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ORIGINAL ARTICLE

Harmonic Focus™ versus "knot tying" during total thyroidectomy: a randomized trial

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Abstract The objective of the study is to compare the outcome of total thyroidectomy (TT) using the Harmonic Focus™ (HF) versus conventional "knot tying" (KT) in terms of operative time, parathyroid function and post-operative complications. This prospective study was designed with a random allocation of subjects using a drawing technique. Eighty-one consecutive patients were submitted to TT in 2010 and randomly divided into two groups: 43 patients operated using HF (HF group) and 38 patients operated using KT (KT group). Parathyroid function was evaluated by parathyroid hormone (PTH) level at 1 h postoperatively and calcium level at first post-operative day. Indications for medical therapy were PTH < 15 pg/ml and/or calcium < 8.0 mg/dl and/or clinical signs or symptoms of hypocalcemia. Main outcomes were operative time, PTH and calcium levels, need for medical therapy and post-operative complications. Mean operative time was significantly lower in HF group compared with KT group (100 ± 34 vs. 119 ± 30 min). There were no significant differences concerning transient hypoparathyroidism requiring calcium and/or vitamin D therapy: 17 patients (39.5%) in HF group versus 21 (55.3%) in KT group. Five patients (11.6%) in HF group experienced symptomatic hypocalcemia versus 6 (15.8%) in KT group, without statistically significant difference. No patients experienced recurrent nerve injury. HF is a new ergonomic, reliable device developed for thyroid surgery. According to our results, HF is a safe, time-saving alternative to "knot tying" thyroidectomy, with no influence on parathyroid function, medical therapy and nerve injury.

Keywords Thyroid · Thyroidectomy · Harmonic Focus · Ultrasonic scalpel

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Introduction

Since Kocher and Billroth operative technique description, total thyroidectomy (TT) is nowadays a highly standardized procedure [1, 2]. In everyday surgical practice it is generally considered a routine operation with a low complication rate and extremely rare mortality, nonetheless it is technically demanding [3–5].

Basic surgical techniques have not changed for decades, but over the years innovative devices have been introduced to reduce operative time, hospitalization and eventually overall costs.

Many studies published in the literature have already focused on new haemostatic techniques employing instruments normally used in open and laparoscopic surgery versus conventional techniques, showing comparable results with regard to complications and shorter operative time [6–12]. Several authors have also cited their potential cost-effectiveness, but these results are still inconsistent [7, 8, 11, 12].

Harmonic Focus™ (HF) is the first device specifically designed for every procedure where meticulous dissection and effective haemostasis is of paramount importance, particularly in such a narrow operating field as in head and neck surgery.

Our goal was to determine the safety and feasibility of this new device applied in thyroid surgery compared to standard knot-tying (KT) procedure.

We designed a prospective randomized protocol to assess differences between two groups of patients submitted to total thyroidectomy (HF group vs. KT group) in terms of operative time and early post-operative complications.

Materials and methods

In 2010, eighty-one consecutive patients with benign or malignant thyroid disease, scheduled for total thyroidectomy in our Department of Surgery at Tor Vergata University Hospital, were prospectively included in the study. They were randomly divided into two groups, using a drawing technique: 43 patients (HF group) operated with the new device; 38 patients (KT group) with the conventional surgical technique (Table 1).

All patients were extensively informed about the surgical procedure and possible complications, giving their written consent preoperatively.

Exclusion criteria included the need for central and/or lateral compartment lymphadenectomy and concomitant parathyroid disorders.

All thyroidectomies were performed by an experienced endocrine surgeon, with a total bilateral extracapsular lobectomy. In the KT group the superior, middle and inferior thyroid vessels, together with other vascularized structures, were divided after being tied with conventional absorbable sutures (polyglactin 2/0 or 3/0). In the HF group division of vessels and structures was obtained using only the Harmonc Focus™ (Ethicon EndoSurgery, Cincinnati, OH, USA).

Further surgical steps were similar for KT and HF groups. Monopolar and bipolar electrocautery were used as accessory instruments. Recurrent laryngeal nerves and parathyroid glands were always identified. A suction drain for each thyroid side was placed after surgical procedure and removed on the first post-operative day.

Parathyroid function was evaluated by measuring parathyroid hormone (PTH) serum level at 1 h postoperatively and calcium serum level at first post-operative day in all patients. Indications for post-operative medical therapy with oral calcium and vitamin D (calcitriol) were PTH < 15 pg/ml and/or calcium < 8.0 mg/dl and/or clinical signs or symptoms of hypocalcemia. Patients with hypo-PTH or hypocalcemia received supplementation therapy even if asymptomatic.

