Small-sized Acute Subdural Hematoma: Operate or Not

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A retrospective study of 90 cases of small-sized (less than 3 mm on the printed CT film) acute (within 24 hours) subdural hematoma (SASDH) is presented. From March 1985 to December 1986, the SASDH were immediately operated on (operation rate: 86.0%). From January 1988 to December 1989, we attempted to treat them conservatively (operation rate: 49.1%). The patient population for this study consisted of 38 surgically-treated patients in the first period (Group I), 26 surgically-treated patients in the second period (Group IIs), and 26 conservatively-treated patients in the second period (Group IIc). We compared the clinical features, radiologic findings, and outcome of these 3 groups. The clinical features of Group I, including age, sex, Glasgow Coma Scale (GCS) score on admission, pupillary status on arrival, and interval from injury to the CT, did not differ significantly from those of Group II ($P > 0.01$). The only difference was the timing of the operation. In Group I, 20 patients (52.6%) received an operation within 4 hours, while in Group IIs, only 7 patients (26.9%) underwent surgery within 4 hours ($P < 0.05$). The radiologic findings of Group I, including the thickness and volume of the hematoma, the degree of midline shift, and the frequency of skull fracture, also did not differ from those of Group II ($P > 0.1$). However, the outcome of Group II strikingly differed from that of Group I. The mortality rate was 76.3% in Group I, while it was 44.2% in Group II ($P < 0.005$). In Group I, only 6 patients (15.8%) had a favorable outcome (4 good recovery and 2 moderate disability), while 27 patients (51.9%) had a favorable outcome (14 good recovery and 13 moderate disability) in Group II. The outcome of Group IIs was also better than that of Group I ($P < 0.005$). However, the outcome of Group IIs did not differ from that of Group IIc. These results strongly suggest that the SASDH should not be operated on immediately. We proposed the criteria of conservative treatment, and discussed possible harmful effects of surgery and a rationale of conservative treatment for the SASDH.

Key Words: Acute subdural hematoma, Size, Surgical treatment. Conservative treatment, Outcome, Computerized tomography, Head injury

INTRODUCTION

In the vast majority of acute subdural hematomas (ASDHs), operative evacuation remains the definitive treatment (Copper, 1987). Most neurosurgeons assume that the early operative removal could reduce the mortality rate (Becker et al., 1977, Seelig et al., 1981,

Gudeman et al., 1989). However, in many patients with ASDH, the hematoma itself may be only an epiphenomenon, and the main lesion determining the final outcome is the primary impact lesion, i.e., the diffuse brain injury (Sahuquillo-Barris et al., 1988). Surgical treatment on the diffuse brain injury is not only ineffective at present (Gudeman et al., 1989) but also may cause significant complications. Gennarelli (1987) cited that if the ASDH is removed, the swelling that accompanies the ASDH might progress rapidly, and this type of malignant swelling actually occurred regularly as seen in an experimental model of ASDH.

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From the middle of 1987, we attempted to treat the SASDH conservatively unless it caused progressive deterioration. The results of our conservative management were promising (Park et al., 1990). We present the results of our management and compare them with those of surgical treatment. We also discuss the rationale for the conservative treatment of SASDH.

MATERIALS AND METHODS

From March 1985 to December 1986, small-sized (less than 3 mm on the printed CT film) acute (within 24 hours) subdural hematomas were immediately removed by surgery. From January 1988 to December 1989, we attempted to treat them conservatively. In the first period of this study, 50 patients had SASDH and 43 (86.0%) received an operation. In the second period, 57 patients had SASDH and 28 (49.1%) received an operation. Of the 28 patients, 18 received an operation within 24 hours. In the remaining 10 patients, initial conservative management failed and an operation was done later.

For proper comparison, five patients whose Glasgow Coma Scale (GCS) score was 3 (four in the first period and one in the second period) and two patients who expired due to extracranial causes such as hypovolemic shock or severe multiple injuries (one in each period) were excluded from the study. We also excluded three patients who had a hematoma less than 2 mm in thickness and whose GCS score was above 13 in the second period. Thus the patient population for this study consisted of 38 surgically-treated patients in the first period (Group I), 26 surgically-treated patients including 10 patients of late operation in the second period (Group IIs), and 26 conservatively-treated patients in the second period (Group IIC). We compared clinical features, radiologic findings, and outcome at one month between Group I and Group II, and between Group IIs and Group IIC.

