Efficacy and Safety of Ultrasonically Activated Shears in Thyroid Surgery

Dimitrios C. Karvounaris, MD, Vassilios Antonopoulos, MD, Kyriakos Psarras, MD, Athanasios Sakadamis, MD

Second Surgical Propedeutical Department, Aristotle University of Thessaloniki, Hippocrates General Hospital, 61 M. Alexandrou Ave. Thessaloniki, Greece GR-54645. E-mail: dkarv@med.auth.gr

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Abstract: Background. The purpose of this prospective study is to evaluate the efficacy of ultrasonically activated shears (UAS) in hemostasis as well as its safety in regard to complications in thyroid surgery.

Methods. Three hundred patients who had undergone surgery on the thyroid gland were divided into 2 groups of 150 patients each. Hemostasis as well as division of blood vessels and thyroid tissue were performed with the use of UAS in the first group and by conventional ligations in the second group.

Results. The use of UAS resulted in as much as a 39.7% reduction in the operative time of the total thyroidectomy and a 30.8% reduction of the lobectomy ($p < .001$). However, there was no important difference in the postoperative blood loss in either the temporary hypoparathyroidism or the paresis of recurrent laryngeal nerves.

Conclusions. The use of UAS in thyroid surgery is a safe method for hemostasis, as well as for the division of blood vessels and thyroid tissue. It leads to the reduction of the total operative time without serious complications.

Keywords: ultrasonically activated shears; harmonic scalpel; thyroid surgery; thyroidectomy

AAlthough surgical operations of the thyroid gland are performed extensively today, the technique has not been changed for about a century since it was first described. Hemostasis is a critical step of thyroidectomy because of the rich blood supply of the gland. In the recent years, ultrasonically activated shears (UAS) have been thoroughly applied in both open and laparoscopic surgery. They use a high-frequency mechanical motion for coagulation and blood vessel or tissue division. To evaluate the effectiveness and safety of UAS in thyroid gland surgery, we prospectively studied UAS application in 150 thyroidectomies, along with 150 operations performed by the classical vessel ligations.

MATERIALS AND METHODS

Three hundred patients who were operated on for several diseases of the thyroid gland in a period of 28 months were included in this prospective study. Written consent was given by all patients. The patients in group A (150 patients) underwent the operation using the UAS for hemostasis and division of blood vessels and isthmus in lobectomies. The Ultracision-Harmonic Scalpel type CS14C (Ethicon Endo-Surgery, Cincinnati, OH) was used. This type was preferred because it
has a shorter shaft and is therefore easier to use. Additionally, the active blades are curved, so it can also be used for tissue dissection. The division of all blood vessels was performed with this device, and no ligations or surgical clips were applied. Transection of the thyroid tissue of the isthmus was performed in a similar fashion with sequential applications across the isthmus.

In another 150 patients (group B), hemostasis was performed by typical suture ligations and monopolar diathermy for smaller vessels. Clips were not applied.

The operation was performed in all cases by the same surgeon (DCK) by following the typical steps of thyroidectomy, with dissection and hemostasis of the blood vessels and identification of the parathyroid glands and the recurrent laryngeal nerves, but not necessarily that of the superior laryngeal nerves. In cases in which the gland was of a large size with a high location of the upper lobe, the superior edge of the sternothyroid muscle was transected with the UAS to obtain a better identification of the superior thyroid vessels.

Vacuum drains were placed in all patients, and their content was registered for the first 24 hours. The operative time from skin incision until closure, along with the postoperative complications, including serum calcium levels and vocal cords function, were recorded.

RESULTS

There were no major differences with regard to age, sex, and type of thyroidectomy between the 2 groups of patients. Group A consisted of 27 males and 123 females, with a mean age of 46.9 ± 15.2 years (range, 14–76 years). Ninety-eight of these patients had undergone total thyroidectomy and 52 of them lobectomy. Group B consisted of 23 males and 127 females, with a mean age of 48.3 ± 13.8 years (range, 14–76 years). Total thyroidectomy was performed in 92 patients and lobectomy in 58 patients.

