be considered in patients with ASDH showing bilateral non-reactive pupils and one pupil 4 mm.

KEYWORDS: Acute subdural hematoma, Single burr hole drainage, Pupil, Herniation, Surgical outcome

ÖZ

AMAÇ: Bilateral nonreaktif pupili olan akut subdural hematomlu hastalarda acil kafa deliği (burr hole) drenajının etkilerinin araştırılması.

YÖNTEM ve GEREÇLER: Retrospektif olarak 1998- 2007 yılları arasında olan medikal kayıtlar incelenmiştir. Araştırmaya sırası ile sayılan özelliklere sahip hastalar alınmıştır. Bunlar; 1- kafa travmasına bağlı bilinç kaybı olan hastalar (Glaskow koma ölçütü: 8); 2- hastaneye kabulde bilateral reaksiyonsuz pupilleri olan hastalar. 3- Akut subdural hematomu olan ve bilgisayarlı tomografide basal sisternleri izlenmeyen hastalar; 4- Acil (burr hole) tek delik açılması yapılmış hastalar. Olgular hayatta kalanlar ve ölenler olarak iki gruba ayrıldı.

BULGULAR: Hayatta kalan olgularda daha küçük olan pupilin çapı, kaybedilen hastaların küçük olan pupil çapından daha küçüktü. Hayatta kalan olguların pupili küçük olan tarafın pupil çapı 4 mm'ydi.

SONUÇ: İki taraflı ışık reaksiyonu olmayan akut subdural hematomlu hastalarda, eğer bir pupil 4 mm ise; bu hastalarda acil (burr hole) tek delik dreanjı yapılması düşünülmelidir.

ANAHTAR SÖZCÜKLER: Akut subdural hematoma, Tek delik drenajı, Pupil, Herniasyon, Cerrahi sonuç

INTRODUCTION

Prognosis is unfavorable for patients with head injury who present showing bilateral non-reactive pupils (BNP) (1,3,7,10,14), similar to the situation seen in patients with acute subdural hematoma (ASDH) (6,13). Koc *et al.* reported that 97% of ASDH patients with BNP died (6), while ASDH patients with BNP showing improvements in pupil size after mannitol infusion display more favorable outcomes (4). However, observation of pupil reactions after mannitol infusion is a time-consuming step to take before making decisions regarding operative strategy, and minimizing the time from injury to operation is crucial to optimizing outcomes (2,11). Accordingly, at this institution, emergency single burr hole drainage is immediately performed for ASDH patients with BNP. To date, no reports have described the effects of single burr hole drainage for ASDH patients with BNP. We therefore describe herein the results of single burr hole drainage for ASDH with BNP.

MATERIAL and METHODS

Institutional review board of the National Defense Medical Hospital approved this retrospective study and waived the requirement for informed consent.

This retrospective study was conducted by reviewing the medical charts of patients treated between 1998 and 2007 at the Level 1 Trauma Center of the National Defense Medical

Hospital, a hospital that treats both military personnel and civilians, and provides medical corps training. Patients meeting the following criteria were included: head injury with unconsciousness (Glasgow Coma Scale (GCS) score ≤ 8); BNP on arrival; ASDH with disappearance of basal cistern on computed tomography (CT); and performance of emergency single burr hole drainage. Patients meeting the following criteria were excluded: cardiopulmonary arrest; or ophthalmic disease affecting pupil diameter. Subjects were divided into survival and non-survival groups based on outcomes as of 3 months after injury. Individual medical records were reviewed with regard to the following data: sex; age; mechanism of injury; vital signs on arrival (systolic blood pressure, heart rate, GCS score), diameters of pupils; isolated or multiple injury; CT findings; application of induced hypothermic therapy; and time from injury to arrival. Pupils were also divided into the large and the small side, according to pupil size when the patient demonstrated anisocoria. If both pupils were the same size, the same values were used for large and small sides. Outcomes were classified into five categories according to Glasgow Outcome Scale score at 3 months after injury: dead, [1]; vegetative, [2]; severely disabled, [3]; moderately disabled, [4]; and good recovery, [5].

