ULTRASONIC GLOSECTOMY—SIMPLE AND BLOODLESS

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Abstract: Background. The aim of the study was the evaluation of the feasibility of glossectomy using an ultrasonic-activated surgical instrument.

Methods. This was a prospective study of 13 consecutive patients who underwent glossectomy (12 partial and one total) for carcinoma of tongue with the use of ultrasonic scissors.

Results. All 13 patients had glossectomy, with median blood loss of 0 mL. The glossectomies were done with an ultrasonic dissector alone. None of the glossectomies required diathermy, ligature, plication, or other methods for hemostasis. The lingual artery and veins of all 13 patients were controlled by use of the ultrasonic scissors alone. No operative complications occurred, including bleeding or wound healing problems.

Conclusions. The excellent combination of coagulation and the cutting effect of ultrasonic scissors has made glossectomy a simple and bloodless procedure. It is a recommended surgical technique in our surgical armamentarium.

Surgery is the preferred treatment of choice for carcinoma of tongue. Glossectomy can achieve satisfactory local control.1–3 There is high propensity of nodal recurrence in the N0 neck.4–6 Elective treatment of the N0 neck may also be considered based on a preoperative MRI assessment of tumor thickness.7 The conventional glossectomy uses steel scissors, monopolar diathermy, or CO2 laser to cut the tissues. These methods have various degrees of hemostatic properties and effects on wound healing.8 Bleeding is still a problem in glossectomy, in which there are many large vessels that cannot be controlled by the diathermy and CO2 laser during dissection. The medium-sized to large vessels in the tongue and adjacent submandibular gland have to be controlled securely with ligature, plication, or clipping.

Ultrasonic-activated surgical instruments (harmonic scalpel, ultrasonic scalpel, ultrasonic scissors, ultrasonic coagulating shear) are indispensable in many endoscopic abdominal and thoracic procedures. Ultrasonically activated surgical instruments are based on the generation of high-frequency harmonic motion of metallic rod. The vibration of the metallic rod at the tissue interface breaks the hydrogen bonds and denatures proteins. When the amplitude of vibration is set to full power, the cutting effect is most effective. Adjustment of the vibration to lower amplitude gives a more prominent coagulating effect. At the low-amplitude coagulating mode, it is possible to achieve hemostasis of vessels up to 6 to 7 mm.
Ultrasonic surgical instruments have two designs, including ultrasonic scissors and ultrasonic hook. The two designs allow the surgeon to adapt to various surgical requirements. The ultrasonic hook has been used successfully in tonsillectomy, submandibular sialoadenectomy, and parotidectomy, and the ultrasonic scissors have been used in thyroidectomy. The conclusions from these studies demonstrate that ultrasonic surgical instruments have advantages of better hemostasis, less postoperative pain, and facilitation of a minimally invasive endoscopic surgical approach in these head and neck operations.

The application of ultrasonic-activated surgical instruments in glossectomy has not been adequately evaluated and popularized. There was a brief case report of glossectomy using the ultrasonic hook and an English-language abstract (full article in German) on PUBMED describing the use of ultrasonic scissors. The use of ultrasonic scissors for secure division of lingual vessels has also been reported in a letter to the editor. This prospective study aims to evaluate the feasibility of using the ultrasonic scissors in glossectomy.

PATIENTS AND METHODS

Patients. In this prospective study of ultrasonic glossectomy, all patients underwent glossectomy since January 2004 by use of 5-mm ultrasonic curved scissors (Sonosurgery System, Olympus, Japan), as shown in Figure 1. The ultrasonic surgical system has a range of ultrasonic frequencies up to 47,000 Hz at full power for the 5-mm scissors. A total of 13 consecutive glossectomies were performed in this period, and all patients were included in this study. There were nine male and four female patients, with a mean age of 57 years (range, 27–81 years). All 13 patients had squamous cell carcinoma of tongue. The distribution by American Joint Committee on Cancer (AJCC) clinical classification was as follows: T1N0M0 (n = 5), T2N0M0 (n = 6), T2N1M0 (n = 1), and T3N2M0 (n = 1). The median tumor diameter was 2.2 cm (range, 1.0–4.5 cm), and the median tumor thickness was 6 mm (range, 1–40 mm).

