

Relationship between drainage catheter location and postoperative recurrence of chronic subdural hematoma after burr-hole irrigation and closed-system drainage

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Object. This study was conducted to determine the best position for the subdural drainage catheter to achieve a low recurrence rate after burr-hole irrigation and closed-system drainage of chronic subdural hematoma (CSDH).

Methods. The authors studied 63 patients with CSDH in whom the drainage catheter tip was randomly placed and precisely determined on postoperative computerized tomography (CT) scans and 104 patients with CSDH in whom CT scans were obtained 7 days postsurgery. The location of the subdural drainage catheter, the maximum postoperative width of the subdural space, and the percentage of the ipsilateral subdural space occupied by air postoperatively were determined and compared with the postoperative recurrence and reoperation rates.

Patients with parietal or occipital drainage had a higher rate of CSDH recurrence and much more subdural air than those with frontal drainage. In addition, patients with residual subdural air demonstrated on CT scans obtained 7 days postsurgery also had a higher recurrence rate than those without subdural air collections. Furthermore, patients with a subdural space wider than 10 mm on CT scans obtained 7 days postsurgery had a higher recurrence rate than those with a space measuring 10 mm or less.

Conclusions. The incidence of postoperative fluid reaccumulation seems to be reduced by placing the tip of the drainage catheter in the frontal convexity and by removing subdural air during or after surgery.

KEY WORDS • subdural hematoma • subdural air collection • closed-system drainage • computerized tomography

AMONG many surgical procedures for CSDH,⁵ burr-hole irrigation with closed-system drainage is now generally accepted as the best treatment method.^{1-3, 4-8, 11-13} However, there are still many unanswered technical questions about this procedure.

Over the last 10 years at our hospital, we have gained the impression that patients with CSDH in whom the subdural drainage catheter is located occipitally have a higher incidence of reoperation than those with frontal drainage, and also that patients in whom subdural air remains 7 days postsurgery have a higher postoperative recurrence rate than those without subdural air collections. Therefore, we investigated the relationship between the position of the postoperative subdural drainage catheter, the amount of postoperative subdural air, and the recurrence rate in 135 patients with CSDH who underwent burr-hole irrigation and closed-system drainage.

Abbreviations used in this paper: CSDH = chronic subdural hematoma; CT = computerized tomography.

Clinical Material and Methods

Patient Population

Of 135 consecutive patients with CSDH who were treated at Tokyo Kosei Nenkin Hospital from January 1989 to April 1998, we performed CT scanning between the 1st and 3rd day postsurgery in 106 patients and on the 7th day in 104 patients. In 63 patients (47 men and 16 women, 41–92 years of age, mean age 68.1 years) with one lesion each, the position of the tip of the drainage catheter was randomly decided and then precisely determined using CT scanning on the day after surgery. In 104 patients (83 men and 21 women, 25–92 years of age, mean age 66.3 years) among whom there were 109 lesions, the extent of subdural air on the 7th day postsurgery was calculated.

Nine patients with risk factors that are known to affect CSDH recurrence (thrombocytopenia, anticoagulant or thrombolytic drug therapy, hemodialysis, infancy, and presence of a ventriculoperitoneal shunt)¹ were excluded from the study.

TABLE 1
Comparative relationships among variables in 135 patients with CSDH*

Factor	No. of Patients (%)	No. W/ Reop (%)	p Value†	No. W/ Recurrence (%)	p Value†
max midline displacement on preop CT scans					
>10 mm	11 (16)	1 (9)	0.6752	1 (9)	0.4354
≤10 mm	59 (84)	11 (19)		14 (24)	
max thickness of SDH on preop CT scans					
≥20 mm	29 (42)	4 (14)	0.7501	7 (24)	0.7709
<20 mm	40 (58)	7 (18)		8 (20)	
max width of ipsilat SDS on CT scans 7 days postop					
>10 mm	43 (60)	4 (9)	0.0064	13 (45)	0.0021
≤10 mm	29 (40)	11 (38)		5 (12)	

* Variables are as follows: maximum midline displacement and maximum SDH thickness as seen on preoperative CT scans; maximum width of ipsilateral SDS on CT scans obtained 7 days postoperatively; reoperation rate; and recurrence rate. Abbreviations: max = maximum; SDS = subdural space.