Head injury patients with signs of cerebral herniation underwent tracheal intubation, manual hyperventilation and infusion of 60 g of mannitol. If CT demonstrated intracranial hematoma, emergency evacuation of hematoma was performed. Body temperature of the patient was initially controlled within the range of 36.0-37.0 °C in the emergency room.

The intensive care unit protocol for severe head injury care was: bed elevation of the 30° above horizontal; mechanical ventilation to maintain PaO_2 at 100-150 mmHg and $PaCO_2$ at 30-40 mmHg; intravenous infusion of 10% glycerol at 10-15 ml/kg/day; and continuous administration of barbiturates at 2-6 mg/kg/h. If intracranial pressure was >30 mmHg despite the above strategies, hypothermic therapy was applied. The protocol for hypothermic therapy was: continuous intravenous infusion of vecuronium at 0.01-0.02 mg/kg/h to prevent shivering; maintenance of core temperature (as measured using a urinary bladder balloon catheter) at 33-34°C using cooling blankets and alcohol applied to the skin of the trunk and extremities; and after controlling intracranial pressure to <20 mmHg, re-warming to 37°C at a rate of ≤0.1°C/h and ≤1°C/day. The re-warming process generally took 3-4 days

Both the χ^2 test and Student's *t*-test were used for statistical analyses. Values of $p<0.05$ were considered significant.

RESULTS

During the investigation period, a total of 892 patients were admitted with head injury. Among these, 40 patients underwent single burr hole drainage for ASDH, with the burr hole positioned at the linea temporalis superior, vertically above external auditory canal. All cases involved non-penetrating injuries. Of the 40 cases, 22 patients showed BNP. Among these, 1 patient with blindness was excluded. The remaining 21 head injury cases were analyzed for this study. All subjects were directly transported to the hospital from the scene by ambulance.

There were 5 subjects in the survival group and 16 subjects in the non-survival group. No significant differences were noted between groups with regard to sex, age, mechanism of injury, vital signs, duration, frequency of isolated head injury (Table I), findings on head CT (Table II) and frequency of induced hypothermic therapy (Table III). Largest pupil size did not differ significantly between groups (Table I). All large-side pupils was ≥4 mm in diameter. Mean (± standard error of

Table I: Background Data for Subjects

	Survival (n=5)	Death (n=16)	P value
Age (years)	39.4 ± 9.7	44.3 ± 6.1	0.69
Male/Female	5/0	9/7	0.12
Mechanism of injury			0.17
Traffic accident	2	13	
Fall	3	2	
Battered	0	1	
Duration from injury to arrival (min)	37.4 ± 3.7	29.5 ± 2.5	0.13
Isolated head injury	3	12	0.59
Glasgow coma scale	5.8 ± 1.8	4.5 ± 0.4	0.30
Systolic blood pressure (mmHg)	140.2 ± 14.4	138.8 ± 10.9	0.95
Heart rate (beats/min)	77.6 ± 8.2	101.1 ± 8.1	0.14
Temperature (°C)	36.8 ± 0.2	35.7 ± 0.3	0.06
Largest pupil (mm)	4.4 ± 0.6	5.5 ± 0.4	0.27
Smallest pupil (mm)	3.6 ± 0.2	5.2 ± 0.4	0.03

the mean) size of the pupil on the small side was significantly smaller in the survival group (3.6 ± 0.2 mm) than in the non-survival group (5.2 ± 0.4, p=0.03). In the survival group, all pupils on the small side were ≤4 mm in diameter (Figure 1). No subjects showed a past history of using drugs that affected pupil diameter. For the survival group, Glasgow Outcome Scale score indicated severe disability in 3 patients and good recovery in 2 patients. All subjects in the non-survival group died within 1 week after injury.

