A new, miniature ultrasonic surgical aspirator with a handpiece designed for transsphenoidal surgery

Technical note


Department of Neurosurgery, Shimane Medical University, Izumo, Japan

The authors describe an innovative surgical instrument designed to remove hard fibrous masses from the pituitary region, which cannot be completely removed using standard transsphenoidal surgical procedures. The innovative features of the instrument include a miniature ultrasonic surgical aspirator and an extra-long bayonet handpiece with a 1.9-mm-diameter translucent tip. Intraoperative use of this refined device may increase the effectiveness of the removal of fibrous lesions within a narrow operative field, while also preserving surgical safety.

KEY WORDS • surgical approach • ultrasonic surgical aspirator • transsphenoidal approach • instrumentation

TRANSSPHENOIDAL surgery has been accepted as an established surgical procedure. The chances of surgical morbidity may be high in patients in whom there is intracavernous invasion or encasement of the ICA, however, because intraoperative ICA-related injuries may cause life-threatening complications. Furthermore, there is a high risk of serious sequelae during removal of fibrous lesions, particularly if the lesions have a hard consistency.

Ultrasonic dissection is one of the most useful methods for removing masses during neurosurgery; however, there has been no effective apparatus available for use in TSS when the operative field is narrow. Recently, a new, small, light handpiece for an ultrasonic surgical aspirator has been designed and may facilitate the effective removal of fibrous lesions that cannot be removed by curettage during TSS.

Instrumentation and Technique

The new ultrasonic aspirator and handpiece used in TSS are the Sonopet UST-2001 and HA-07S, respectively (M & M Co., Ltd., Tokyo, Japan). The aspirator emits high-frequency vibrations and has a programmable suction system. The suction pressure can be controlled from 0 to 500 mm Hg by using a linear correlation system. The handpiece has an extra-long bayonet attachment device, is small (325 mm long with a diameter of 21 mm), and weighs 100 g (Fig. 1 and Table 1). The tip of the handpiece, which measures 1.9 mm in diameter, is translucent and vibrates longitudinally at

---

**Abbreviations used in this paper:** ICA = internal carotid artery; MR = magnetic resonance; TSS = transsphenoidal surgery.
a fixed rate (25 kHz) with a maximal displacement of 300 μm. Water circulation is required for cooling the handpiece of a conventional aspirator, which is driven by a magnetoelectrical system, but not for cooling the new HA-07S, which is connected to an aspirator run by a piezoelectrical system. During manipulation of the new handpiece the operator thus has the impression that it weighs less than a conventional one.

Intraoperatively, the miniature ultrasonic aspirator is introduced when the usual procedure of curettage is of little or no value in removing a mass lesion. For example, in the case of a large solid craniopharyngioma that occupied the pituitary region (Fig. 2), preoperative MR images demonstrated involvement of the cavernous sinus and encasement of the bilateral ICAs. The intraoperative findings revealed that the mass was so fibrous that curettage was impossible. The compact ultrasonic surgical aspirator with suction pressure control was useful for removing the fibrous and hard components of the solid lesion. It was noted that the extra-long bayonet handpiece did not disturb the operative field because its tip was so small and translucent. The ultrasonic technique that was selected for this procedure was basically the same as that used for the conventional type of instrument.

Discussion

The compact ultrasonic surgical aspirator has three main advantages. First, the 1.9-mm-diameter translucent tip of

Table 1

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>HA-07S Handpiece</th>
<th>Handpiece W/ Conventional Aspirator</th>
</tr>
</thead>
<tbody>
<tr>
<td>length of handpiece (mm)</td>
<td>112</td>
<td>190</td>
</tr>
<tr>
<td>effective length (mm)</td>
<td>105</td>
<td>65</td>
</tr>
<tr>
<td>diameter of tip end (mm)</td>
<td>1.9</td>
<td>2.5</td>
</tr>
<tr>
<td>translucency of tip</td>
<td>translucent</td>
<td>opaque</td>
</tr>
<tr>
<td>type of oscillator system</td>
<td>piezoelectrical</td>
<td>magnetoelectrical</td>
</tr>
</tbody>
</table>

