Ultrasound-guided Evacuation of Spontaneous Intracerebral Hemorrhage in Basal Ganglia

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Objective: Ultrasound can be used in the treatment of large intracerebral hematoma. The authors present our experiences with Ultrasound-guided catheter placement for lysis and drainage of ganglionic hematoma, with emphasis on technical aspects.

Methods: The authors applied real-time ultrasonography for the aspiration of intracerebral hematoma in 6 cases. Ultrasound-guided aspiration via a burrhole was performed under local anesthesia. We selected a temporal entry point instead of the frequently used precoronal approach in ganglionic hematoma. A burrhole was made 4 to 6 cm posterior from posterior border of frontal process of the zygomatic bone at the level of 4 to 5 cm above the external auditory meatus.

Results: In all patients, the catheter was placed accurately into the hematoma target. All patients were irrigated with urokinase once to three times a day. The catheter could be removed within two or three days. The mean hematoma volume was reduced from initially 32 mL to 5 mL in an average of two days. There were no intraoperative complications related to the use of real-time ultrasonography and no postoperative infections were noted.

Conclusion: Ultrasound allows an easy and precise localization of the hematoma and the distance from the surface to the target can be calculated. Ultrasound-guided catheter placement for fibrinolysis and hematoma drainage is a simple and safe procedure.

KEY WORDS: Ultrasound · Intracerebral hemorrhage · Fibrinolytic therapy.

Introduction

Spontaneous intracerebral hematoma (SICH) is a common neurological condition, with higher incidence rates in African and Asian populations1). Neurological grade and preoperative level of consciousness are thought to be key factors in predicting surgical outcome2). The treatment of patients with SICH remains controversial. Hematoma volume can be reduced by 50 to 70% with minimal brain damage by hematoma puncture, aspiration and subsequent fibrinolytic therapy. In comparison with natural course of the disease, fibrinolytic therapy significantly accelerated the reduction of hematoma volume3). But frame-based stereotactic surgery is a time-consuming and overprecise procedure for SICH4). This could be simplified using intraoperative ultrasound (US). US is utilized to develop real-time anatomical representations of intracranial mass lesions. Not only does it serve to precisely locate lesions to be excised, but it also provides an accurate method to either biopsy or drain appropriate lesions5,6,7,8,9,10,11,12,13,14,15,16,17). US-guided catheter placement can be used in case of large enough hematoma because the accuracy is sufficient for majority of ganglionic hematoma by the burrhole evacuation.

Materials and Methods

Patients

6 consecutive noncomatose patients with SICH in the basal ganglia underwent hematoma puncture and catheter placement using US. Selection criteria for operation were Glasgow Coma Scale 7 to 13, existence of a neurologic deficit, and hematoma volumes over 20 mL. All patients were women and the age ranged between 31 and 74 years (mean 61.5 years). The volume of the hematomas ranged from 20 to 45 mL, the average being 32 mL, which were calculated using a computed tomography (CT)-based planimetric method.

Equipment

All US imagings were performed with real-time sector scanner (Model S-2, Diasonics, Milpitas, California). A transducer with 5 MHz frequency was used and its outer diameter was 10 mm. Every image was continuously labeled with centimeter depth markers as it was displayed on the monitor and the depth of image was determined.
Intraoperative technique
To assure sterile conditions in the operative field, US transducer is carefully placed in a sterile rubber glove partially filled with a coupling gel. The procedure was performed under local anesthesia. We made a burrhole on the skull 4 to 6 cm posterior from posterior border of frontal process of the zygomatic bone at the level of 4 to 5 cm above the external auditory meatus (Fig. 1). The US probe was placed directly on the exposed brain surface via burrhole and ultrasonic examination was performed. The hematomas were clearly identified and selection of a target point as well as calculation of the depth of penetration from brain surface to target point were possible. Ultrasonic images of the hematomas within the brain were mostly hyperechoic whether the blood was clotted or unclotted. After removal of the US probe, a silicone catheter with guide wire was inserted to the precalculated depth with the same direction to target, followed by careful manual hematoma aspiration and the injection of a thrombolytic agent, urokinase. Finally the catheter was sutured to the skin, and connected to a closed external drainage system.

Results
Using US guidance, the intended placement of the catheter was achieved in all patients. All patients were irrigated with 10,000U urokinase once to three times a day. The catheter could be removed within two or three days. The mean hematoma volume was reduced from initially 32 mL to 5 mL in an average of two days. There were no intraoperative complications related to the use of real-time ultrasonography and no postoperative infections were noted.

Illustrative Case
Case 1
This 74-year-old woman suffering from a sudden onset of right hemiparesis and a decreased level of consciousness was brought to the emergency room. On admission, she was stuporous with Glasgow Coma Scale score 7 and motor examination revealed right hemiparesis Grade II. Preoperative CT scans showed a intracerebral hematoma in the left putamen. US-guided catheter placement was performed through the left temporal burrhole. Ultrasonic imaging of the hematomas showed hyperechoic mass 2 to 5 cm in depth. After subsequent fibrinolysis with urokinase and hematoma drainage, postoperative CT scans obtained 2 days later showed almost removal of hematoma (Fig. 2).

