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Clinical Article

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 6cases. 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 6cm posterior from posterior border of frontal process of the zygomatic bone at the level of 4 to 5cm 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 32mL to 5mL 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 populations[2]. Neurological grade and preoperative level of consciousness are thought to be key factors in predicting surgical outcome[17]. 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 volume[11]. But frame-based stereotactic surgery is a time-consuming and overprecise procedure for SICH[10]. 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 lesions[1,3,4-6,9,13,14,16,18]. 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.

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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 20mL. 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 45mL, the average being 32mL, 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 10mm. Every image was continuously labeled with centimeter depth markers as it was displayed on the monitor and the depth of image was determined.

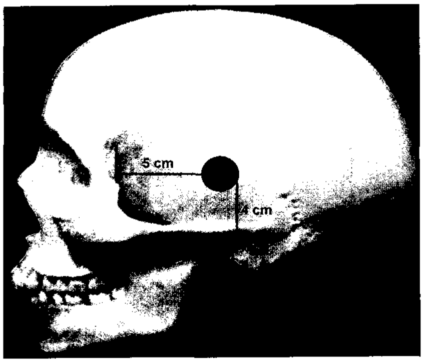

Fig. 1. Schematic location of the burrhole for temporal entry.

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 6cm posterior from posterior border of frontal process of the zygomatic bone at the level of 4 to 5cm 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 hyperechogenic 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 32mL to 5mL 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 5cm in depth. After subsequent fibrinolysis with urokinase and hematoma drainage, postoperative CT scans obtained 2days later showed almost removal of hematoma (Fig. 2).

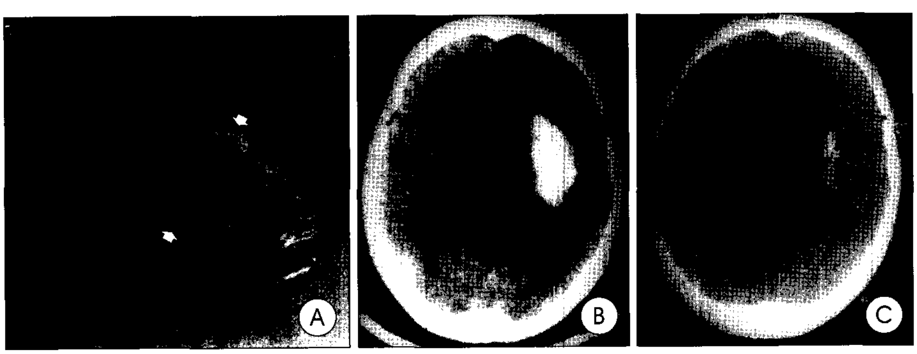

Fig. 2. (A) Ultrasound(US) image before removal of hematoma showing a hyperechoic mass(arrowhead). Computed tomography(CT) scan showing a intracerebral hematoma prior to (B) and 2days after US-guided evacuation(C).

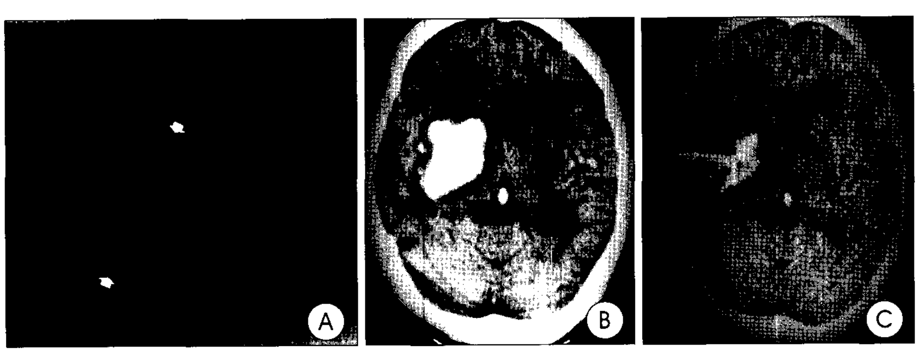

Fig. 3. (A) Ultrasound image of hematoma, CT scan before(B) and 3 days after surgery showing a cannula in the hematoma cavity(C).

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 3days after surgery showed small remained hematoma and a cannula in the hematoma cavity (Fig. 3).