Surgical Procedures. All 13 operations were performed by or under the supervision of the first author. Twelve patients with T1–2 disease underwent partial glossectomy only. One patient with T3 disease underwent total glossectomy, performed using the ultrasonic scissors, and radical neck dissection. All glossectomies were performed with the patient under general anesthesia. The 12 partial glossectomies were performed transorally. A 1.5- to 2-cm resection margin was used, as recommended in our previous publication. The line of resection on the mucosa was outlined by blue dye and diathermy (Figure 2). The glossectomy was subsequently performed using the ultrasonic scissors alone. The tissue was grasped with the tip of the ultrasonic scissors, and the full-power mode was activated by foot pedal. It is important that a small amount of tissue is grasped near the tip of the blades to achieve rapid cutting and good hemostasis. Too much tissue between the blades would reduce the speed of cutting and obscure the identification of large vessels. When the dissection neared the lingual artery and vein, more large vessels were anticipated, and 60% power (frequency, 28,200 Hz) was used to achieve secure hemostasis. All vessels, including the lingual artery and veins, were divided by the ultrasonic scissors alone (Figure 3). The triple-seal technique was used.
in the transection of the lingual artery and vein; in this technique, the vessels were first sealed at two adjacent sides of the cutting point without division of the vessel by applying the ultrasonic scissors for 3 to 4 seconds before the vessel was divided at the center. In the one patient who had total glossectomy and radical neck dissection, the neck dissection was performed by conventional technique using steel scissors and diathermy; the tongue was then pulled down to the neck, and the glossectomy was performed by use of ultrasonic scissors alone.

The intraoperative hemostasis effect, including the control of lingual vessels and blood loss, was documented. The blood was evacuated by suction during glossectomy. The amount of blood loss was measured immediately after completion of glossectomy by marking of the suction bottle. The postoperative complications and recovery were also documented. The patients were given escalating doses of analgesics, beginning with oral paracetamol and moving to oral and intramuscular injection of narcotic. The daily requirement of analgesics was documented. The marginal tissue specimen was also evaluated by histologic section.

RESULTS
All 13 glossectomies were completed with ultrasonic scissors alone, without using diathermy or steel scissors. Diathermy was used before resection only to outline the mucosal resection margin. All vessels, including the lingual artery and vein, were controlled by the ultrasonic scissors alone. None of the patients required other modes of assistance, including ligation, plication, diathermy, laser, or clip, in resection and hemostasis. The median blood loss was 0 mL. Blood loss was nearly absent in 12 patients who underwent glossectomy. In one patient, the lingual artery was partially divided by the ultrasonic scissors, resulting in blood loss of 20 mL. The bleeding lingual artery was subsequently divided completely with secure hemostasis by the ultrasonic scissors.

Of the 12 partial glossectomies, the volume of the glossectomy specimens was measured by displacement of water in a measuring cylinder. The median glossectomy volume was 18.5 mL (range, 9–134 mL). The median resection duration was 49 minutes (range, 35–110 minutes), and the last seven glossectomies were all finished within 35 to 60 minutes.

Multiple resection margins of the specimen were examined by microscopy. Minimal cellular necrosis from thermal injury to marginal tissues was noted (Figure 4). In the 12 patients who had partial glossectomy and primary closure of the wound, all wounds healed uneventfully without complication. The patient with total glossectomy underwent a free anterolateral thigh flap reconstruction of the floor of mouth and had uncomplicated recovery of all wounds. All 12 patients with partial glossectomy and primary closure resumed an oral fluid diet the next day after operation. The postoperative pain of all patients...
could be controlled with paracetamol, and none of the patients required narcotic analgesics.

**DISCUSSION**

The advent of technology has significantly improved surgical techniques and the results of many surgical procedures. Ultrasonic-activated surgical instruments are an important landmark in surgical technology that has been widely used in recent years, particularly in minimally invasive endoscopic approaches. The excellent combination of coagulation and cutting effects of ultrasonic-activated surgical instrument has made it possible to operate through small holes in endoscopic abdominal or thoracic surgery in which conventional diathermy or ligature methods are difficult to apply. With the vast experiences of endoscopic abdominal and thoracic surgery, the ultrasonic scalpel is increasingly used in the head and neck region. The ultrasonic hook has been reported in tonsillectomy, submandibular sialoadenectomy, parotidectomy, and thyroidectomy. The benefits of simultaneous hemostasis and cutting would facilitate the surgery, particularly in minimal-access techniques.

