The place of new haemostatic techniques in thyroid surgery

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Introduction

The theme of this year’s annual teaching session organised by the Collège Français d’Oto-rhino-laryngologie et de Chirurgie Cervico-Faciale was thyroid surgery. This technical note is based on one of the presentations of this teaching session and is designed to review the current data concerning various haemostatic techniques in thyroid surgery.

Two types of haemostatic technologies are currently used in thyroid surgery: LigaSure® (Covidien, USA, and more recently Optima® Lamidey Noury, France) and Harmonic® (or “Ultracision”, Ethicon, USA). These devices were developed over the last 20 years to ensure reliable and rapid haemostasis during endoscopic or open surgery, in order to avoid the systematic use of sutures and/or vascular clips. They are designed to allow more rapid surgery with less intraoperative bleeding and, depending on the type of surgery, decrease the collateral thermal damage compared to conventional monopolar or bipolar cautery, thereby decreasing morbidity.

Theoretical bases

The Ligasure® device (and Optima®) delivers a bipolar electrical current between the two jaws of the forceps (Teflon-coated metal jaws). The device measures the impedance between the two jaws, then delivers a pulsed electrical current at a frequency of 3333 Hz. An electronic feedback system adjusts the energy level delivered to the tissues and indicates interruption of the current when tissue fusion has been achieved. Coagulation of blood vessels up to 7 mm in diameter is achieved by coagulation of collagen and elastin. The mean fusion time is 2 to 4 seconds, with heat diffusion of less than 100°C over a radius of one millimetre around the forceps. This technology cannot be used to section vessels, which must be performed separately with scissors or a scalpel integrated in the forceps (depending on the model). The Optima® device (Lamidey Noury) is identical to the Ligasure® device, but the forceps can be sterilized. In both cases, the electrical generator is a multipurpose generator, which can also be used for conventional monopolar or bipolar cautery.

The Harmonic® technology is based on an entirely different principle. It consists of a metal blade that vibrates at a frequency of 55 kHz (55,000 vibrations by second), i.e. in the ultrasound range. This blade generates heat, but especially denatures tissue proteins and consequently coagulates vessels between 5 and 7 mm in diameter. The radiofrequency used in medicine generally has a frequency of about 470 kHz, while microwaves (electromagnetic waves) have a frequency of about 300 MHz. The blade of one side vibrates and heats (at a temperature less than 100°C) while the other, heat-resistant surface protects more fragile structures from the vibrating blade.
protein denaturation ensures haemostasis of blood vessels as well as spontaneous section of coagulated tissues. One of the advantages of this technology is the absence of electric current that can cause damage to nerves. The Harmonic® generator only generates ultrasound vibrations.

Results of the literature

These technologies are now used routinely by many teams all over the world, resulting in a large number of good quality publications. Three teams have conducted meta-analyses of the data derived from prospective randomized trials and non-randomized trials [1–3]. These meta-analyses demonstrate that total thyroidectomy is significantly more rapid with these new technologies compared to conventional thyroidectomy comprising ligation, clips and monopolar and bipolar cautery. In all three meta-analyses, the Harmonic® device decreases the duration of total thyroidectomy by an average of 23 minutes or 25%, while the Ligasure® device decreases operating time by an average of 20 minutes. A recent retrospective comparison of these two technologies demonstrated a significant difference of 15 minutes in terms of operating room occupation time for total thyroidectomy, with the shortest operating time observed with the Harmonic® device [4]. In terms of operative morbidity, the Harmonic® device decreases the risk of transient postoperative hypocalcaemia by 31% compared to conventional thyroidectomy, possibly due to decreased manipulation of parathyroid glands or decreased heat diffusion compared to conventional haemostasis [1]. The Harmonic® device decreases blood loss during total thyroidectomy by an average of 20 ml, and postoperative pain and length of hospital stay are both significantly reduced [2]. According to these three meta-analyses, the Ligasure® device decreases postoperative pain, but without decreasing hypocalcaemia or blood loss [3].

Two prospective, randomized studies compared the two technologies [5,6]. Pons et al. demonstrated a significant 8-minute reduction of operating time with the Harmonic® device compared to the Ligasure device (P = 0.04). These two studies did not detect any significant difference between the two technologies in terms of postoperative complications, postoperative pain, blood loss, or length of hospital stay.

As the use of these haemostatic forceps in the vicinity of the recurrent laryngeal nerve cannot be assessed by a randomized, prospective study in man due to the risk of nerve damage, Jiang et al. conducted an experimental study in rabbits using the Harmonic® device at a medium power setting (level 3) close (1 to 5 mm) to the recurrent laryngeal nerve and for variable durations (1 to 5 seconds) [7]. The effect of surgery on recurrent laryngeal nerve latencies and conduction velocities was measured by electromyography and thermal damage to the tissues was assessed by histology. Nerve lesions were observed when haemostasis was performed less than 2 mm from the nerve (for the vibrating part of the forceps) for durations greater than 3 seconds. The authors concluded that this technology could be used for haemostasis close to the recurrent laryngeal nerve provided the vibrating blade was maintained more than 2 mm from the nerve and was activated for no more than 3 seconds.

The Harmonic® technology appears to present a number of advantages when neck dissection is indicated in the treatment of thyroid cancer. Miccoli et al. conducted a prospective, randomized study of 37 patients comparing selective dissection of level II–IV–V nodes by the conventional technique and dissection using the Harmonic® device [8]. The operating time was significantly decreased by an average of 11 minutes, and, most importantly, drainage (36 ml versus 6 ml, P < 0.01) and pain (P = 0.05) were both significantly decreased on day 2.

Medico-economic aspects

Although the surgical advantages have been clearly demonstrated, the economic value of these haemostatic technologies in thyroid surgery also needs to be addressed. An ‘‘Ace’’ type of Harmonic® device costs about 400 euros (according to a local agreement with the supplier) and a ‘‘Precise’’ type of Ligasure® device costs about 300 euros. The purchase price and amortization of generators must also be taken into account in the global cost. The sterilizable Optima® device costs about 800 euros according to a local agreement). A prospective, randomized medico-economic comparison was recently conducted by ENT and head and neck surgeons at Val de Grâce military hospital in Paris [5]. Sixty patients were randomized to three arms: conventional total thyroidectomy, thyroidectomy with Ligasure® technology, and thyroidectomy with Harmonic® technology. The three arms were comparable in terms of epidemiological characteristics and size of the thyroid. The total operating time was significantly decreased by an average of 29 minutes with Ligasure® and by an average of 37 minutes with Harmonic®. However, the cost of disposable items was higher in the new technology arms: an average of 375 dollars more for Ligasure® thyroidectomy and 407 dollars more for Harmonic® thyroidectomy. However, when the total cost was calculated and compared, Ligasure® thyroidectomy cost 11 dollars (about 8 euros) less than conventional thyroidectomy and Harmonic® thyroidectomy cost 85 dollars (about 65 euros) less than conventional thyroidectomy.

Conclusion

In conclusion, the surgical and medico-economic advantages of these haemostatic technologies have been demonstrated by various studies with a high level of proof. The clearly demonstrated major advantage is the significant reduction of the operating time, allowing optimization of operating room resources (or even allowing a greater number of procedures to be performed on the same operating list). Harmonic® technology also appears to provide an advantage in terms of a reduction of transient postoperative hypocalcaemia and pain. In the current medico-economic context, investment in these new technologies can provide a benefit to patients and to all actors of the health care system.
Disclosure of interest

The author declares that he has no conflicts of interest concerning this article.

References