Timing of Brain Expansion and Recurrence after Surgery of Chronic Subdural Hematoma

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Background: *Chronic subdural hematoma (CSDH) is common in neurosurgical practice. The exact timing of brain expansion is still unknown.*
Objective: *To study prospectively the timing of full brain expansion and timing of recurrence after surgery of CSDH.*
Material and Method: *After burr hole and closed-system drainage for the treatment of CSDH, serial CT brains were done at 24 hours after removal of draining system, 1 week, 2 weeks, 4 weeks, 8 weeks postoperatively or whenever abnormal neurological symptoms being suspicious for recurrence occurred.*
Results: *102 CSDHs from 75 patients were included in the study. A total 450 serial CT brains were done and reviewed. Full brain expansion after the surgery occurred 1% between the 1st and 2nd weeks, 5.9% between the 2nd and 4th weeks, 80.4% between the 4th and 8th weeks and 12.7% after the 8th weeks. The incidence of recurrent CSDH was 9.8%. In patients with recurrent CSDH, the recurrence was 10% before removal of draining system, 70% between the 1st and 2nd week, 10% between the 2nd and 4th week and 10% after the 8th week.*
Conclusion: *Brain expansion after surgery of CSDH is a very slow process. There is a discrepancy between the timing of full brain expansion and timing of recurrence. Recurrent CSDH mostly occurred between the 1st and 2nd week while full brain expansion mostly occurred after the 4th week. The period between the 1st and 2nd week should be the crucial period of clinical follow-up. Persistence of subdural space on a random postoperative CT brain, without any symptoms, should be considered as a normal process of brain expansion.*

Keywords: *Chronic subdural hematoma, Brain expansion, Recurrence*

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Chronic subdural hematoma (CSDH) is a common neurosurgical disease. Its conventional treatment is burr hole with or without closed-system drainage. The method is the most widely accepted surgical option[1] and has recurrence rates reported between 3 to 20%[2-6]. Typically, the brains do not expand immediately after the surgery but gradually expand over certain periods, which, to our knowledge, the timing of brain expansion has never before been adequately investigated. If postoperative CT or MRI brain is done during this time, persistence of subdural collection will be seen. Similarly, the timing of recurrent CSDH after the operation has not been sufficiently investigated. These make for uncertainty whether the persistence of subdural space seen on the postoperative images is a normal evolution process of brain expansion or an abnormal evolution process of recurrent CSDH. If there is a discrepancy between the timing of brain expansion and recurrence after surgery of CSDH, a more accurate prediction and identification of patients who have a risk of recurrent CSDH can be done.

The primary objective of the present study is to determine the timing of brain expansion and recurrence after surgery of CSDH. The secondary objective is to determine the incidence of recurrent CSDH and factors associated with the recurrence. The findings will be used for the postoperative surveillance of the high risk group of recurrence.

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Material and Method

Patient population and data collection

A prospective controlled study of CSDH was done at our institute during 2006 to 2009. Patients' data were collected which included age, sex, occupation, characteristic of injury, symptoms, alcohol abuse,

underlying diseases, previous medications, duration between head injury to initial CT scan of the brain. Relevant laboratory, such as platelet count and coagulogram, were also recorded.

Characteristics of CSDH on CT brain, including location, size, side and density, were collected. Internal architecture of hematoma was stratified into homogenous stage, separated stage (hematoma containing two components of different densities with a clear boundary lying between the lower densities component located above a higher density component), laminar stage (having a thin high density layer along the inner membrane), trabecular stage (having high density septums running between the inner and outer membrane on a low to isodensity background)[6]. Severity of brain atrophy on CT scan was also taken into account. Mild brain atrophy was defined as mild cerebral and/or cortical atrophy with slight enlargement of the lateral ventricle. Moderate brain atrophy was well established cerebral and/or cortical atrophy, ballooning of the lateral ventricle and/or involvement of the other ventricles and severe brain atrophy was defined as extreme atrophy and/or extreme dilatation of the ventricular system[7].

The surgery was performed under general anesthesia. Two burr holes, drainage of hematoma, irrigation and insertion of closed-system drainage were done in all patients by nonspecific random surgeons.

All patients were investigated by serial postoperative CT scan before removal of draining system, at 1 week, 2 weeks, 4 weeks, 8 weeks postoperatively and whenever any abnormal neurological symptoms suspected for recurrence occurred.

The recurrence of subdural hematoma was defined as recurrence of clinical symptoms or development of new symptoms and presence of subdural space on the serial CT brain being larger than the previous CT brain.