Discussion

SICH accounts for 10~20% of all stroke[2]. The incidence of mortality and severe morbidity following SICH is higher than that of other forms of stroke[11]. 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[7,17]. 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[2]. 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 85mL and a clinical deterioration are candidates for surgical therapy[12]. 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[1,7]. 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(rt-PA)[10,15]. Repeated injection of urokinase or rt-PA into the hematoma cavity was introduced to liquefy the clots chemically and to facilitate subsequent aspiration[8]. 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[4]. Cerebral lesions are best imaged with a 3- or 5-MHz transducer[4]. 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 4cm 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[10]. 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 herniation sign, US-guided catheter placement for fibrinolysis and hematoma drainage is a simple and safe procedure.

References

1. Auer LM : Ultrasound stereotaxic endoscopy in neurosurgery. **Acta Neurochir (Suppl) 54** : 34-41, 1992
2. Butcher K, Laidlaw J : Current intracerebral haemorrhage management. **J Clin Neurosci 10** : 158-167, 2003
3. Chandler WF, Knake JE, McGillicuddy JE, Lillehei KO, Silver TM : Intraoperative use of real-time ultrasonography in neurosurgery. **J Neurosurg 57** : 157-163, 1982
4. Chandler WF, Rubin JM : Intraoperative use of Real-time ultrasound in Neurosurgery. **Comtemp Neurosurg 8** : 1-8, 1986
5. Iwamoto N, Kusaka M, Tsurutani T, Kameda H, Ito H : Ultrasound imaging for stereotactic evacuation of hypertension-associated intracerebral hematomas with aqua-stream and aspiration. **Stereotact Funct Neurosurg 60** : 194-204, 1993
6. Kim HG, Oh SJ, Jho HD, Yoo YR, Kim NK, Chung HY : Diagnostic value of ultrasonographic brain scan. **J Korean Neurosurg Soc 13** : 697-705, 1984
7. Little KM, Alexander MJ : Medical versus surgical therapy for spontaneous intracranial hemorrhage. **Neurosurg Clin N Am 13** : 339-347, 2002
8. Marquardt G, Wolff R, Seifert V : Multiple target aspiration technique for subacute stereotactic aspiration of hematomas within the basal ganglia. **Surg Neurol 60** : 8-13, 2003
9. Ozaki T, Tanabe H, Kusunose M, Kajimoto Y, Matsushima S : Intraoperative use of real-time ultrasonography in neurosurgery : with special reference to head injury and intracerebral hemorrhage. **No Shinkei Geka 20** : 645-649, 1992
10. Rohde V, Rohde I, Reinges MH, Mayfrank L, Gilsbach JM : Frameless stereotactically guided catheter placement and fibrinolytic therapy for spontaneous intracerebral hematomas : technical aspects and initial clinical results. **Minim Invasive Neurosurg 43** : 9-17, 2000
11. Rohde V, Rohde I, Thiex R, Ince A, Jung A, Duckers G, et al : Fibrinolysis therapy achieved with tissue plasminogen activator and aspiration of the liquefied clot after experimental intracerebral hemorrhage : rapid reduction in hematoma volume but intensification of delayed edema formation. **J Neurosurg 97** : 954-962, 2002
12. Ruth A, Josef SF, Chris W, Alexander B : Intracerebral haemorrhage : surgical therapy vs. patient-adapted treatment concept. **J Clin Neurosci 11** : 259-262, 2004
13. Seidel G, Kaps M, Dorndorf W : Transcranial color-coded duplex sonography of intracerebral hematomas in adults. **Stroke 24** : 1519-1527, 1993
14. Shanley DJ, Eline MJ : Intracerebral hematoma localization and removal using intraoperative ultrasound. **Mil Med 157** : 622-624, 1992
15. Son BC, Kim MC, Park CK, Lee KS, Hong YK, Kang JK : Stereotactic endoscopic evacuation of basal ganglionic intracerebral hematoma-three case report. **J Korean Neurosurg Soc 28** : 1523-1528, 1999
16. Unsgaard G, Gronningsaeter A, Ommedal S, Nagelhus Hernes TA : Brain operations guided by real-time two-dimensional ultrasound : new possibilities as a result of improved image quality. **Neurosurgery 51** : 402-411, 2002
17. Weiner HL, Cooper PR : The Management of spontaneous intracerebral hemorrhage. **Comtemp Neurosurg 14** : 1-8, 1992
18. Yanagawa Y, Kiyozumi T, Terai C, Sakamoto T, Okada Y : A case of traumatic hematoma in the basal ganglia : successful drainage with ultrasound-guided aspiration surgery via burr hole. **No Shinkei Geka 25** : 1105-1108, 1997