Two patients who achieved good recovery are reviewed herein. In Case 1, a 34-year-old man with ASDH, multiple rib fractures, pulmonary contusion, and pelvic and radial bone fracture due to a fall was transported directly to the hospital (Figure 2). Total GCS score was 5. He displayed anisocoria with BNP (large side, 7 mm; small side, 3 mm). After an emergency operation, pupil anomaly was improved. Hypothermic therapy was induced to control the high intracranial pressure and internal decompression (partial lobectomy of contusional temporal brain) was performed on hospital day 3. He was finally discharged on foot on hospital day 41. In Case 2, a 19-year-old man with isolated ASDH due to a motorcycle accident was transported to the hospital (Figure 3). Total GCS score was 3. He showed mydriasis with BNP (both pupils, 4 mm). After an emergency operation, pupil anomaly improved. Induced hypothermic therapy was performed. He was finally discharged on foot on hospital day 43.

DISCUSSION

This is the first report to suggest that even ASDH patients with BNP may show favorable outcomes if one of pupil ≤4 mm in diameter before single burr hole drainage is performed for ASDH.

Pupil size may be affected by hypothermia or various drugs (9). In this study, no patients were in a severely hypothermic

Table II: Head CT Findings in Subjects

	Survival (n=5)	Death (n=16)	P value
Simple acute subdural hematoma	1	1	0.42
Width of acute subdural hematoma (mm)	13.4 ± 1.0	13.0 ± 2.1	0.93
Midline shift (mm)	11.6 ± 1.5	15.2 ± 1.9	0.32

Table III: Treatment information

	Survival (n=5)	Death (n=16)	P value
Duration from injury to operation (min)	106.2 ± 15.5	98.3 ± 5.8	0.56
Initial intracranial pressure (mmHg)	23.7 ± 7.3 (n=4)	65.9 ± 14.8 (n=11)	0.12
Induced hypothermic therapy	4	8	0.33

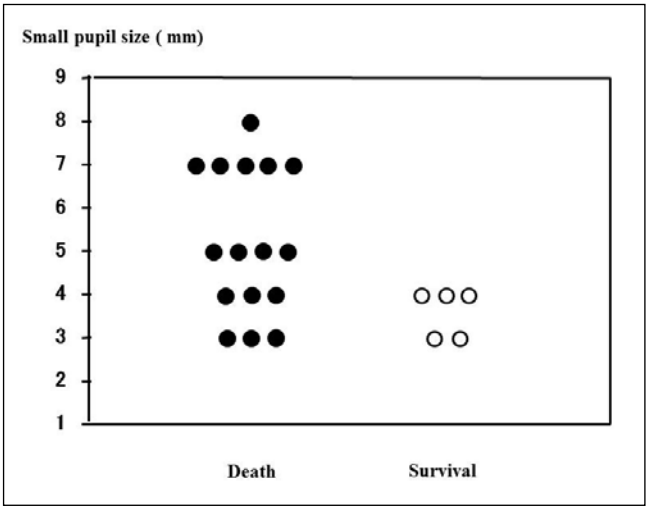

Figure 1: Size of the smallest pupil on arrival. The smallest pupil was significantly smaller in the survival group than in the non-survival group.

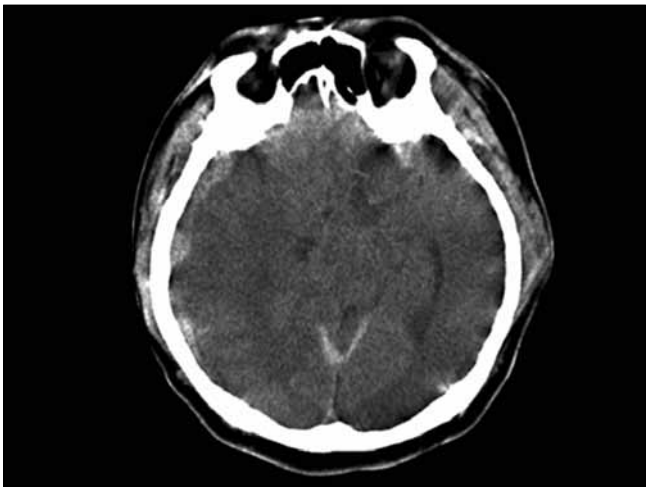

Figure 2: Computed tomography (CT) in Case 1. Head CT shows acute subdural hematoma with compression of the basal cisterns.