Statistical analysis

Results were demonstrated as descriptive statistics, which continuous data were described as mean, standard deviation, median, range, and categorical data, was described as frequencies and in percentages. All data were analyzed using SPSS for Windows version 10.0 (SPSS Inc., Chicago IL, USA).

Results

A total number of 102 CSDHs from 75 patients and 450 serial CT brain were included in the study. There were 79 lesions in men (77.5%) and 23 lesions in women (22.5%). The patients' age ranged from 1 to 88 years with a mean age being 60.67 years and median age being 66 years. There were 31 (30.4%) patients who had history of head trauma. The duration of injury ranges from 6 to 50 days with a mean duration of 21 days and median duration of 14 days.

The duration of symptoms ranged from 1 to 60 days with a mean time of 9.45 days and median time of 7 days. Headache was the most common presenting symptom, followed by weakness, alteration of consciousness, dizziness or unstable gait and seizure, respectively. There were 60 subjects (58.8%) who had coexisting diseases. Five patients (4.9%) had coagulopathy and 6 patients (5.9%) had thrombocytopenia. Thirty-one subjects (30.4%) took antiplatelet or anticoagulant. The most common drug was aspirin followed by warfarin and clopidigrel, respectively. Deterioration of consciousness and abnormal Glasgow Coma Scale score were found in 32.4% of patients. Demographic characteristics were summarized in Table 1.

Unilateral CSDH (48, 64%) was found more common than bilateral lesions (27, 36%) and was on the left side (60, 58.8%) more than the right side (42, 41.2%). The most common hematoma stage was separated (46, 45.1%) followed by homogenous (44, 43.1%), laminar (8, 7.8%) and trabecular stages (4, 3.9%), respectively. All hematomas were in the convexity area (102, 100%). Fronto-parieto-occipital was the most common location (83, 81.4%) followed by fronto-parietal (16, 15.7%), parieto-occipital (2, 2%) and fronto-temporal area (1, 1%). Brain atrophy was divided into 4 groups according to the severity as none (29, 28.4%); mild (35, 34.3%); moderate (24, 23.5%); and severe (14, 13.7%). Table 2 shows characteristics of CSDH and brain atrophy on CT brain.

The timing of full brain expansion and recurrence were observed by postoperative serial CT brain and were divided into 6 periods. Period 1 was before removal of the draining system. Period 2 was after removal of the draining system to the 1st week. Period 3 was the 1st week to the 2nd week. Period 4 was the 2nd week to the 4th week. Period 5 was the 4th week to the 8th week and Period 6 was after the 8th week. There were total 450 serial CT brain reviewed for the study. The brain expansion was found to be a delayed pattern in all patients and never been found before the 1st postoperative week. Indeed in most patients (80.4%), full brain expansion occurred after the 4th week with almost all patients (87.3%) experiencing full brain

Table 1. Demographic characteristics

Clinical symptoms	
Headache	69 (67.6%)
Weakness	51 (50%)
Alteration of consciousness	32 (31.4%)
Dizziness/unstable gait	25 (24.5%)
Seizure	3 (2.9%)
Coexisting diseases	
Hypertension	30 (29.4%)
Heart disease	15 (14.7%)
Diabetes mellitus	11 (10.8%)
Chronic renal failure	2 (2%)
Alcoholism	2 (2%)
Dyslipidemia	11 (10.8%)
Other diseases	24 (23.8%)
Bleeding disorders	
Coagulopathy	5 (4.9%)
Thrombocytopenia	6 (5.9%)
Use of drugs interfere platelet function or coagulation	
Aspirin	27 (26.5%)
Warfarin	5 (4.9%)
Clopidogrel	3 (2.9%)
Glasgow Coma Scale score on admission	
15	69 (67.6%)
13 to 14	18 (17.6%)
9 to 12	13 (12.7%)
<9	2 (2%)

Table 2. Characteristic on CT brain

Thickness of CSDH	
Mean ± SD (mm)	15.01±5.82
Median (mm)	13.5
Range (mm)	6-36
Laterality of CSDH (n = 75)	
Unilateral	48 (64%)
Bilateral	27 (36%)
Side of CSDH	
Right side	42 (41.2%)
Left side	60 (58.8%)
Internal architecture of CSDH	
Homogenous	44 (43.1%)
Separated	46 (45.1%)
Laminar	8 (7.8%)
Trabecular	4 (3.9%)
Location of CSDH	
Fronto-parietal	16 (15.7%)
Fronto-parieto-occipital	83 (81.4%)
Fronto-temporal	1 (1%)
Parieto-occipital	2 (2%)
Brain atrophy	
None	29 (28.4%)
Mild	35 (34.3%)
Moderate	24 (23.5%)
Severe	14 (13.7%)