Conservative treatment consisted of a steroid (Dexamethasone 20-40mg/day), mannitol, and intermittent hyperventilation. Barbiturates were not used, and intracranial pressure (ICP) was not monitored. The interval from injury to CT scanning was obtained by a 0.5-hour interval. The size of the hematoma was measured using 2 parameters, the thickness and the volume. The thickness was measured at the slice where the hematoma revealed the largest size. It was measured on the printed CT film and multiplied by the reduction ratio ($\times 2.85$). The volume was estimated by the formula $V = \pi/6 \times ABC$ (A: thickness, B: width, C: height). We utilized Chi-square test for statistical com-

parison. Significance was attributed to a P value of <0.05 .

RESULTS

Clinical Features

Clinical features are summarized in Table 1. Between Group I and Group II, there were no significant differences in age, sex, GCS score on admission, pupillary status on arrival, or interval from injury to CT ($P>0.1$). In Group I, 20 patients (52.6%) received an operation within 4 hours, while in Group IIs, only 7 (26.9%) underwent surgery within 4 hours ($P<0.05$). Between Group IIs and Group IIC, only one statistically significant difference was found. In Group IIs, 21 patients (80.8%) were above the age of 40, while in Group IIC, 12 (46.2%) were older than 40 ($P<0.05$). Patients who received late operations in Group IIs were more than 40 years old except one. Five of them underwent operations within 10 days and remaining 5 patients received operations more than 10 days later.

Radiologic Features

Radiologic features are summarized in Table 2.

Table 1. Clinical features

Characteristics	Group I	Group II			Statistics*	
		IIs	IIC	Total	I:II	IIs:IIC
Total	38	26	26	52		
Age (yrs)						
Less than 40	14	5	14	19	$P>0.1$	$P<0.01$
40 or more	24	21	12	33		
Sex						
Male	31	19	20	39	$P>0.1$	$P>0.1$
Female	7	7	6	13		
GCS on admission						
4-8	23	15	17	32	$P>0.1$	$P>0.1$
9-15	15	11	9	20		
Pupils on arrival						
Normal	15	12	11	23	$P>0.1$	$P>0.1$
Abnormal	23	14	15	29		
Interval (injury-CT)						
= <4	32	18	22	39	$P>0.1$	$P>0.1$
>4	6	8	5	13		
Interval (injury-OP)						
= <4	20	7	7	14	$P<0.05$	
>4	18	19	19			

* chi-square test; I:II = comparison of Group I vs Group II; IIs:IIC = comparison of Group IIs vs Group IIC; OP = operation

There were no significant differences in thickness and volume of the hematoma, the degree of midline shift, effacement of quadrigeminal cistern, and the frequency of skull fracture between Group I and Group II ($P>0.1$). Between Group IIs and Group IIc, there were no significant differences.

Table 2. Radiological features

Characteristics	Group I	Group II			Statistics*	
		IIs	IIc	Total	I:II	IIs:IIc
Total	38	26	26	52		
Thickness ¹ (mm)						
= <2	17	10	14	24	$P>0.1$	$P>0.1$
>2, = <3	21	16	12	28		
Volume ² (ml)						
= <20	19	15	16	31	$P>0.1$	$P>0.1$
>20	19	11	10	21		
Midline shift ¹ (mm)						
= <2	23	14	18	32	$P>0.1$	$P>0.1$
>2	15	12	8	20		
Quadrigeminal cistern						
Normal	14	10	11	21	$P>0.1$	$P>0.1$
Obliterated	24	16	15	31		
Skull fracture						
Present	22	15	16	31	$P>0.1$	$P>0.1$
Absent	16	11	10	21		

¹ on the printed CT film; ² calculated volume; * chi-square test; I:II=comparison of Group I vs Group II; IIs:IIc=comparison of Group IIs vs Group IIc.

Outcome

The outcome of Group II strikingly differed from that of Group I (Table 3). The mortality rate was 76.3% in Group I, while it was 44.2% in Group II ($P<0.005$).