Fig. 2. Example of a craniopharyngioma involving the bilateral cavernous sinuses. Upper Left: Preoperative enhanced coronal T₁-weighted MR image revealing encasement of the intracavernous portion of the ICA. Upper Right: Preoperative sagittal T₂-weighted MR image demonstrating a hypointense mass extending through the suprasellar region to the clivus. The brainstem appears to be compressed by the lesion. Center Left: Intraoperative photograph showing that posterior ethmoidectomy allows effective inspection of the left cavernous sinus. Combining a miniature ultrasonic surgical aspirator with a translucent tip (arrowhead) and 1-mm-diameter microvascular Doppler probe (arrow) does not disturb the operative field. The wall of the cavernous sinus and a small piece of tumor are seen. Bleeding from the sinus could be controlled by the miniature aspirator. Center Right: Schematic drawing of the operative view in relation to the pertinent anatomy. Lower: Computerized tomography scans obtained 1 day postoperatively, demonstrating debulking of the lesion. Fragments of abdominal fatty tissue placed during surgery are depicted as hypodense areas. The patient’s postoperative course was uneventful and a visual disturbance was improved. There was no cerebrospinal fluid leakage or neurological complication. CS = cavernous sinus; T = tumor.
the handpiece enables observation of the entire TSS site, even within a narrow operative field. The extra-long bayonet device is useful for removal of a lesion that involves the cavernous sinus. The miniature design enables pulsed-wave microvascular Doppler ultrasonography to be used in combination with a 1-mm-diameter miniature probe, thus allowing for the detection of the critical and nonvisible portion of the ICA, as reported previously. Second, the suction pressure-control system also helps preserve the critical ICA during removal of the intracavernous lesion. This may result in less bleeding and shortening of the total operation time. Third, the compact unit is compatible with both microsurgical and endoscopic surgical approaches to the pituitary region. This ultrasonic apparatus, therefore, will contribute to the effective removal of solid masses that occupy the pituitary region such as craniopharyngiomas (Fig. 2), meningiomas having a hard consistency, and fibrous pituitary adenomas resulting from long-term administration of bromocriptine.

Potential complications may arise from mechanical injuries to critical vessels, such as the ICA during manipulation of the device. The angle of approach may be restricted by the anatomical confines of the sphenoid bone and the sella turcica, which may prevent the surgeon from placing the instrument in an appropriate position to remove a lesion involving the cavernous sinus effectively. Thus, in individual cases, one must determine preoperatively both the range and the extent of the tumor to be removed to avoid intraoperative ICA-related, life-threatening complications. Although mechanical injuries cannot be prevented completely, the possibility of vascular damage can be minimized by a combination of technology and technique. First, appropriate control of suction pressure can be achieved using this compact ultrasonic surgical aspirator with the extra-long bayonet handpiece. Adequate suction pressure is the most important factor in preventing ultrasonic aspirator–related vascular damage. Our apparatus allows such pressure control, and this is one of the main benefits of the device. Second, the transmaxillosphenoidal approach or extended transsphenoidal approach with posterior ethmoidectomy allows access to and manipulation of a lesion in the cavernous sinus effectively. Thus, in individual cases, one must determine preoperatively both the range and the extent of the tumor to be removed to avoid intraoperative ICA-related, life-threatening complications. Although mechanical injuries cannot be prevented completely, the possibility of vascular damage can be minimized by a combination of technology and technique. First, appropriate control of suction pressure can be achieved using this compact ultrasonic surgical aspirator with the extra-long bayonet handpiece. Adequate suction pressure is the most important factor in preventing ultrasonic aspirator–related vascular damage. Our apparatus allows such pressure control, and this is one of the main benefits of the device. Second, the transmaxillosphenoidal approach or extended transsphenoidal approach with posterior ethmoidectomy allows access to and manipulation of a lesion in the cavernous sinus through the sphenoid sinus. The standard transsphenoidal approach can be converted to an expanded or extended approach, if necessary. Third, pulsed-wave microvascular Doppler ultrasonography facilitates safe dissection from the ICA through real-time monitoring of the vessel with a 100% detection rate. Both the depth and size of the vessel are measured accurately by turning the dial of the signal gain from waxing to waning Doppler acoustic sounds. Even if the vessels are not visible, they can be detected at frequent intervals by positioning the probe appropriately. The ultrasonic method is easy, simple, and noninvasive. Fourth, incorporation of the endoscopic method into the surgical procedure can enhance its safety, thus reducing the incidence of unpredictable damage and complications.

In this regard, we have recently reported our experience with the application and benefits of microvascular ultrasonography and endoscopy. Blind areas in the operative field can be inspected effectively by varying the endoscopic gateways. When endoscopy is of little or no value, ultrasound monitoring helps to overcome the limits of endoscopy.

Conclusions

A new, safe, and reliable method of performing TSS by using a compact ultrasonic surgical aspirator with a small handpiece may increase surgical accuracy and safety by providing finer control for tumor removal. We recommend combining this method with a standard TSS or endoscopic technique to increase the precision of tumor removal.

Disclaimer

None of the authors has any financial interest in the equipment described in this paper.

References


Manuscript received July 25, 2002.
Accepted in final form March 11, 2003.
Address reprint requests to: Toshiki Yamasaki, M.D., Department of Neurosurgery, Shimane Medical University, 89-1 Enya-cho, Izumo 693-8501, Japan. email: ytoshiki@shimane-med.ac.jp.