† Fisher's exact test was used for analysis of the differences.

We defined CSDH as an SDH surrounded by a thin capsule that contained dark red liquefied blood at operation. If the date of head trauma was known, CSDH was defined as a hematoma remaining more than 3 weeks after such trauma.

All patients underwent surgical intervention, including drilling of one burr hole and irrigation of the SDH with sterile saline, followed postoperatively by closed-system drainage with a silicone tube (Type B ventricle drainage tube; Hanako Medical, Urawa, Japan). The patients were assigned a number on admission and were treated with either frontal or occipital drainage according to their assigned number. If random selection failed, the patient was excluded from the study. Therefore, in all individuals the tip of the drainage catheter was randomly placed in the frontal or occipital region.

We examined the maximum hematoma thickness and maximum midline displacement on CT scans obtained immediately before surgery, as well as the position of the tip of the drainage catheter on CT scans obtained 1 day after surgery. In addition, the maximum width of the subdural space and the percentage of the ipsilateral subdural space containing air were determined on CT scans obtained 7 days after surgery.

At our hospital, CT scanning is routinely performed five times in every patient with CSDH: preoperatively and 1 to 3, 7, 30, and 90 days postsurgery.

Regardless of whether residual hematoma and subdural air collections were seen on CT scans, all the drainage catheters were removed within 48 hours postsurgery and the daily activities of the patients were not restricted afterward. Before the drainage catheter was removed, patients were required to keep their heads level with their hearts all day long.

We considered CSDH to have recurred if the volume of subdural fluid on the treated side increased compared with the volume measured 1 to 3 days postsurgery and if the brain was compressed by subdural fluid observed on CT scans obtained within 3 months after surgery. Patients underwent reoperation if neurological symptoms recurred or the cerebral sulci were seen to be diffusely effaced by recurrent hematoma on CT scans. Those with no neurologi-

cal deficit or with a small residual hematoma were followed up as outpatients. The postoperative recurrence rate and the reoperation rate were calculated in each group and were analyzed statistically.

Thickness of SDH, Midline Displacement on Preoperative CT Scans, and Width of Subdural Space 7 Days Postsurgery

The maximum preoperative thickness of SDH and the maximum preoperative midline displacement were calculated, as was the maximum width of the ipsilateral subdural space 7 days postsurgery. The relationships between these measurements (converted to millimeters) and the recurrence or reoperation rate were analyzed statistically.

Postoperative Subdural Air Collection

The percentage of subdural air relative to the entire ipsilateral subdural space was calculated in the patients in whom CT scans obtained 1 to 3 days and 7 days after surgery were available. On all CT slices, the area of the subdural space and that of subdural air were measured using National Institutes of Health image analysis software, and these areas were summed for all slices. The percentage of the subdural air was then calculated as the volume of subdural air divided by the volume of the subdural space.

Location of the Tip of the Subdural Drainage Catheter

Although the drainage catheters were assigned randomly for placement in either the frontal or occipital region, each catheter was blindly inserted into the subdural space at surgery and it was unclear where the tip was placed. Therefore, we determined the precise location of the tip of each drainage catheter by inspection of CT scans obtained 1 day after surgery. Such scans were available for 63 patients. The location of the tip was classified as frontal, parietal, occipital, or temporal (base), and the recurrence rate was calculated for each region. In the other patients, we could not detect the tip of the drainage catheter precisely on CT scans on the day after surgery or failed to randomly select the catheter position.

Drainage catheter location and postoperative recurrence of CSDH

TABLE 2

*Relationship between SDA collection on Day 7 postsurgery, reoperation rate, and recurrence rate in 104 patients**

Factor	No. of Lesions (%)	No. W/ Reop (%)	p Value†	No. W/ Recurrence (%)	p Value†
<i>percentage of SDA on CT scans 7 days postop</i>					
<20	84 (77)	4 (5)	<0.0001	8 (10)	0.0003
≥20	25 (23)	10 (40)		11 (44)	
0	51 (47)	1 (2)	0.012	4 (8)	0.0212
>0	58 (53)	13 (22)		15 (26)	
total	109				

* SDA = subdural air.

† Fisher's exact test was used for analysis of the differences.

Statistical Analysis

For statistical analysis, Fisher's exact test or the chi-square test for independence were used with commercially available software (StatView J 4.11; SAS Institute, Inc., Cary, NC).