Table 3. Timing of full brain expansion and recurrence of CSDH

Full brain expansion (n = 102)	
P1: before removal of drainage	0 (0%)
P2: removal of drainage to 1st week	0 (0%)
P3: 1st to 2nd week	1 (1%)
P4: 2nd to 4th week	6 (5.9%)
P5: 4th to 8th week	82 (80.4%)
P6: after 8th week	13 (12.7%)
Time of recurrent CSDH (n = 10)	
P1: before removal of drainage	1 (10%)
P2: removal of drainage to 1st week	0 (0%)
P3: 1st to 2nd week	7 (70%)
P4: 2nd to 4th week	1 (10%)
P5: 4th to 8th week	0 (0%)
P6: after 8th week	1 (10%)

P = period

expansion by the 8th week (Table 3).

Ten patients (9.8%) developed recurrent CSDH. Seven patients (70%) developed recurrence between the 1st and 2nd weeks. There were only 3 patients who had recurrence of CSDH outside the period between the 1st and 2nd weeks. Two of them had coexisting thrombocytopenia. One patient had thrombocytopenia caused by acute hemorrhagic fever developed early recurrence before removal of drainage and another patient had thrombocytopenia due to aplastic anemia developed delayed recurrence after the 8th week. By excluding these 2 patients with coexisting thrombocytopenia, the possibility of recurrence between the 1st and the 2nd weeks increased to 87.5% and all recurrence (100%) happened before the 4th week.

Discussion

In studies of recurrent CSDH, several factors had been proposed as risk factors associated with recurrence such as advanced age[8], coagulopathy[9,10], atrophy of brain parenchyma[8,11,12], larger hematomas[11,13], chronic alcoholism[14], poor expansion rate of brain[15], frequency of falling and head injury[13], postoperative hematoma density[16], separated type of CSDH[6,17,18] and extension into cranial base[6]. Though there were total 102 CSDHs in our study, the

incidence of recurrence was low and we could not determine the significance of these risk factors.

Although we cannot clarify the definitive factors related to recurrent CSDH but the definitive timing of recurrent CSDH are observed. Most patients in the recurrent group, especially those who did not have coexisting bleeding disorder had recurrent CSDH happening between the 1st and 2nd weeks. Postoperative clinical observation in this period is crucial and CT brain should be done for any particular patients who develop symptom, even mild, in this period.

Full brain expansion after surgery of CSDH is usually considered as the goal of the operation and is the end point of postoperative follow-up. However, this issue has never been investigated before. The expansion rate and timing of full brain expansion are unknown. Our study clearly showed that brain expansion was always a delayed pattern. Most patients had their full brain expansion after the 4th week which was later than the timing of most recurrence. Several patients had even more delayed brain expansion after the 8th week. All these patients with much delayed brain expansion did well eventually, though the poor expansion rate was proposed as a risk factor for recurrence[15]. Thus, persistence of subdural space seen on postoperative CT scan without any clinical symptom should be considered as a normal process of brain expansion and should be managed conservatively, not to repeat the surgery or place a subduroperitoneal shunt. Concerning the significant difference of timing between recurrent CSDH and brain expansion and the insignificant prognostic value of delay brain expansion, benefit of a random postoperative CT brain, especially done after the 2nd week, without any clinical symptom cannot be identified. Only a subgroup of patients who develop recurrent symptom, especially between the 1st and 2nd weeks, that CT brain is highly recommended.

The drawback of this study is limited period of postoperative follow-up. Long-term clinical outcome and radiographic finding after 8th week are required to investigate the correlation between delayed brain expansion and recurrence of CSDH.

Conclusion

Recurrent CSDH mostly occurred between the 1st and 2nd week while full brain expansion mostly occurred after the 4th week. Follow-up of clinical symptoms, especially between the 1st and 2nd week, is more valuable than postoperative CT brain for detection of recurrence. Persistence of subdural space on a random postoperative CT scan, even long-lasting, without any neurological symptoms, should be considered as a normal process of brain expansion and managed conservatively.

What is already known from this topic?

Risk of recurrent CSDH was associated with old age, abnormal coagulation, cerebral atrophy, large hematoma, poor brain expansion, frequent head injury and separated stage of CSDH.

What this study adds?