The total operative time for group A was 50 ± 11 minutes for the thyroidectomy and 36 ± 9 minutes for the lobectomy. In group B, the total operative time was 83 ± 13 minutes and 52 ± 10 minutes, respectively. Thus, the operative time was shortened by 39.7% for all the total thyroidectomies and by 30.8% for the lobectomies. This result was found to be statistically significant in both cases (p < .001).

No blood transfusion was needed and no intraoperative complication occurred. There was no death. The content of the aspiration drains for the first 24 postoperative hours was, for total thyroidectomy, 84.5 ± 25.7 mL in group A and 87.7 ± 29.9 mL in group B, as compared with 57.9 ± 31.6 mL and 57.7 ± 22.6 mL, respectively, for lobectomy. The difference between the 2 groups was not statistically significant (p > .5).

The postoperative hospital stay was equal for all patients (48 hours). No postoperative bleeding or hematoma formation occurred, and no permanent postoperative complication was observed.

In 16.3% of patients in group A and 12.8% in group B, a transient hypocalcemia was detected, but this was soon corrected with per os administration of calcium and vitamin D. Temporary unilateral paresis of the recurrent laryngeal nerve with voice hoarseness was observed in 7.8% and 8.1% of cases, respectively, which improved within a few days.

DISCUSSION

The thyroid gland, thanks to its rich blood supply, presents special interest in the study of several methods of hemostasis. The high-frequency ultrasound energy allows the coagulation and cutting of tissues at low temperatures.\(^1\) The electrical power produced by the generator is transmitted through the shaft of the instrument and converted by piezoelectric crystals into a mechanical motion. The mechanical motion is transferred onto the active blade, which vibrates at a 55.5-kHz frequency. When the vibrating blade touches the vessel, its mechanical energy results in the breakup of the hydrogen bonds of the tissue proteins and in coagulation. Thus, hemostasis is attained. The tissue division is based on the “cavitational effect” brought about by the high-frequency vibration of the tip of the instrument, the evaporation of the tissue fluids, the bubble formation, and, finally, transection without tissue damage and without the thermal coagulation caused by electrical diathermy. Hemostasis is achieved at low temperature (range, 50° to 100°C) in contrast to electrical diathermy or lasers, through which hemostasis is achieved at higher temperatures (range, 150° to 400°C). Thus, tissue is not charred, there is no smoke production, and electrical current does not flow through the patient’s body.\(^2,3\) Moreover, the energy and heat diffusion into the surrounding tissues are much less with UAS (1 mm\(^2\) vs 2.5 mm\(^2\) for electrical diathermy and 4 mm\(^2\) for lasers).\(^4\) The speed of tissue dissection, as well as the amount of coagulation, is inversely proportional to the power supplied by the generator. At a
low-power level, the vibration of the blade is 70 µm, and better hemostasis is achieved at this level, but with longer cutting time. Inversely, at a higher-power level, the vibration increases to 100 µm, the hemostasis is less, but the cutting speed is increased. Experimental studies have confirmed that, at the lower-power level, the temperature difference in a 2-mm distance from the application point was not higher than 6°C, whereas at the higher-power level, and with a continuous application of 15 seconds, an important increase in temperature was observed at a distance of 1 cm. Furthermore, the UAS have been found to be safer when used at nerve proximity. In thyroidectomy, because the blood supply of the gland is rich, low-power levels are preferred and blood vessel division is achieved by an increase of pressure at the tip of the instrument after hemostasis is complete. The UAS have been used for several years in laparoscopic surgery, but also in general and gynecological surgery.

