The use of a harmonic scalpel in thyroid surgery: report of a 3-year experience

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Abstract

Background: Hemostasis in thyroid surgery is of utmost importance for a successful surgery and an uneventful postoperative course. The present article reports a single surgeon’s 3-year experience in the use of the harmonic scalpel. The device was developed in the early 1990s and offered adequate and safe hemostasis for vessels up to 3 mm in width.

Methods: This was a prospective observational study. Data sheets from all patients who had surgery by a single endocrine surgeon in the period from 1999 to 2004 were evaluated. Patients were divided into 3 groups based on the surgical technique used: group I comprised the conventional knot-and-tie technique, group II comprised the ligation of all but the superior thyroid vessels with a scalpel, and group III comprised patients in whom the device was used exclusively. The groups were compared in regard to surgical time, cost, and complication rate.

Results: A total of 272 patients were included in the study: 107 patients were included in group I, 77 in group II, and 88 group III. The surgical time of group I differed significantly compared with groups II and III (P < .001 in both cases). Surgical times between groups II and III did not differ significantly (P = .701).

Conclusions: The use of the harmonic scalpel reduces surgical time, but it increases the cost of the surgery. It is our belief that by including in the absolute cost the time saved and the reduction in human resources needed, the use of the scalpel would prove to be economic. © 2007 Published by Excerpta Medica Inc.

Keywords: Thyroid surgery; Harmonic scalpel; Thyroidectomy

Hemostasis in thyroid surgery is time consuming and requires a meticulous technique. Nevertheless, it is a prerequisite for an uneventful postoperative course. Thyroid surgery was not performed routinely until the late 19th century because the removal of large goiters frequently led to massive—if not fatal—blood loss. The procedure was standardized by Theodore Kocher [1] (1841–1917), who introduced the preliminary ligation of the 4 principal arteries, thus substantially reducing the volume and danger of bleeding.

His strict technique resulted in a reduction of the mortality rate from 12.8% in 1883 to less than .5% fifteen years later. Theodore Billroth [1] (1829–1894), who performed surgery more rapidly with less regard for the tissues and less concern for hemorrhage, reproduced the results but with a high incidence of tetany. According to Halsted [2], Billroth’s rough technique was responsible for the removal or devascularization of the parathyroids.

The introduction of many sophisticated methods for hemostasis did not affect thyroidectomies and the single advance since the 1970s was the adoption of electrocautery in thyroid surgery. A technical advance in the early 1990s was the development of an ultrasonically activated device that includes shears and a scalpel, thus permitting the surgeon to
cut tissues and control blood loss at the same time [3]. The harmonic scalpel uses high-frequency mechanical energy to cut and coagulate tissues and vessels simultaneously without the need for knot tying [4]. Because thyroidectomy requires a large number of clamp and tie maneuvers for the small thyroid vessels, the use of the harmonic scalpel in thyroid surgery may result in a reduction of surgical time, cost, and morbidity. Initial reports on the use of the harmonic scalpel were encouraging, showing a significant reduction in surgical time. The present article reports a single surgeon’s 3-year experience in the use of the harmonic scalpel.

Materials and Methods
This prospective observational study was conducted at a teaching university hospital. Data from all patients who underwent thyroid surgery in the Department of Endocrine Surgery have been recorded prospectively on special data sheets since 1998. All patients have their routine work-up as outpatients and are admitted to the hospital on the morning of the elective surgery. Records contain information on the patient’s demographics, primary diagnosis, type of surgery, surgical time, intraoperative complications, surgical cost, hospitalization time, and immediate postoperative complications. Surgical time is defined as the time from induction of anesthesia to skin closure. Intraoperative complications include excessive blood loss and severe cardiovascular events. Surgical cost is defined as the actual cost of all surgical disposable materials used for the surgery. Savings in surgical time were not considered in these calculations. This is because in the Greek National Health System, insurance companies are charged according to the total hospitalization time. The type of surgery, the underlying pathology, and the duration of the surgical procedure are not considered in the total costs. Immediate postoperative complications included death, cervical hematomas, clinically evident hypocalcemia, and recurrent nerve palsy. A series of serum calcium levels were obtained at 6 and 24 hours after the end of the surgery. Patients underwent serial physical examinations at 2, 6, and 24 hours after surgery, including control of verbal communication, estimation of hoarseness, verification of pain control, and absence of Trouseau’s and Chvostek’s signs. Patients were discharged 24 hours after the surgery given that no complication had occurred and the serum calcium levels were within the normal range (8.5–10.5 mg/dL).

