Usefulness of Ultrasonography With a Burr-hole Transducer During Surgery Through a Burr hole

—Technical Note—

Kentaro HAYASHI,1 Takayuki MATSUO,1 Kazuhiko SUYAMA,1 and Izumi NAGATA1

1Department of Neurosurgery, Nagasaki University School of Medicine, Nagasaki, Nagasaki

Abstract

Ultrasonography has become a common method for evaluation of the central nervous system. We present our experience with ultrasonography monitoring with a burr-hole transducer for investigation of intracranial lesions. Common indications for this technique included guidance for placement of catheters, localization of masses, aspiration of cystic lesion, and confirmation of removal. Postoperative computed tomography (CT) was obtained to corroborate the appropriate procedures performed under ultrasonography guidance. Intraoperative ultrasonography provided immediate real-time information about the anatomy and pathological location of lesions. Postoperative CT findings were consistent with intraoperative ultrasonography findings. No procedure-related complication was noted and problems were minimal. Intraoperative ultrasonography using a burr-hole transducer has proved to be useful in burr-hole surgery.

Key words: ultrasonography, burr-hole surgery, ventricular puncture, subdural hematoma, cystic lesion

Introduction

Ultrasonography allows real-time imaging of the target lesion and is widely used in neurological surgery.1,4,6,7,11 Recently, a small transducer has been developed which can be introduced into the burr-hole, and has been used to image intracranial lesions during burr-hole surgery.11 This small transducer with bayonet-style handle and straight, untapered head fits directly into the burr-hole. The sector type transducer is particularly useful when scanning through a small acoustical window. The transducer with a bayonet-style handle is basically designed for obtaining percutaneous biopsies and facilitates imaging as the ventricular catheter is being inserted. Our experience has found the technique to be beneficial for the placement of external ventricular drains into small ventricles in patients with head injury, placing catheters into cystic lesions without stereotactic guidance, aspirating brain abscesses, and tapping cystic fluid collections. The transducer can be sterilized with gas like other operative instruments and the gas sterilization does not affect the transducer. Here, we present our experience of ultrasonography monitoring conducted through a burr-hole.

Methods

A portable ultrasonography scanner (Aloka SSD–2000; Hitachi Aloka Medical, Ltd., Tokyo) and a small transducer with bayonet-style handle and straight, untapered head (Aloka UST-5268P-5, 3.0–8.0 MHz, phased-array sector probe; Hitachi Aloka Medical, Ltd.) were used (Fig. 1). After sterilization, this transducer could be used without sterile drapes. Common indications for this technique included guidance for placement of catheters, localization of masses, aspiration of cystic lesion, and confirmation of removal. After opening a standard burr-hole, the transducer was placed in the operative field and the ultrasonography scanner was positioned so that the surgeon can easily view the display screen (Fig. 1). Intracranial lesions were examined by carefully inserting the transducer into the burr-hole until in contact with the dura surface. The time-gain compensation was adjusted during imaging to improve the image quality on the display screen. Rarely, sa-
line solution was dripped onto the field to improve image quality. The surgeon began by identifying normal anatomical landmarks, looking for the falx cerebri and ventricular walls. Once landmarks were identified, the head of the transducer was rotated clockwise or counterclockwise along the long axis of the device to achieve a more standard anatomical image (that is, coronal, axial, or sagittal). The depth for catheter insertion and the distance from the dura mater to target location were determined using ultrasonography. Moreover, color Doppler imaging was used to identify important vasculatures.

Results

The sector probe provided fan-shaped views ranging from 45°–135° and the region from 1 cm to approximately 10 cm was visualized clearly. Intraoperative ultrasonography provided immediate ongoing information about the anatomy and pathological lesion. Scanning was performed in multiple planes. The trajectory to the best location for the catheter were determined and the needle or drainage catheter was visualized during the approach and entry to the target. Thus, we could measure the distance from burr-hole to the target. This information is useful to decide catheter length. The findings of postoperative computed tomography (CT) were consistent with the findings of intraoperative ultrasonography. System operation was easy, with no specific difficulties and only minor alterations in the standard surgical techniques. Total examination time was approximately 5 minutes, and no procedure-related complication was noted with minimal problems.