In our prospective study, we performed a comparative analysis of 2 patient groups with no differences in age, sex, and underlying disease. The operations were performed following the same steps, the only difference being that hemostasis and tissue division in group A were achieved by UAS, whereas in group B they were performed by the conventional ligations and by suturing the divided margin of the gland by continuous absorbable suture in lobectomies. All blood vessels in group A were divided by the UAS, as this has been reported by most authors. The instrument was even used for the superior thyroid vessels, for which some investigators continue to prefer ligations, and also in proximity to the recurrent laryngeal nerve, where some reports suggest avoiding its use, although without any better results.

The most important advantage of the use of UAS was the reduction of the total operative time, which was statistically significant both for lobectomies (30.8%) and for total thyroidectomies (39.7%). Similar findings about the operative time have been reported by all the investigators. Voutilainen et al reported a 35% reduction in their first study, and a 23.2% reduction in a later randomized study. Siperstein et al presented a 22.6% reduction in lobectomies and an 18% reduction in thyroidectomies, and Meurisse et al reported a 26.7% reduction in 34 thyroidectomies. Shemen reported a reduction of 37.5% in lobectomies and of 33.3% in thyroidectomies. Furthermore, Miccoli et al presented an important reduction in operative time by the use of UAS instead of clips in endoscopic thyroidectomy.

The intraoperative blood loss was not estimated in our study. There is no agreement on any reduction of blood loss, since some authors report reduction of bleeding even in thyroidectomies for Graves’ disease, whereas other studies show that the difference in blood loss is not statistically significant. In patients with Graves’ disease, blood loss was higher due to the richer blood supply of the gland, although Burkey et al did not find any statistically significant difference in bleeding risk relating to the disease.

Similar to all other studies, postoperative bleeding or hematoma formation was not observed in any of our patients. The bleeding for the first 24 hours did not show any statistical difference between the 2 groups. Other authors reported similar results. Interestingly, Takami et al observed a greater than 50% reduction in postoperative blood loss for patients who underwent surgery with UAS for Graves’ disease.

Concerning postoperative complications, the transient hypocalcemia of the patients with total thyroidectomy did not appear to be statistically different in the 2 groups, and no patients developed permanent hypoparathyroidism. Similar results have been reported by most authors, except for Meurisse et al, who showed a very important decrease of postoperative hypoparathyroidism (5.8% vs 23.5%).

Although we used the UAS for the division of the inferior thyroid artery in proximity to the recurrent laryngeal nerve, we did not observe any difference in the transient paresis of the nerve, which confirms the safety of this device, as previously shown by others. Only Voutilainen et al reported higher percentage of postoperative recurrent laryngeal nerve paresis and concluded that the instrument should not be used close to the nerve.

The UAS can be safely used in dividing the thyroid tissue in lobectomies. Similar to this study, in all other reports no sutures were used at the cut margin of the isthmus, even in cases with toxic goiters that are more likely to bleed or in cases of endoscopic thyroidectomy.

A reduction of the length of skin incision has also been reported by Shemen and Casadei et al, as better control of blood vessel division can be achieved when the UAS are used, even in this smaller operative field.

A disadvantage of the use of UAS is the cost of the instrument, which is disposable. We did not study this parameter in this present work. However, in other studies in which the cost of dispos-
able material was estimated along with the total operative time reduction, a statistically significant difference was found; the cost was reduced by making use of the UAS, although with no big difference.17,23 Meurisse et al16 reported that the cost can be reduced further by reusing disposable materials (hook). Ortega et al21 found a statistically significant difference in the cost of ultrasonic shears by reusing the same disposable instrument 3 to 5 times, although the instrument manufacturer recommends that tissue remnants between the blades can reduce the function and effectiveness of the instrument.1

To conclude, the ultrasonic coagulating shears provide a safe and effective method of hemostasis of thyroid blood vessels and the division of thyroid tissue. It mainly reduces the total operative time and possibly the blood loss. The technique gives the same percentages of morbidity with the classical techniques of hemostasis and does not affect the total cost of the operation.

REFERENCES