Results

Compared with the CT findings at 1 to 3 days postsurgery, 16 lesions had enlarged and the other 110 had not at 7 or more days after surgery. Twelve of the 16 lesions required repeated evacuation. The postoperative recurrence rate was calculated to be 13% and the reoperation rate was 10%.

Maximum Hematoma Thickness and Midline Displacement Preoperatively and Maximum Width of Subdural Space Postoperatively

The maximum hematoma thickness and the maximum midline displacement on preoperative CT scans had no correlation with the postoperative recurrence rate (Table 1).

In contrast, there was a significant difference in the postoperative recurrence rate between the patients who had a narrower or wider subdural space on CT scans obtained 7 days postsurgery. The patients with a subdural space measuring 10 mm or less at 7 days postsurgery had a postoperative recurrence rate of 12%, whereas those with a subdural space wider than 10 mm had a postoperative recurrence rate of 45% ($p = 0.0021$; Fisher's exact test).

Postoperative Subdural Air Collection Rate

The patients with no subdural air observed on CT scans obtained 7 days postsurgery had a postoperative recurrence rate of 8% (four of 51 patients), whereas those with 5% or more subdural air had a postoperative recurrence rate of 26% (15 of 58 patients; $p = 0.0212$, Fisher's exact test). Patients with less than 20% subdural air had a postoperative recurrence rate of 10% (eight of 84 patients), whereas those with 20% or more subdural air had a postoperative recurrence rate of 44% (11 of 25 patients; $p = 0.0003$, Table 2). Those with less than 30% subdural air had a postoperative recurrence rate of 8% (eight of 86

TABLE 3

Relationship between position of the drainage catheter tip, the reoperation rate, and recurrence rate in 63 patients with CSDH

Position of Drainage Catheter Tip	No. of Patients (%)	No. W/ Reop (%)	p Value*	No. W/ Recurrence (%)	p Value*
occipital	25 (40)	5 (20)	>0.9999	9 (36)	0.1453
frontal	21 (33)	1 (5)	0.0478	1 (5)	0.0131
temporal (base)	9 (14)	3 (33)	0.3543	3 (33)	0.6811
parietal	8 (13)	3 (38)	0.4075	3 (38)	0.17
total	63	12 (19)		16 (25)	

* Calculated using Fisher's exact test.

patients), whereas those with 30% or more subdural air had a postoperative recurrence rate of 48% (11 of 23 patients, $p < 0.0001$).

There were many patients with a large amount of subdural air or fluid on the CT scans obtained on the 1st to 3rd postoperative day, but this usually decreased on the 7th day, and the CT findings on the 1st to 3rd day regarding subdural air, subdural fluid, or maximum midline displacement were not correlated with the postoperative recurrence and reoperation rates.

Position of the Tip of the Subdural Drainage Catheter

Among 63 patients in whom the position of the tip of the subdural drainage catheters was confirmed on CT scans obtained on the day after surgery, in 21 the tip was located in the frontal region and the postoperative recurrence rate was 5% (one of 21), in eight the tip was in the parietal region and the postoperative recurrence rate was 38% (three of eight), in 25 the tip was in the occipital region and the postoperative recurrence rate was 36% (nine of 25), and in nine the tip was at the temporal base and the postoperative recurrence rate was 33% (three of nine; Table 3). Patients in whom the tip resided in the frontal region had the lowest recurrence rate, and there was a significant difference between frontal and occipital drainage ($p = 0.0243$; Fisher's exact test), and frontal drainage and all other types ($p = 0.0131$).

Postoperative subdural air collections were confirmed in 55 of 63 patients in whom the position of the tip of the drainage catheter was verified on CT scans. In the other eight patients CT scans were not obtained on the 7th day postsurgery. At 7 days after postsurgery, 11% of patients in whom the catheter tip was observed in the frontal region (two of 18) had some subdural air, compared with 88% in whom the tip was in the parietal region (seven of eight), 60% with the tip in the occipital region (12 of 20), and 44% with the tip in the temporal region (four of nine; Table 4). There was a significant difference in postoperative subdural air between frontal and occipital drainage ($p = 0.0025$; Fisher's exact test); frontal and parietal drainage ($p = 0.0004$); frontal drainage and all others ($p = 0.0004$); and parietal drainage and all others ($p = 0.0175$).