Table 4. Hospital course in Group II

GCS (No of Cases)	Hospital Course	Results
13-15 (8)	recovered without operation (5)	recovered
	late operation due to enlargement (3)*	1 death
9-12 (12)	recovered (4)	recovered
	delayed (5-24 hrs) operation (3)*	1 death
	late operation due to delayed lesion (5)*	3 deaths
4-8 (32)	rapid improvement (7) recovered (5)	recovered
	late operated (2)*	recovered
	immediate (within 4 hrs) operation (7)*	5 deaths
	delayed (5-24 hrs) operation (6)*	2 deaths
	sustained coma (12)	12 deaths

In Group I, only 6 patients (15.8%) had a favorable outcome (4 good recovery and 2 moderate disability), while 27 (51.9%) had a favorable outcome (14 good recovery and 13 moderate disability) in Group II.

The outcome of Group I was worse than that of Group IIs ($P<0.005$), while, immediate operations were more commonly performed in Group I (Table 1). Despite of the fact that patients who were above the age of 40 were more common in Group IIs, the outcome of Group IIs did not differ significantly from that of Group IIc.

Hospital Course during the Second Period

In the second period of this study (Group II), 8 patients (15.4%) had a GCS score of 13-15 on admission. Three of them required an operation due to enlargement of the hematoma on the follow-up CT scans. They could be treated by burr-hole drainage. The remaining 5 patients recovered without operations

Table 3. Outcome

Outcome	Group I	Group IIs	Group IIc	Group II*
Total	38	26	26	52
FO	6	16	11	27
GR	4	8	6	14
MD	2	8	5	13
UO	32	10	15	25
SD/VS	3	1	1	2
DD/DM	29	9	14	23
Mortality (%)	76.3	34.6	53.8	44.2

* Group II=Group IIs+Group IIc; FO=favorable outcome; GR=good recovery; MD=moderate disability; UO=unfavorable outcome; SD=severe disability; VS=vegetative state; DD=death; DM=discharged moribund; Statistical comparison between I vs II= $P<0.005$, IIs vs IIc= $P>0.1$

(Table 4).

In 12 patients who had a GCS score of 9-12, 3 patients received an operation within 24 hours and one expired. In 5 patients, operative removal was performed due to delayed lesions and/or deterioration and 3 expired. The remaining 4 patients became alert within a day and recovered without surgery.

Management of the patients who had a GCS score of 3-8 seemed to be risky. However, there were often dramatic improvements in consciousness. In some patients, consciousness rapidly improved from a state of coma while preoperative preparations were being made. Repeated CT scanning was immediately performed on those patients. Frequently the degree of midline shift was much reduced, and the thickness of the hematoma was also reduced. Operations were deferred on those patients. In 32 patients who had a GCS score of 3-8, 7 patients (22.6%) improved rapidly, and 2 required operative removal later. Seven patients (38.7%) received an operation within 4 hours after the injury. Five of them expired. Six other patients received an operation between 5 to 24 hours after the injury. Two of them expired. Twelve patients (38.7%) remained in a coma, and all of them expired within 4 days.

DISCUSSION

There were no significant differences in clinical and radiologic features between Group I and Group II. However, the mortality rate of Group II was significantly lower than that of Group I. Not only the mortality rate but also the functional result was better in Group II. In Group I, only 6 patients (15.8%) had a favorable outcome, while 27 (51.9%) had a favorable outcome in Group II. We could explain these results as the following reasons.

Rationale for Conservative Treatment

Classification of the lesional types in head injury as either focal or diffuse (Gennarelli et al., 1982) seems to be widely accepted as a useful clinical tool. However, in many cases, these 2 types of lesions may be found together (Lobato et al., 1983; Lobato et al., 1988; Sahuquillo-Barris et al., 1988). Thus, this classification is often a misleading simplification (Sahuquillo-Barris et al., 1988). Even in focal lesions, the lesion that made the patient immediately comatose is the diffuse brain injury. It is well-known that the initial loss of consciousness after a head injury is not by a focal lesion but by a diffuse brain injury (Gennarelli and Thibault, 1985). Gennarelli et al. (1982, 1985) cited that coexistence of subdural hematoma and diffuse axonal injury is com-

mon because the mechanism of these two injuries is similar. Coexisting ASDH and diffuse axonal injury was clinicopathologically proved by Sahuquillo-Barris et al. (1988). Lobato et al. (1988) also reported the ASDH of varying sizes were associated with cerebral hemispheric swelling in 85% of their series. In comatose patients with SASDH, the main lesion was the diffuse brain injury, and the SASDH was only a "epiphenomenon" (Sahuquillo-Barris et al., 1988), especially in patients who arrived shortly after a head injury.