Because of the excellent hemostatic properties of ultrasonic scissors, glossectomy can be performed without interruption for hemostasis simply by grasping the tissue with the scissors and pressing on the foot pedal. The entire resection is very easy and fast without interruption in a bloodless operative field. This is perhaps the most advantageous selling point for ultrasonic scissors. Glossectomy using steel scissors is slow and ineffective because of the frequent interruption of resection for hemostasis. The first author has used monopolar diathermy for glossectomy for many years. Monopolar diathermy has less hemostatic efficiency than ultrasonic scissors; interruption for bleeding is still necessary, and partial glossectomy usually takes about 1 to 2 hours. CO₂ laser glossectomy is a very difficult procedure, with poor hemostasis, particularly in cases in which the resection reaches the tongue base, where there are more abundant larger vessels. The ultrasonic scissors are primarily designed for abdominal and thoracic surgery. The device may not be ergonomic for head and neck surgery, for which a shorter shaft and smaller blade may be more desirable. With the increasing applications in head and neck surgery, this may have market value to attract the manufacturer. With regard to technical difficulty of the various procedures, ultrasonic scissors are the easiest and CO₂ laser the most difficult.

There is an article in the German literature by Metternich et al., for which we can read only the English abstract on PUBMED. Metternich et al reported 25 glossectomies performed using a harmonic scalpel. Eight patients required additional ligature to control bleeding in the tongue base. The authors, therefore, recommended that vessels up to 1 mm, including lingual vessels, should be ligated. It has been shown that ultrasonic scissors can safely seal off vessels up to 3 mm in diameter with a bursting pressure of 226 mmHg, 4 to 5 mm diameter with a bursting pressure of 205 mmHg, and 6 to 7 mm diameter with a bursting pressure of 175 mmHg. The triple-seal technique using 60% power, described in the Methods section, should be used to cut and seal the large vessels, including lingual vessels. The lingual artery and vein are usually 2 to 3 mm in diameter, even in the tongue base and at its origin from carotid artery, and can be safely controlled by the ultrasonic scissors alone, as demonstrated in this study and also in a brief letter to the editor. Ultrasonic glossectomy can be used safely with secure hemostasis for glossectomy to include the tongue base. In contrast, CO₂ laser has higher risk of postoperative bleeding.

Despite the excellent hemostatic effect, we had one incident of partial grasping of the lingual artery that resulted in cutting open the partially sealed artery and blood loss of about 20 mL. The bleeding lingual artery was immediately grasped again completely with the ultrasonic scissors, and hemostasis was secured. This incident is preventable with proper technique. In this author’s early phase with ultrasonic glossectomy, the author grasped a large section of tissue with the ultrasonic scissors, obscuring the view of the lingual artery buried within the tissues, and unaware that the lingual artery was partially grasped by the tip of the blades. This author thereby learned that only a small amount of tissue at a time should be grasped, so that any large vessels can be clearly visualized. It is important to ensure that the entire lingual artery is within the ultrasonic blades to achieve complete sealing of the vessel. The small cutting technique will ensure that the surgeon can clearly see the tissues and prevent partial cutting of large vessels. In fact, the entire glossectomy procedure is much faster and safer when accomplished by more small bites than fewer big bites.

Hemostasis is not the only benefit of using the ultrasonic scalpel. The ultrasonic scalpel uses
high-speed harmonic mechanical vibration to denature protein, and the temperature is approximately 80°C. The amount of heat produced is much lower than that produced by electrocautery diathermy and CO₂ laser. It has been demonstrated that the damaging effect to tissue by the ultrasonic scalpel is just next to the steel scalpel and is much less than monopolar diathermy, bipolar diathermy, and CO₂ laser. The histologic section of the resection margin of the surgical specimen in this study (Figure 4) also showed minimal cellular necrosis in ultrasonic dissection margin. It has been shown in guinea pig oral mucosa that ultrasonic scalpel surgery has more rapid resolution of inflammation and tissue re-epithelialization and stronger tensile strength of the wound compared with monopolar diathermy, bipolar diathermy, and CO₂ laser. All patients in this study had uneventful wound healing. There was also no wound healing problem in the report by Metternice et al. Wound healing is also not a problem for steel scissors and diathermy in which the wound is closed primarily or with flaps. The wound healing in cases of CO₂ laser may take a longer time if the wound is left exposed for re-epithelialization, and there is a higher incidence of postoperative bleeding.

