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Postoperative pneumocephalus increases the recurrence rate of chronic subdural hematoma

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ABSTRACT

Objectives: Pneumocephalus is a common operative complication of chronic subdural hematoma. This study is to analyze the relationship between postoperative pneumocephalus and the recurrence and surgical outcomes.

Patients and Methods: This is a retrospective case-cohort study, including a pneumocephalus group (n = 46) and a control group (n = 181). Their recurrence rates, CT attenuation values, hospital stay, healing time and the neurological status were recorded and analyzed.

Results: The pneumocephalus group had a recurrence rate of 32.6%, significantly higher than the control (17.7%). In addition, the pneumocephalus group had a higher rate of postoperative epilepsy (21.7% vs 3.3%), longer hospital stay (11.5 ± 2.8 vs 7.8 ± 1.2 days), longer healing time (10.8 ± 5.4 vs 6.5 ± 2.3 months), and worse neurological scores than the control.

Conclusion: Pneumocephalus increases the recurrence rate of chronic subdural hematoma, and it not only prolongs the hospital stay and healing time, but also leads to deterioration of the neurological status.

1. Introduction

Chronic subdural hematoma (CSDH) is a common disease in neurosurgery, with an incidence of 1–2 per 100'000/year [1–3]. As China becomes the aging society, the incidence of CSDH is gradually growing [4,5]. Burr-hole trephination procedure is the current standard therapy for most patients with CSDH, and this procedure is simple and safe enough to be endured even in the 90-year-aged patients [6,7].

In the elderly people, brain atrophy leaves an enlarged subdural space, and this is the main cause of CSDH [3]. Since this underlying factor is not removed by operation or post-operative adjuvant treatments, the recurrence rate of CSDH is quite high, ranging from 10% to 33% in previous literatures [8–10]. The surgical outcome of chronic subdural hematoma is substantially related with recurrence [8–11].

There were many studies regarding the risk factors associated with the postoperative recurrence of chronic subdural hematoma [10–15]. For example, Kim et al. reported that male gender, a history of malignant neoplasm and single-layer hematoma were associated with higher rate of recurrence. However, such factors as age, degree of headache, motor weakness, midline shift, saline irrigation, and the number of burr holes were not related with recurrence [15].

In our clinical practice, we have a preliminary impression that those patients who had large amount of pneumocephalus after burr-hole trephination seemed encounter recurrence more often. To verify this impression, therefore, we measured the volume of postoperative pneumocephalus in patients with CSDH and investigated its association with recurrence and the outcomes.

2. Patients and methods

2.1. Design of the retrospective case–cohort study

This study was approved by the Ethics Committee of our hospital.

The exposure factor was postoperative pneumocephalus. The next day after operation, a cranial CT scan was routinely performed, and the volume of pneumocephalus was calculated as described later. If the volume of pneumocephalus is more than 30 ml in one side, the case was assigned to the "pneumocephalus group". If CSDH is bilateral, any side of > 30 ml pneumocephalus, is considered as of the "pneumocephalus group". In contrast, the control group consisted of patients with little pneumocephalus, that is, less than 30 ml.

The study was retrospective and observational, and no intervention was given. We just recorded the results such as the recurrence, CT attenuation value, hospital stay, healing time and the neurological status,

Abbreviation: CSDH, chronic subdural hematoma; CT, computed tomography; MGS, Markwalder's Grading Scale

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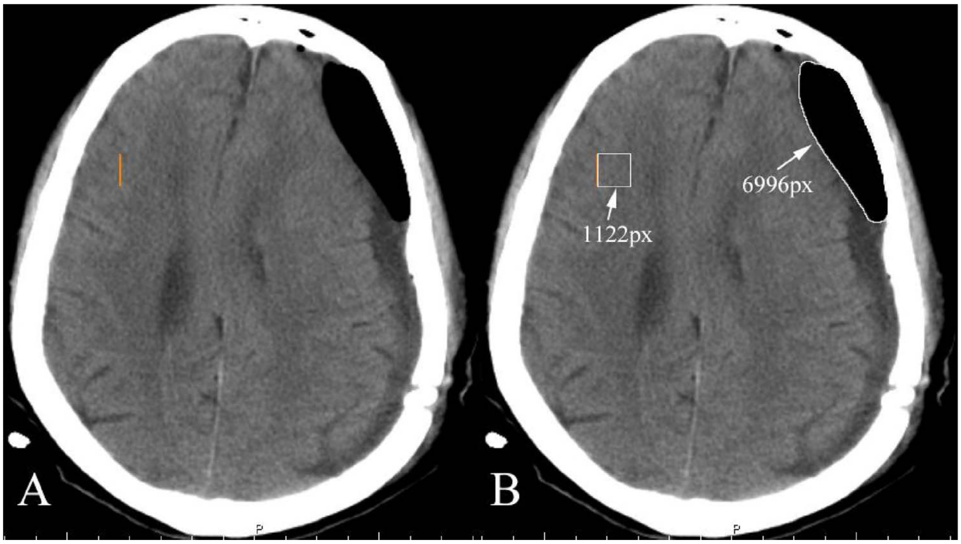