Data sheets from all patients who underwent surgery by a single endocrine surgeon in the period from 1999 to 2001 were collected and used as historic controls (group I). Hemostasis in these surgeries was performed with the conventional knot-and-tie technique. In 2001, the harmonic scalpel (CS-14c; Ethicon Endosurgery, Cincinnati, OH) was introduced in our department. In all patients who had surgery by the same surgeon between April 2001 and May 2004, hemostasis was achieved with the harmonic scalpel, apart from the superior thyroid vessels that were ligated conventionally (group II). Since May 2004, as a result of improved expertise, hemostasis was achieved with the exclusive use of the harmonic scalpel (group III).

Surgical technique
All patients were positioned, monitored, and draped in the standard way. A 4- to 6-cm incision was made over the level of the isthmus, 3 to 4 cm above the sternal notch. Subplatysmal flaps were developed with Metzenbaum scissors or the harmonic scalpel and the strap muscles were separated at the midline. When the gland was exposed, the thyroid vessels were ligated in one of the following ways. The Conventional Knot-and-tie Technique: Formal thyroid vessels (inferior middle and superior) were clamped and tied using 3/0 silk sutures, and in all other vessels absorbable 2/0 or 3/0 sutures were used.

The Use of the Harmonic Scalpel for Inferior and Middle Thyroid Vessels: The harmonic scalpel was used for the ligation of all thyroid vessels apart from the superior thyroid artery, which was ligated with the conventional knot-and-tie technique (3/0 silk sutures). The generator of the ultrasonic device was adjusted to a minimum power level of 3 and a maximum power level of 5 [5].

The Use of the Scalpel for All Thyroid Vessels: All thyroid vessels were ligated with the harmonic scalpel. For the ligation of the superior thyroid vessel, we used a double-ligation technique in which the device was used in 2 succeeding areas of the superior thyroid vessel. In the distal part of the artery we used the device just to coagulate the vessel. In the proximal part, after coagulation, we used the shears to cut the tissue. The configuration of the device was the same as in the previous group. No suture ligation was used.

The wound was closed using a continuous 3/0 absorbable suture for the strap muscles and a 3/0 or 4/0 interrupted absorbable suture for the platysma. In all patients a closed suction drain (soft drain flat; pfm Produkt fur die Medizin AG, Kohn, Germany) was placed below the strap muscles.

Statistical analysis
Data were analyzed with the use of the SPSS 10.0 statistical package (Microsoft Corp, Redmond, WA) and statistical significance was set at 5% as standard. Analysis included an unpaired 2-tailed Student t test and the chi-square test for a comparison of means.

Results
In total, data from 272 patients were studied. Of these, 250 patients underwent total thyroidectomy and the remaining 22 patients underwent lobectomy or subtotal thyroidectomy. A total of 107 surgeries were performed using the conventional clamp-and-tie technique (group I), 77 were performed with the use of the harmonic scalpel for the ligation of all but the superior thyroid vessels (group II), and 88 were performed with the exclusive use of the harmonic scalpel for hemostasis (group III). The 3 groups did not differ in regard to age, sex, and underlying pathologies. The demographics of each group and further details of the procedures are given in Table I. There were no postoperative deaths in the presented series.

In group I there were 5 postoperative complications (4.67%). Two patients with cervical hematomas required re-exploration within 24 hours and 3 patients developed clinically evident hypocalcemia and were treated with an
intraintravenous calcium substitution for 24 hours followed by oral substitution for 7 days. In these patients, discharge was postponed until the restoration of the serum calcium levels to a normal range (8.5–10.5 mg/dL). Two patients in group II (2.59%) and 2 patients in group III (2.27%) developed hypocalcemia postoperatively that was treated in the same manner. Clinically evident recurrent nerve palsy was not observed in any of the groups.

The surgical time for group I differed significantly compared with groups II and III (P < .0001 in both cases). Surgical times between groups II and III did not differ significantly (P = .701).

The use of the harmonic scalpel is more expensive than the conventional technique. The mean surgical cost for group I was 151.1 euros (SD, 9.1), for group II the mean surgical cost was 371.8 euros (SD, 8.2), and for group III the mean surgical cost was 352.9 euros (SD, 9.1). All groups differed significantly regarding surgical costs (P < .001), with group I being the cheapest and group II being the most expensive procedure.