The reduced tissue damage with the ultrasonic scalpel has been shown to reduce postoperative pain in tonsillectomy compared with diathermy. Although we did have a daily pain score record of the patients in this prospective study (data not shown), the data, however, cannot address the question of benefit in pain reduction compared with steel scissors, monopolar diathermy, and laser. The pain can only be compared in a prospective randomized study, and the sample size is inadequate in any single center. All patients in this study had satisfactory pain control with paracetamol alone, without the requirement of stronger narcotic analgesics.

The costs of glossectomy by using various instruments are summarized in Table 1. The data on lifetime of the ultrasonic scissors and the operative time cost are based on assumption and the author’s personal experiences only, and the data cannot be applied to other surgeons and hospitals without modification. The ultrasonic surgical instruments are not new and are usually available in most hospitals. The equipment has been used routinely in daily practice for minimally invasive surgery by abdominal and thoracic surgeons for many years. We can always share the equipment with various departments. Because we use the ultrasonic scissors for many other procedures apart from glossectomy, we cannot estimate accurately the lifetime of the scissors for glossectomy alone. The authors are still using the same ultrasonic scissors after 13 glossectomies and many other head and neck

<table>
<thead>
<tr>
<th>Surgical method</th>
<th>Initial investment equipment cost (US dollars)</th>
<th>Annual equipment maintenance cost (5% of equipment cost, US dollars)</th>
<th>Consumable used</th>
<th>Total consumable cost (US dollars)</th>
<th>Operative time (h)</th>
<th>Staff time cost* (US dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultrasonic scissors</td>
<td>20,000</td>
<td>4,000</td>
<td>Reusable scissors (US 1,527/scissors; assume reusable 20 times = US 76) Disposable diathermy pen (US 6)</td>
<td>82</td>
<td>0.5–1</td>
<td>175–350</td>
</tr>
<tr>
<td>Monopolar diathermy</td>
<td>6,900</td>
<td>1,380</td>
<td>Disposable diathermy pen (US 6) Hemostatic suture and ligation (US 6)</td>
<td>12</td>
<td>1–1.5</td>
<td>350–525</td>
</tr>
<tr>
<td>CO₂</td>
<td>90,000</td>
<td>18,000</td>
<td>CO₂ gas consumption (assume 2 h = US 55) Microscope drape (US 20) Disposable diathermy pen (US 6) Hemostatic suture and ligation (US 6)</td>
<td>87</td>
<td>1.5–3</td>
<td>525–1050</td>
</tr>
</tbody>
</table>

*Staff time cost in operating theater (US $350/h) include the following: one professor/consultant surgeon, one trainee surgeon, one consultant anesthetist, three nurses, one theater assistant.
procedures. It is estimated to be at least adequate for 20 to 30 times if it is used for glossectomy alone. In this author’s experience, the ultrasonic procedure is faster than steel scissors, diathermy, and laser; it is, therefore, the most inexpensive procedure because of the reduction of operative time and staff cost.

There is no prospective randomized study in the literature comparing the cost, difficulty, time of operation, pain, healing, hemostasis, local control, and survival of various methods of glossectomy. Because the number of glossectomies would be too few in any single center, it is almost impossible to conduct a prospective randomized study in any single center to address many of these issues. Each method has its advantages and disadvantages. All surgical techniques are acceptable in our surgical armamentarium. Readers need to acquire personal experience with various surgical techniques and develop their own preference for applications on an individual basis.

In conclusion, simple and bloodless glossectomy with satisfactory wound healing can be achieved with ultrasonic scissors. It is a recommended surgical technique in our surgical armamentarium.

REFERENCES