Illustrative Case 1: A 72-year-old man was referred to our hospital because of left hemiparesis. CT showed a ring-enhanced lesion (Fig. 2A). Magnetic resonance spectroscopy indicated brain abscess, so drainage was planned. After opening a burr-hole, the intracranial lesion was observed with the transducer. A hypoechoic cystic lesion was identified just under the burr-hole (Fig. 2B). Yellowish fluid was aspirated. Postoperative CT demonstrated shrinkage of the lesion and correct placement of the tube (Fig. 2C).

Illustrative Case 2: A 28-year-old man lost consciousness and was brought to our hospital. He had a history of hydrocephalus treated with ventriculoperitoneal shunt. Neurological examination showed consciousness disturbance and right hemiparesis. CT demonstrated left putaminal hemorrhage (Fig. 3A). Endoscopic hematoma evacuation was planned emergently. After placement of a burr-hole, the location of the hematoma was evaluat-
Burr-hole Ultrasonography

Fig. 3 Illustrative Case 2. A: Computed tomography (CT) scan demonstrating left putaminal hemorrhage (arrows) as well as perifocal low density lesion (arrowheads). The previously placed ventricular catheter is also seen. B: Ultrasonogram through the burr-hole showing a hyperechoic mass indicating hematoma (arrows) as well as hypoechoic lesion, consistent with CT (arrowheads). C: Postoperative CT scan showing disappearance of the hematoma (asterisk). D: Ultrasonogram after the endoscopic procedure showing disappearance of the hematoma (asterisk).

The direction to the hematoma was evaluated with ultrasonography and the distance from the burr-hole to the hematoma was measured as 3.5 cm (Fig. 3B). A sheath was placed to the hematoma without difficulty and the hematoma was aspirated using the endoscope. After the procedure, ultrasonography confirmed removal of the hematoma (Fig. 3D). Postoperative CT showed removal of the hematoma (Fig. 3C).

Discussion

Burr-hole surgery is less invasive and widely used for the treatment of several intracranial lesions, especially hydrocephalus and drainage of chronic subdural hematoma. However, most of the intracranial procedures are done without visual monitoring. For instance, the trajectory of frontal ventricular catheter placement is determined according to the surface landmarks such as the medial canthus or external auditory canal. Consequently, targets are occasionally slit-like or shifted because of coexisting masses and multiple taps may result in cerebral injury or hemorrhage. Moreover, a pericallosal artery pseudoaneurysm developed secondary to errant cannulation of the frontal horn during endoscopy-assisted ventricular catheter placement.

Real-time ultrasonography monitoring can be employed in the treatment of very small lesions such as minimally dilated ventricle. In that case, another monitoring burr-hole is made in addition to the treatment burr-hole. The drainage tube is introduced along with a slot made in the head of the bayonet transducer as shown in Fig. 1C. A transducer equipped with duplex Doppler is useful for evaluation of intracranial blood flow. Confirmation of successful drainage of the fluid collection can be made at the time of surgery, decreasing the need for postoperative imaging.

Disadvantages or possible drawbacks associated with the burr-hole ultrasonography technique include the additional operation time needed to perform ultrasound imaging, and introduction of an additional foreign body (ultrasonography transducer) into the operative field, which may increase the incidence of infection. However, we have not seen any increase in the infection rate. Since operation of the surgical system was easy and only minor alterations in the standard surgical techniques were required, additional operation time was minimal. Due to recent technological advances, the ultrasonography scanner has been transformed into a smaller and more portable device. As a result, use of ultrasonography monitoring is widely used to ensure safe catheterization.

Intraoperative ultrasonography is now useful in a range of burr-hole surgeries including shunt catheter insertion, drainage procedures, and mass evaluation.

Disclosure

The authors have no personal financial or institutional interest in any of the drugs, materials, or devices described in the article.

References

3) Chandler WF, Knake JE, McGillicuddy JE, Lillehei


Address reprint requests to: Kentaro Hayashi, MD, Department of Neurosurgery, Nagasaki University School of Medicine, 1–7–1 Sakamoto, Nagasaki 852–8501, Japan.

e-mail: k-enkuni@net.nagasaki-u.ac.jp

Neurol Med Chir (Tokyo) 52, March, 2012