**Comments**

The ultrasonically activated shears is a system that uses high-frequency ultrasonic energy to cut and coagulate tissues at a relatively low temperature. The device consists of a generator, a foot pedal, a hand piece, and a blade. The acoustic wave is produced by a generator at a frequency of 55,000 Hz. The harmonic sequence is transmitted to the blade, creating the same frequency vibration. When the blade comes in contact with the tissue, protein and collagen structures are fragmented and coagulation is achieved. The device has been used extensively in general abdominal, cardiac, head and neck, and gynecologic surgeries and has proven to be safe and effective [6, 7]. Its specifications permit the safe ligation of vessels less than 3 mm in diameter. The relatively low temperature that is produced causes less tissue trauma and generates less smoke compared with electrocautery. To enhance safety, the hand piece ends in 2 jaws: an active stable jaw for the transmission of energy and a movable jaw that is used for tissue clamping. The energy is not transmitted to the movable part, which can therefore be used as a barrier against thermal transmission.

The most important aspect of the use of the harmonic scalpel is the adequacy of hemostasis. The specified safety limit refers to vessels of a maximum diameter of 3 mm. Nevertheless, there have been reports that have suggested the use of the harmonic scalpel for larger vessels such as the superior thyroid artery. Ortega et al [8] used the clamp-and-tie technique for most of the superior thyroid vessels without stating whether in some cases the harmonic scalpel would have been adequate. Shemen [9] reported using the scalpel for all thyroid vessels including the superior thyroid artery and vein in 105 consecutive patients with a historical control group of 20 retrospectively studied patients. Siperstein et al [10] suggested the use of the ultracision for all thyroid vessels and were the first to describe the double-ligation technique. The key point for hemostasis with the use of the double-ligation technique is that the vessels should be coagulated in 2 succeeding areas. The technique described in the Siperstein report is very similar to the one we used in group III.

In general, the use of the harmonic scalpel is associated with a significant decrease in surgical time compared with the conventional technique. Voutilainen and Haglund [11] reported a 31.5% decrease in surgical time with the use of the scalpel by an experienced endocrine surgeon. Ortega et al [8] reported mean surgical times of 101 ± 16 minutes and 86 ± 20 minutes for the conventional technique and the use of the ultracision, respectively. The reduction of surgical time was significant but the very short surgical time with the conventional technique prevents a further decrease in time with the use of the scalpel.

The learning curve for the use of the ultrasonic device is reported as short [9]. It is our belief that the curve for the optimal use is not that short. In our series, an experienced endocrine surgeon was constantly decreasing his surgical time for the initial 100 cases. An important factor for the accurate assessment of the surgical time is the composition of the surgical team. In thyroid surgery, the surgeon usually dissects or applies the scalpel, leaving various surgical maneuvers to the assistant. In our practice in a teaching hospital, the endocrine surgeon performed all of the surgeries, assisted by rotating residents. We believe that a standard synthesis of the surgical team would allow for a further decrease in the surgical time for both techniques.

Concerning the surgical cost with the use of the harmonic scalpel, Voutilainen and Haglund [11] performed a cost-benefit analysis including the cost of the device and the savings in surgical time. They concluded that for the standards of their institution, despite the reduction in surgical time, the use of the scalpel does not counterbalance the cost. Ortega et al [8] reported costs of 985.77 ± 107.08 and 1148 ± 153.25 euros (mean ± SD) for the clamp-and-tie and the ultracision group, respectively.

In our series the combined technique in which we used both the scalpel and sutures (group II) was the most expensive, and the conventional knot-and-tie technique was the cheapest (group I). The surgical cost for group III was between groups I and II. Group II was the most expensive...
because in the combined technique we used both the scalpel and sutures. It should be noted that in the Greek National Health System, hospital costs are calculated according to the length of hospital stay. There are no charges on the basis of the type of surgery performed. Nevertheless, there is no actual way to estimate the benefit in surgical time savings and in the reduction of human resources used in the operating room. Moreover, in this study we did not calculate the nonsurgical utensils used in the operating room by the anesthesiologist and the nursing staff. Therefore, the use of the harmonic scalpel seems to be more expensive than the conventional technique, but it is our belief that if one could include the expenses mentioned previously, then the use of the scalpel could prove to be cheaper.

References