Recently, rapid, spontaneous disappearance of ASDH was reported by some (Nagao et al., 1986; Polman et al., 1986; Mikiyama et al., 1987; Bae et al., 1989). Mikiyama et al. (1987) noted that such cases were relatively common as one or 2 a year. Polman et al. (1986) reported an important observation by MRI, i.e., rapid redistribution of the subdural clot. Increased pressure around the hematoma pushes the blood to redistribute, which could decrease the local pressure gradient and enlarge absorption surface. There should be some time allowed for this redistribution. During this period, surgery may be harmful rather than beneficial. Surgery may cause a sudden decompression at the time of dural opening. A significant pressure difference can be produced by the reflex hypertension (Cushing's phenomenon) and sudden decompression. Traumatized vessels could not tolerate this pressure difference, hence, exacerbation of brain edema or swelling with or without intracerebral hematoma would result, just like "popping." Gennarelli (1987) noted that the swelling with ASDH might progress rapidly if the ASDH is removed, and this type of malignant swelling occurred regularly in an experimental model of ASDH. Cooper et al. (1979) also observed that decompressive craniectomy exacerbated the brain edema in an experimental model.

In a sense, the swelling may be a biologic response to act as a repairing process. Bleeding from a small tear in the bridging veins or cortical vessels could be stopped by this tamponading effect. Small localized hematoma could be redistributed to increase absorption capacity and reduce the pressure gradient. As far as the ICP accompanied by swelling does not reduce the perfusion pressure or bring transtentorial herniation, the swelling could lead to beneficial results such as another type of repairing process or compensation. Massive hematoma beyond this compensation requires immediate surgical removal. However, SASDH can be managed by providing time for redistribution. We supposed that close observation for a few hours or immediately repeated CT scanning could provide time

for redistribution and seemed to be more beneficial than decompression. For diffuse brain injuries, whether the lesion is diffuse hemispheric swelling or diffuse axonal injury, there is no evidence that surgery is beneficial at present (Gudeman et al., 1989). It seems unlikely that the patients who had SASDH and who expired soon after could have been improved by surgery because the main lesion was a diffuse brain injury.

Although the ICP may be an important factor in decision-making, we did not monitor the ICP due to following reasons. One is the fact that the higher the ICP, the more severe popping would occur. So, reduction of the ICP should not be attempted from the outside, but from the inside. As another reason, we should consider the cost to benefit ratio. We could perform four times of CT scanning at the same cost of the ICP monitoring. ICP monitoring is an invasive diagnostic procedure having some of its own complications. And it could not show the exact cause, even though the ICP is very high. Thus, we preferred repeated CT scanning.

Criteria for Conservative Treatment

Who can be managed by conservative treatment? At first, the hematoma should not have a significant mass effect by itself. Second, there should not be any signs suggesting transtentorial herniation, such as pupillary abnormality. Finally, the age of the patient should be considered. Between Group IIa and Group IIc, the only statistically significant difference was the age. Thus, conservative treatment could be done successfully for patients who fulfilled the following criteria: 1) the thickness of the hematoma is smaller than the skull bone thickness (about 1 cm); 2) there is little midline shift or little mass effect by the hematoma itself; 3) the pupils are normal or rapidly became normal; and 4) the age of the patient is less than 40 years.

Pitfalls of Conservative Treatment

Although a mass is small, it is difficult to decide whether or not to operate upon the comatose patient with mass lesions. The mass effect is not necessarily related to the size, and the hematoma may be still growing. So, we operated upon about half of the patients during the second period. Even with close observation and repeated CT scanning, there may have been a few missing cases. However, recent reports prove that the rapidity of operative removal does not significantly affect the outcome, and there is no critical time for the acute subdural hematoma (Wil-

berger et al., 1990, 1991). Close observation for a few hours and/or immediate CT scanning could be done without significant harmful effects. The results of conservative management in this study are clearly better than those of operative management. In any event, to prevent missing a chance of rescue, close observation of the clinical course and repeated CT scanning seem to be essential, and further studies are needed for accurate decision-making.

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