Fig. 1. Calculation of the volume of pneumocephalus. A. Using the Uniweb Viewer to draw a 1 cm line on the CT image, which serves as ratio reference between the pixels of CT image and intracranial volume. B. Using GIMP, with the aforementioned 1 cm line as the side, select a square area, through the "histogram" window we can read out the pixel number, which is the CT image pixel number corresponding to 1 square centimeter of the intracranial space, namely, pixel-intracranial space ratio. Then we used the "magic wand tool" to select the pneumocephalus portion on the CT image, and read the pixel number through the "histogram" window, namely, slice pixels of pneumocephalus. Since the thickness of an axial CT slice is 0.6 cm, we can calculate the volume of pneumocephalus of the slice with the following equation: Slice volume of pneumocephalus (ml) = slice pixels of pneumocephalus/pixel-intracranial space ratio *0.6. The total volume of the whole pneumocephalus can be calculated by adding all the slice volumes.

and then analyzed the relationship between the exposure factor and the results.

2.2. Calculation of the volume of pneumocephalus

The axial cranial CT images were analyzed with the UniWeb Viewer (version 6.1.1152, EBM Technologies INC, http://www.ebmtech.com/) and GIMP (version 2.8, http://www.gimp.org/). At first we use the Uniweb Viewer to draw a 1cm line on the CT image (Fig. 1A), which serves as the ratio reference between the pixels of CT image and the intracranial volume of the real human body. Then the CT image was opened with the GIMP. With the aforementioned 1cm line as the side, select a square area, through the "histogram" window we can read out the pixel number, which is the CT image pixel number corresponding to 1 square centimeter of the intracranial space, namely, pixel-intracranial space ratio (Fig. 1B). Afterwards, we used the "magic wand tool" to select the pneumocephalus portion on the CT image, and read the pixel number through the "histogram" window, namely, slice pixels of pneumocephalus. Since the thickness of an axial CT slice is 0.6 cm, we can calculate the volume of pneumocephalus of the slice with the following equation: Slice volume of pneumocephalus (ml) = slice pixels of pneumocephalus/pixel-intracranial space ratio *0.6. The total volume of the whole pneumocephalus can be calculated by adding all the slice volumes.

2.3. Patients

During January 2012–December 2013, we performed burr-hole trephination procedure for 227 patients with CSDH, among which 85 patients were bilateral. At the second day after operation, the cranial CT (Fig. 2) revealed that 46 patients had more than 30 ml pneumocephalus in at least one side (Fig. 2B), and they are assigned to the "pneumocephalus group"; the other 181 cases are assigned to the "control group" (Fig. 2A). There were 36 males and 10 females in the pneumocephalus group, with the median age of 68 years old (57–85 years). The control group consisted of 142 males and 39 females, and the median age was 66 years old (52–91 years). Therefore, the age ($P > .05$) and gender ($P > .05$) compositions are similar between two groups. There were 5 patients in the pneumocephalus group, and 24 patients in the control group taking anti-platelet or anti-coagulant drugs before admission, so the deference of blood thinner usage between two groups was insignificant statistically ($P > .05$). After admission, any anti-platelet and anti-coagulant drugs were ceased. There was no liver or renal failure in either group. The average Glasgow coma scale (GCS) score was 12.5 (5–15) for the pneumocephalus group and 12.7 (4–15) for the control group. There was no significant difference in GCS scores between two groups ($P > .05$). In the pneumocephalus group, 1 patient had a history of malignant neoplasm, and in the control group, 3 patients had the history ($P > .05$). CT images revealed that 29 patients in the pneumocephalus group, and 111 patients in the control group belonged to the type of single-layer hematoma, so the percentages of single-layer were similar between two groups ($P > .05$).

2.4. Surgical technique and postoperative management

In all patients of both groups, the surgical treatment and postoperative management were similar. The surgery was performed under general anesthesia. A single 2-cm burr hole was created with a high-speed drill. The dura was coagulated with bipolar coagulation forceps and opened with a sharp-pointed scalpel. Then the CSDH capsule was opened with the scalpel. The liquid hematoma content would flow out. Afterwards, the hematoma cavity was irrigated with 300–500 ml saline. A 5N silicon catheter was inserted into the cavity for drainage. The catheter was connected with a drainage bag and fixed at the same height as the patient's tragus to allow continuous drainage. The catheter was removed the second day after operation, after the CT scan was performed. Hemostasis drug, such as tranexamic acid was administered intravenously only in the first day after operation. To prevent seizure, sodium valproate was administered intravenously for the first 3 days, and then orally for 1 month. If the patient is unable to eat, nasal feeding was performed.

2.5. Follow-up and evaluation of recurrence

After discharge, the patients were followed up at outpatient clinic every month if the patient's condition was stable, otherwise the patient should visit the outpatient clinic as soon as possible. CT scan was performed every month for the first 3 months, and then every 3 months till final recovery, which means the CSDH is completely absent from the CT images; and the period from operation to final recovery is defined as healing time.

The patient's neurological status was assessed according to the Markwalder's Grading Scale (MGS) [16]. Grade 0 indicates neurologically intact. Grade I indicates the conscious and oriented patients complaining of headache. Grade II indicates those disoriented or drowsy patients, probably complicated with hemiparesis. Grade III indicates the patients who are stuporous and hemiplegic, but still respond appropriately to noxious stimuli. Grade IV indicates the comatose