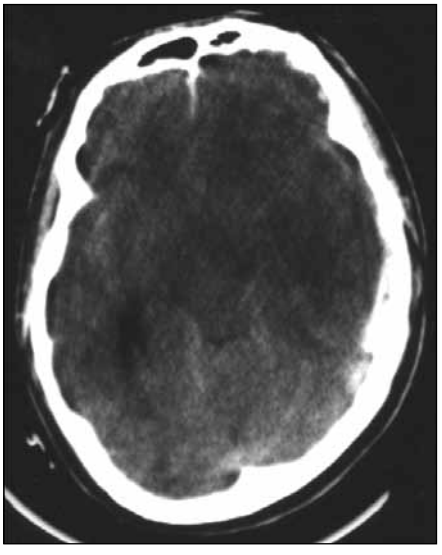

Figure 3: Computed tomography (CT) in Case 2. Head CT shows acute subdural hematoma with compression of the quadrigeminal cistern.

state on arrival and no past histories of drug use that could affect pupil size were elicited. Only comatose patients with head injury showing disappearance of the basal cistern on CT were selected for this study, so pupil anomalies were all considered attributable to intracranial lesions with cerebral herniation.

Outcomes of head injury with BNP are typically unfavorable, but this is not an absolute sign of poor prognosis. A small number of reports have described good recovery in patients with head injury and BNP (4,5,12). Good recovery after severe head injuries even with the appearance of BNP in this study may have been associated with relatively young age (1), short duration from injury to operation (11), selection of a simple procedure for evacuation of ASDH, minor cerebral contusion with main mass effect formed by ASDH (8) and fortunate spontaneous hemostasis. When the brain is injured, younger patients tend to have better potential for recovery than older patients. If the patient shows signs of cerebral herniation, a short duration from injury to operation can minimize the damage resulting from hypoxia due to traumatic cerebral perfusion. If the ASDH is mainly formed by an injury to the cortical artery or vein, the cerebral edema induced by cerebral contusion can be minimized.

Single burr hole drainage is less invasive than craniotomy. In addition, this procedure is simpler than craniotomy, so early release of the high intracranial pressure can be achieved. Moreover, this procedure can be performed in an examination room or even at the bedside. One limitation of single burr drainage is the inability to evacuate hematoma containing a hard clot. However, in cases of cerebral herniation in the acute phase of injury, the hematoma is relatively soft and contains a larger liquid component than that in the subacute phase, so the hematoma is easily extruded from the burr hole by the increased intracranial pressure. Another limitation is the inability to perform hemostasis through a burr hole. If hemorrhaging is recognized after hematoma drainage or a residual hematoma is observed through the burr hole, additional craniotomy may be required.

The current study was limited by the absence of controls in this study, such as comparisons with patients showing severe head injury and signs of herniation who were treated using emergency craniotomy. At least, burr hole drainage for ASDH with bilateral non-reactive pupils is not be recommend if the pupils are >4 mm in diameter, as all patients showing this finding died. Another limitation was the small number of subjects in this retrospective study. Further prospective studies with larger subject populations are thus warranted to determine the efficacy of single burr hole drainage for ASDH patients with BNP.

CONCLUSION

The prognosis for unconscious patients with ASDH and bilateral non-reactive pupils is poor. However, emergency burr hole drainage should still be considered in patients showing ASDH with bilateral non-reactive pupils and one pupil ≤4 mm in diameter.

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