Full brain expansion after surgical drainage of CSDH is usually found after 4 weeks post surgery. One to two weeks after surgery is a critical period of recurrent hematoma. In cases with residual subdural fluid collection visible on CT brain without clinical symptoms of recurrent CSDH before 4 weeks after drainage, follow-up of CT brain is recommended.

Potential conflicts of interest

None.

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เวลาของการขยายตัวของสมองและการกลับเป็นซ้ำของเลือดออกใต้เยื่อหุ้มสมองแบบเรื้อรังหลังการผ่าตัด

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ภูมิหลัง: เลือดออกใต้เยื่อหุ้มสมองแบบเรื้อรังเป็นโรคทางประสาทศัลยศาสตร์ที่พบบ่อย ยังไม่เป็นที่ทราบแน่ชัดเกี่ยวกับการขยายตัวของสมอง

วัตถุประสงค์: การวิจัยนี้เป็นการศึกษาไปข้างหน้าเพื่อศึกษาเวลาของการขยายตัวของสมองและการกลับเป็นซ้ำของเลือดออกใต้เยื่อหุ้มสมองแบบเรื้อรัง

วัสดุและวิธีการ: ภายหลังการผ่าตัดระบายเลือดและใส่สายระบายเลือดใต้เยื่อหุ้มสมอง ผู้ป่วยแต่ละรายจะได้รับการตรวจเอ็กซเรย์คอมพิวเตอร์สมองที่เวลาต่างๆ ดังนี้ ก่อนนำสายระบายเลือดใต้เยื่อหุ้มสมองออก หลังผ่าตัด 1 สัปดาห์ 2 สัปดาห์ 4 สัปดาห์ และ 8 สัปดาห์ หรือเมื่อมีอาการผิดปกติทางระบบประสาทที่สงสัยว่าจะมีการกลับเป็นซ้ำของเลือดออกใต้เยื่อหุ้มสมองแบบเรื้อรัง

ผลการศึกษา: การศึกษานี้รวบรวมเลือดออกใต้เยื่อหุ้มสมองแบบเรื้อรัง 102 ครั้ง ในผู้ป่วย 75 ราย เอกซเรย์คอมพิวเตอร์สมองทั้งหมด 450 ครั้ง ในผู้ป่วยทั้งหมดได้รับการศึกษาพบผู้ป่วยที่มีการขยายตัวของสมองเต็มที่ระหว่างสัปดาห์ที่ 1 และ 2 เพียงร้อยละ 1 ระหว่างสัปดาห์ที่ 2 และ 4 ร้อยละ 5.9 ระหว่างสัปดาห์ที่ 4 และ 8 ร้อยละ 80.4 และหลังสัปดาห์ที่ 8 ร้อยละ 12.7 พบอุบัติการณ์ของการกลับเป็นซ้ำของเลือดออกใต้เยื่อหุ้มสมองแบบเรื้อรังร้อยละ 9.8 โดยในผู้ป่วยที่มีการกลับเป็นซ้ำ ร้อยละ 10 เกิดก่อนนำสายระบายเลือดใต้เยื่อหุ้มสมองออก ร้อยละ 70 เกิดระหว่างสัปดาห์ที่ 1 และ 2 ร้อยละ 10 เกิดระหว่างสัปดาห์ที่ 2 และ 4 และร้อยละ 10 เกิดหลังสัปดาห์ที่ 8

สรุป: การขยายตัวของสมองหลังการผ่าตัดเลือดออกใต้เยื่อหุ้มสมองแบบเรื้อรังเป็นกระบวนการที่เป็นไปอย่างช้าๆ จากการศึกษาพบการไม่เข้ากันระหว่างเวลาของการขยายตัวของสมองและการกลับเป็นซ้ำของเลือดออกใต้เยื่อหุ้มสมองแบบเรื้อรัง การกลับเป็นซ้ำส่วนใหญ่จะพบระหว่างสัปดาห์ที่ 1 และ 2 ในขณะที่การขยายตัวของสมองเต็มที่จะพบภายหลังสัปดาห์สัปดาห์ที่ 4 ช่วงเวลาระหว่างสัปดาห์ที่ 1 และ 2 เป็นช่วงเวลาที่สำคัญสำหรับติดตามอาการหลังผ่าตัด การที่พบช่องว่างใต้เยื่อหุ้มสมองหลังผ่าตัดจากการตรวจเอกซเรย์คอมพิวเตอร์สมองที่เวลาแบบสุ่มหลังผ่าตัดโดยที่ผู้ป่วยไม่มีอาการผิดปกติถือว่าเป็นกระบวนการที่เกิดขึ้นปกติของการขยายตัวของสมอง