Use of the Ultrasonically Activated Scalpel in Acoustic Neuroma Surgery: Preliminary Report

ABSTRACT—Recently, the ultrasonic activated scalpel (the Harmonic Scalpel, HS) has been introduced in laparoscopic surgery. We have applied the HS in debulking the tumor in the posterior fossa and concluded that this is useful in acoustic neuroma surgery. Fifteen patients with a tumor extending more than 20 mm into the posterior fossa were included in this study. The extended middle cranial fossa approach type II was used in 13 patients and type III (hearing preservation surgery) was used in 2 patients. In one of two patients, hearing was preserved. Postoperative facial nerve function according to the House-Brackmann method was grade I in 12 patients, grade II in 2 patients, and grade III in 1 patient. Comparing the technique of using HS to a pair of bipolar forceps and/or ultrasonic cavitation aspirator, the former can result in better preservation of the facial nerve function.

Recently, we had the opportunity to use the ultrasonically activated scalpel (UAS), commonly known by the commercial name the Harmonic scalpel (Ethicon Endo-Surgery, Inc. a Johnson-Johnson company, Cincinnati, OH). This was originally introduced in laparoscopic surgery such as cholecystectomy, seromyotomy, appendectomy, herniorrhaphy, and liver biopsy.^{1,2}

The UAS has been applied in debulking the tumor in the posterior fossa and has proved to be useful in preserving the facial nerve function in acoustic neuroma surgery.

METHODS AND MATERIALS

A blunt or sharp hook blade with a 5-mm diameter was used (Fig. 1). The UAS cuts and coagulates tissue at a frequency of 55.5 kHz with a maximum longitudinal

displacement of 80 μ m of the blade tip. The UAS consists of a handpiece housing the acoustic transducer that transmits a mechanical vibration to an extending rod; this is housed in a 10-mm hollow stainless steel tube.

The vibrating blade couples with tissue protein and mechanically denatures the protein. The disorganized protein forms a sticky coagulum that seals blood vessels. The UAS controls bleeding by coaptive coagulation. Blood vessels are coapted and tamponated and then sealed with a denatured protein coagulum.

Fifteen patients with a tumor extending more than 20 mm into the posterior fossa were included in this study. The results of postoperative facial nerve function were compared in these patients to determine the advantages of using the UAS. The advantages in postoperative facial nerve function can be seen most clearly when comparing the results in larger tumors. Those 27 patients in whom the UAS was not used are patients whose

Figure 1. Hook blade (5 mm diameter) of the ultrasonically activated scalpel.

operation took place before the introduction of this new device. At that time, a pair of bipolar forceps and/or ultrasonic cavitation aspirator (UCA) were usually used.

Tumor size ranged 20 to 35 mm in size in the posterior fossa (average, 23 mm). Age of the patients ranged 34 to 72 years old (average, 49.3 years old). Three patients in this series were over 65 years old.

The extended middle cranial fossa approach type II was used in 12 cases and type III was used in 2 cases. Type II refers to a labyrinthectomy via the middle cranial fossa together with the separation of the superior petrosal sinus and the incision of the cerebellar tentorium. Type III refers to the transtentorial approach via the middle cranial fossa leaving the labyrinth intact to preserve hearing.³

Before decompression of the tumor extending into the posterior fossa, the absence of the facial nerve on the surface in which we intend to cut into the tumor should be confirmed using a stimulus dissector. This was specially designed by the author and the Nagashima Medical Instrument Company in Tokyo.⁴

Statistics

Statistically significant differences were tested using the chi-square test.

RESULTS

Debulking the Tumor in the Posterior Fossa Using UAS

After cutting the capsule of the tumor, a hook type 5-mm wide UAS is used to dissect the tumor and at the same time suction it. The tumor should be removed leaving the capsule as thin as possible, which is often difficult when using a UCA or a pair of bipolar forceps (Fig. 2). By this procedure the tumor is decompressed and separated from the brainstem, resulting in the identification of the facial nerve located anteriorly and inferiorly to the tumor.

Figure 2. Before (A) and after (B) debulking. This acoustic neuroma is extending 15 mm into the posterior fossa.