Primary end-points were: operative time (from skin incision to skin closure), PTH and calcium levels and early post-operative complications. Secondary end-points were need for medical therapy and length of hospital stay.

Statistical analysis was performed using Student's t test for continuous variables and Fisher exact test for categorical variables. The results were expressed as mean ± SD if not stated otherwise. All tests were double-sided and the level of statistical significance was set at a p value of less than 0.05.

Table 1 Patients' demographics and preoperative diagnosis

	HF ($n = 43$)	KT ($n = 38$)	p value
Age (years) (mean ± SD)	49 ± 13	48 ± 15	ns
Gender, n (%)			ns
Male	9 (20.9)	4 (10.5)	
Female	34 (79.1)	34 (89.5)	
Thyroid malignancies, n (%)	28 (65.1)	27 (71.1)	ns
Thyroid volume, mL (mean ± SD)	47.7 ± 14.8	42.3 ± 17.2	ns

Results

The two groups were well matched for gender, age, pathology and thyroid volume (Table 1). Fifty-five patients had thyroid cancer: 28 (65.1%) in HF group versus 27 (71.1%) in KT group. Twenty-six patients had benign diseases: 15 (34.9%) in HF group versus 11 (28.9%) in KT group (Table 1).

Mean operative time was significantly lower in HF group compared with KT group (100 ± 34 vs. 119 ± 30 min, respectively; $p = 0.01$).

In HF group mean PTH level at 1 h postoperatively was 32.9 ± 21.2 pg/ml; mean calcium level at first post-operative day was 8.36 ± 0.54 mg/dl. In KT group mean values were 30.22 ± 22.31 pg/ml and 8.12 ± 0.56 mg/dl, respectively. This difference was not statistically significant. There were no significant differences between the two groups concerning transient hypoparathyroidism requiring calcium and/or vitamin D therapy: 17 patients (39.5%) in HF group versus 21 (55.3%) in KT group; $p > 0.05$. Five patients (11.6%) in HF group experienced symptomatic hypocalcemia versus six patients (15.8%) in KT group, without statistically significant difference ($p > 0.05$) (Table 2). One patient in KT group suffered from a prolonged symptomatic hypocalcemia which increased hospital stay.

There were no intra-operative complications for both groups. One post-operative bleeding requiring reoperation was observed in KT group; a single patient in HF group experienced wound haematoma treated conservatively with medical therapy. One slight transient unilateral hypomotility of the vocal cords was documented by indirect laryngoscopy in KT group; no patients experienced permanent recurrent nerve injury (Table 2).

Table 2 Comparison of the operative and post-operative results

	HF	KT	*p* value
Operative time (min) (mean ± SD)	100 ± 34	119 ± 30	0.01
PTH 1 h p.o. (pg/ml) (mean ± SD)	32.9 ± 21.2	30.22 ± 22.31	ns
Calcium, I p.o. day (mg/dl) (mean ± SD)	8.36 ± 0.54	8.12 ± 0.56	ns
P.o. medical therapy, *n* (%)	17 (39.5)	21 (55.3)	ns
Symptomatic hypocalcemia, *n* (%)	5 (11.6)	6 (15.8)	ns
P.o. haemorrhage (re-operation), *n* (%)	0	1 (2.6)	ns
Nerve injuries, *n*	0	0	–
Hospital stay, days (mean ± SD)	2.8 ± 1	2.9 ± 2	ns

Mean post-operative hospital stay was similar in both study groups (2.8 days in HF vs. 2.9 days in KT; $p > 0.05$) (Table 2).

Discussion

Thyroidectomy is one of the most frequently performed procedures in general surgery. It consists in devascularization of both lobes from thyroid vessels, followed by extracapsular excision of the gland. Results and patient outcomes are generally excellent; morbidity rate is very low and mortality is rare [3–5].

The thyroid is a highly vascularized organ, and therefore it is of primary importance to achieve good haemostasis to avoid post-operative haemorrhage which potentially causes patient's asphyxia and death [4, 13, 14]. Moreover, a meticulous dissection and a safe anatomical exposure are fundamental to avoid damage to important adjacent structures, such as the inferior laryngeal nerve and the parathyroid glands [4, 5, 14].

The most common complications are recurrent nerve palsy, which varies from 0 to 23%, and post-operative hypoparathyroidism, which may reach 63% in terms of transient asymptomatic hypocalcemia following total thyroidectomy [15].

Since the development of a standardization of thyroidectomy, the basic surgical techniques have changed a little. Traditional surgery involves hand-tied ligatures to control the two ends of a vascular structure before division; this procedure is safe in terms of complications, but requires a large number of surgical ligatures and therefore is time-consuming [16].