Case 2
This 72-year-old woman presented with somnolence and left hemiparesis Grade II. Preoperative CT scan demonstrated a intracerebral hematoma in the right putamen. After US-guided catheter placement and subsequent fibrinolysis
and hematoma drainage, CT scans 3 days after surgery showed small remained hematoma and a cannula in the hematoma cavity (Fig. 3).

**Discussion**

**SICH** accounts for 10–20% of all stroke. The incidence of mortality and severe morbidity following SICH is higher than that of other forms of stroke. The major risk factors are hypertension and age. The basal ganglia are the most common site of supratentorial ICH and are associated with a 50% mortality rate. Controversy exists concerning the indications for operative treatment of SICH. Clinical presentation, patient age, size and localization of the hematoma influence the decision for conservative or surgical treatment. The hematoma volume and initial level of consciousness are valuable in predicting early outcome, and should therefore be evaluated in conjunction with the patients neurological grade as well as hematoma location. Patients with a hematoma volume between 25 and 85 mL and a clinical deterioration are candidates for surgical therapy. The goal of surgical treatment of SICH is to reduce intracranial pressure produced by the mass rather than radical evacuation of clots and potentially secondary neuronal injury while minimizing further brain injury during evacuation. Surgical hematoma evacuation can be accomplished by several methods, including microsurgical removal after craniotomy, endoscopic hematoma evacuation or by frame-based or frameless stereotactically placed catheter for subsequent fibrinolytic therapy with urokinase or recombinant tissue plasminogen activator (t-PA). Repeated injection of urokinase or t-PA into the hematoma cavity was introduced to liquify the clots chemically and to facilitate subsequent aspiration. Recently frame-based or frameless stereotactic hematoma puncture, aspiration and fibrinolysis of portions of hematoma have been focused.

Intraoperative US is the first direct and real-time imaging method to show intracranial lesions. During cranial neurosurgical procedures, US imaging provides an excellent means for localizing lesions and characterizing their internal structures. Besides providing images of the lesion and the surrounding brain structures, it allows the directing of instruments such as a biopsy needle, an aspiration cannula or an endoscope to a target point in the real-time image. The distance from the surface to the target can be calculated. The relationship of various lesions to the surrounding brain can be appreciated before, during, and after excision or biopsy. Cerebral lesions are best imaged with a 3- or 5-MHz transducer. The accuracy of US-guided stereotaxy is sufficient for majority of supratentorial lesions, and they can be safely applied for the burrhole evacuation of hematomas. There are two ways of reaching a target point: simultaneous and consecutive US-guided stereotaxy. For the simultaneous US-guided stereotaxy, instrument holder is to be attached on the US probe to introduce the catheter alongside the transducer. The advantage of this method is that it can provide direct visual verification that the catheter has arrived in the target area. But it requires a small craniotomy to allow access for the probe and the catheter. In this report, we used the consecutive US-guided stereotaxy that is consecutive insertion of US probe and catheter via a burr hole. The disadvantage of this method is that imaging is not available while the catheter is in place. However, the precise localization of the catheter was possible in our experience. Because the usual depth of catheter insertion was 3 to 4 cm through the temporal entry and a metal stylet in the catheter was inserted together, the chance of catheter deviation was thought to be low. Nonetheless, this disadvantage can be overcome with adoption of a fixation device.

Optimum procedure for removal of a hematoma should be a rapid and simple method that combined a high success rate with low risk. Frame-based stereotaxy is time-consuming. After the initial CT scan, which established the diagnosis, the scanning has to be repeated with the fixed frame. Then, surgical planning computer programs are used to define the trajectory after preoperative selection of target points. Frameless stereotaxy can reduce the time and do not need fixed frame, but general anesthesia is usually necessary and it is not always available in many hospitals. Although there is no doubt about the accuracy of frame-based and frameless stereotaxy, the pin-point accuracy is not really necessary for the successful treatment of large SICH. Regarding to the selection of trajectory and burrhole site, we refrained from selection the frequently used precoronal approach in ganglionic hematomas. Instead we selected a temporal entry point. When the catheter is introduced through precoronal burrhole, the catheter is more likely to deviate because of long trajectory. With the temporal entry, the catheter can be inserted through short cut and the risk of catheter deviation can be reduced.

US allows an easy and precise localization of the hematoma and the distance from the surface to the target can be calculated. With simultaneous US-guided stereotaxy, the directing of silastic catheters to a target point and optimum placement are easily identified in the real-time image. This simple technique reduce the risk of missing intracranial hematomas during burrhole aspiration. With combination of endoscopy, it will be more effective in hematoma evacuation with direct visual control. Multiple target aspiration technique is also another option for the rapid removal of hematoma.
Conclusion

Ultrasound allows an easy and precise localization of the hematoma and the distance from the surface to the target can be calculated. In patients with SICH who doesn't show impending hemiation sign, US-guided catheter placement for fibrinolysis and hematoma drainage is a simple and safe procedure.

References

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