When a tumor is removed with a UAS, there is no smoke generated except a minimum amount of vapor. This enables the visual field to be clear during the whole procedure. Tissue that is coagulated does not stick to the scalpel because of its vibration and low heat generation (less than 80°C). These advantages make debulking of the tumor easier and enable the surgeon to remove the tumor in a shorter time than before. Considering the age of the patients and the preservation of the postoperative facial nerve function and the quality of life that they have left, a near total removal (95%) of the tumor was performed in 15 cases.

Preservation of the Facial Nerve

After debulking the tumor and separating it from the brain, the facial nerve can be identified. We do this by using the stimulus dissectors. In the final stage of the surgery, the tumor can further be decompressed with the UAS, and the capsule can then finally be removed with a pair of bipolar forceps and scissors.

During this procedure using the UAS, the facial nerve function is monitored using an electromyogram (EMG). This is the advantages of the UAS when compared with the bipolar forceps. We use this monitoring system while we work inside the tumor capsule because any effect on the facial nerve can easily be detected and thereby preserve the function of the facial nerve. We have noticed that a UAS causes less bleeding than using a UCA or pair of bipolar forceps. While debulking the tumor using the UAS, occasionally there will be some bleeding, but this can be easily controlled by a cotton sheet and/or a pair of bipolar forceps.

Postoperative Facial Nerve Function

The facial nerve was successfully preserved in all cases. Even though in cases in which the facial nerve was fanned out due to the compression of the tumor, evoked potentials of the facial nerve were obtained after removal of the tumor. One year after surgery, postoperative facial nerve function according to the House-Brackmann method was grade I in 12 patients, grade II in 2 patients, and grade III in 1 patient. These results were compared with the patients on whom the UAS was not used (Table 1). The results were statistically better in the UAS group (tumor size, 20–29 mm; House-Brackmann I and II) compared with the group of patients on whom the UAS was not used ($p < 0.01$). Figure 3 shows a pre- and postoperative magnetic resonance imaging (MRI) of a case in which near-total removal was performed.

Postoperative Hearing

In one of two patients, preoperative hearing was preserved. These two patients had 22- and 30-mm tumors extending into the posterior fossa, respectively. Hearing was preserved in the latter patient with a 30-mm tumor.

DISCUSSION

Coagulation with the UAS relies on coaptation of the bleeding site. This coaptation immediately stops the bleeding, which results in better visualization of the sur-

Figure 3. MRI: before (A) and after (B) resection.

Table 1. Postoperative Facial Nerve Function

Tumor Size	House-Brackmann Grading						Total
	I	II	III	IV	V	VI	
20–29 mm							
With UAS	9 (1)	2	1	—	—	—	12
Without UAS	6	2	3	5	2	1	19
≥ 30 mm							
With UAS	3 (1)	—	—	—	—	—	3
Without UAS	2	0	5	1	0	0	8

Comparison between patients in which the UAS was used and not used. Numbers in parentheses are cases in which hearing preservation surgery was performed.

gical field. This facilitates the debulking procedure to be performed more smoothly without any disturbance, which can be caused by crusting at the suction tip.

The facial nerve is often found to be fanned out on the surface of the tumor capsule, particularly in a case in which the tumor extends more than 20 mm in the posterior fossa. Total removal of the tumor with functional preservation is very difficult in some cases. Thus, to preserve the facial nerve function, it is sometimes necessary to remove all segments of the tumor but leave a piece of the tumor capsule attached to the facial nerve. This is often referred to as “near-total removal,” in which 95% of the tumor is removed. In such a case we check the course of the facial nerve using stimulus microinstruments. It is important to be very careful not to mistake it for the tumor capsule. We know, however, from past experience and from the literature⁵ that in the patients in which the near-total removal of the tumor was done, the incidence of a recurrence is low.

While debulking the tumor, it is necessary to leave the capsule as thin as possible without rupturing the capsule. This makes it easier to elevate the tumor and separate it from the brain or vessels and to identify the facial nerve, which might be located anteroinferiorly to the tumor. The procedure is performed using EMG monitoring that acoustically informs the surgeon when the UAS is too close to the facial nerve and when the facial nerve is stimulated by the blade of the UAS. The patient should have follow-up examina-

tions using MRI in the long term, usually about once in a year.

In this series, the number of patients are still not enough for us to fully evaluate the usefulness of the UAS for preserving the facial nerve function. Comparing the technique of using a UAS to a pair of bipolar forceps or UCA, we conclude that technical improvement including debulking using the UAS and the near-total removal can result in better preservation of the facial nerve function.

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