Discussion

There have been no previous studies on the relationship

TABLE 4

*Relationship between position of the drainage catheter tip and percentage of SDA compared with SDS on CT scans obtained 7 days postoperatively in 55 patients**

Position of Drainage Tube Tip	No. of Patients (%)	SDA (%)†	No. of Patients W/ SDA <20%:≥20%	p Value		No. of Patients W/ SDA 0%:>0%	p Value	
				Fisher's ET	Chi		Fisher's ET	Chi
occipital	20 (36)	15	13:7	0.3347	0.0185	8:12	0.1591	0.0011
frontal	18 (33)	2	17:1	0.0217		16:2	0.0004	
temporal (base)	9 (16)	11	7:2	>0.9999		5:4	>0.9999	
parietal	8 (15)	22	3:5	0.1814		1:7	0.0175	
total	55							

* Eight patients were excluded because CT scans were not obtained 7 days postoperatively. Abbreviations: Chi = chi-square test for independence; ET = exact test.

† Average percentage of SDA compared with SDS on CT scans obtained 7 days postoperatively.

between the position of the tip of the subdural drainage catheter and the postoperative recurrence rate after burr-hole irrigation and closed-system drainage for CSDH. Therefore, the location of the drainage catheter has depended on the discretion of the neurosurgeon.

In our investigation, the position of the tip of the drainage catheter affected the postoperative recurrence rate. Patients with a subdural drainage catheter located in the parietal or occipital region had an extremely high recurrence rate, whereas those with a catheter located in the frontal region had the lowest recurrence rate.

The low recurrence rate in patients with frontal drainage is mostly explained by two other findings in our study: 1) patients with massive subdural air collections after 7 days had a higher postoperative recurrence rate than those with little or no air, and 2) patients with frontal drainage had the least subdural air postoperatively.

The patients in our study in whom a large amount of residual subdural air was seen on CT scans obtained 7 days postsurgery had a higher recurrence rate than those with little or no subdural air. Nagata, et al.,⁹ reported that the amount of subdural air found postoperatively correlated negatively with the resolution rate of CSDH. Although they did not refer to the postoperative recurrence rate, their observation may support our result.

It has been stated that postoperative recurrence of CSDH is caused by a pressure imbalance between the outside and inside of the inner membrane, that is, high pressure in the hematoma cavity and/or low pressure in the subarachnoid space, or brain atrophy.⁵ The former situation is indicated by massive subdural air collection, residual SDH, and persistent widening of the hematoma cavity. The latter situation is related to excessive fluid loss including dehydration, anemia, and bleeding; severe brain atrophy; and excessive cerebrospinal fluid drainage (ventriculoperitoneal shunt placement or ventricular drainage).¹⁰

Among these conditions, massive postoperative subdural air is considered to be one of the major factors leading to pressure imbalance across the inner membrane. It also induces prolonged widening of the subdural space and disturbs adhesion between the inner and outer membrane, which is considered to be necessary for cure of CSDH.

The location of the catheter tip was correlated significantly with the size of the postoperative subdural air col-

lection. Drainage catheters located occipitally or parietally are considered to be ineffective for removing air from the subdural space because air accumulates in the frontal convexity while the patient is supine immediately after surgery. For subdural air to be discharged, the drainage catheters should be inserted precisely into the frontal convexity. Therefore, we believe that placing the tip of the drainage catheter accurately in the frontal convexity to remove subdural air is the most effective method for preventing the postoperative recurrence of CSDH.

Conclusions

- 1) Patients with parietal or occipital drainage had a higher recurrence rate and much larger subdural air collections than those with frontal drainage after burr-hole surgery and closed-system drainage for CSDH.
- 2) Patients with residual subdural air on CT scans obtained 7 days postsurgery also had a higher recurrence rate than those with no subdural air; therefore persistent subdural air seems likely to induce the recurrence of CSDH.
- 3) Patients with a subdural space more than 10 mm wide on CT scans obtained 7 days postsurgery had a higher recurrence rate than those with a space measuring 10 mm or less.
- 4) Postoperative reaccumulation of CSDH can be reduced by placing the tip of the drainage catheter in the frontal convexity and by removing subdural air during or after surgery.

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Drainage catheter location and postoperative recurrence of CSDH

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