Other common devices available for thyroid surgery are mono or bipolar diathermy, which use electric energy applied directly to the soft tissue, and metal clips.

However, electrosurgical instruments, especially monopolar diathermy, are unsafe in thyroid surgery because of the risk of damaging the surrounding structures from lateral thermal spread, which can reach 400°C; bipolar diathermy is useful near recurrent nerves, but less versatile in other surgical steps [17, 18]. Instead clips have no enough efficacy for thin vessels and are subjected to dislodgment [13]. In other terms, none of them is fully applicable in thyroid surgery.

During the last decades many devices have been introduced into clinical practice aiming to facilitate surgical procedures, and ultrasonically activated shears are an example. These instruments employ mechanical energy for simultaneous coagulation and tissue cutting. The active blade vibrates at 55.5 kHz, dividing tissue by breaking down hydrogen bonds and denaturing proteins at temperatures ranging from to 50 to 100°C, causing less injury to the surrounding tissue than either electrosurgical devices [19, 20].

Today the Harmonic Scalpel (HS) is widely used in several fields of surgery [21–23], in laparoscopic and open technique [24, 25]; it has proven to be a safe and useful device in neck surgery [11, 26], but some surgeon consider this tool to be cumbersome for fine dissection.

The HF is a new device characterized by lesser weight and smaller size compared to previous shears; the thin and curved tip, associated to the ergonomic shape and consequent handiness, guarantees precise and safe dissection, very useful for thyroid surgery.

In our study, the use of the HF was associated to a statistically significant reduction in operative time, with a mean advantage of 20 min for each surgical procedure, according to other recent series [27].

Haemostasis with HF is quick and effective, and we did not observe any post-operative haemorrhage in HF group.

Primary end-points of this study included the potential impairment of recurrent laryngeal nerves and parathyroid glands. In the literature there are several articles which evaluated these aspects, with conflicting results [9–11, 28, 29]; although most of them reported similar incidence of such complications using ultrasonic dissector compared to knot tying (KT) surgery, an increased rate is described by some authors in the new technology groups. Marchesi et al. [29] showed an increased risk for transient paresis associated with the HS compared to standard surgery. Sartori et al. [9] noticed a significant greater incidence in

hypoparathyroidism in the HS group; moreover, they had also a significantly lower calcemia than the conventional technique. Prgomet et al. [28] showed similar results in their series.

Regarding recurrent laryngeal nerves, we did not observe any temporary or permanent injury in HF group, whereas we had one single case of slight transient unilateral hypomotility of vocal cord in KT group. To minimize this risk, we use to irrigate the surgical field with physiologic saline solution during coagulation near the nervous structures, reducing in this way the local temperature and consequently potential thermal damages.

In our series there were no statistical significant differences about PTH levels 1 h postoperatively and calcium level at first post-operative day between HF and KT groups, which were considered as effective parameters to evaluate glandular preservation by scientific community [30–32].

According with other studies, the post-operative hospital stay was not influenced by surgical technique in our series [8, 11]; the mean length of stay for patients of HF group was similar, without statistical differences, to those of KT group.

Globally considering the potential complications of total thyroidectomy, our results show that the HF is a reliable and safe device, without increased incidence of injuries or haemorrhage compared to knot tying technique.

One of the main criticisms to the use of the HF is the excessive cost of this device. However, several studies showed that when overall surgery and hospital stay charges were take into account, it was possible to regain the overcharge of the ultrasonic dissector [7, 8, 12]. The reduction of operative times might allow to reduce operating room occupancy costs. Lombardi et al. [12] suggested a better utilization of health resources and a potential significant reduction of the waiting list using the ultrasonic dissector during thyroidectomy.

In this study we did not evaluate systematically the global costs for this kind of surgery, due to objective difficulties in data collection; anyway, making a global appraisal of health charges, we could confirm cost-effectiveness of the HF in thyroid surgery. However, future systematic analysis of fixed and variable costs is needed to provide accurate data on total charge for National Health System.

Conclusions

According to our results, the HF is a reliable, comfortable and safe instrument alternative to knot tying technique, very suitable hand-piece for total thyroidectomy. It creates a clean, bloodless surgical field, and there is an advantage for the surgeon to use a single tool for both dissection and haemostasis.

Moreover, the HF is a time-saving option, allowing for a significant reduction of operative time, without affecting parathyroid function, need for medical therapy, recurrent nerve injury and haemostasis in the early post-operative period.

Conflict of interest The authors declare that they have no conflict of interest.

References

1. Kocher T (1883) Uber kropfextirpation und ihre Folgen. Arciv fur Klinische Chirurgie 29:254–337
2. Delbridge L (2003) Total thyroidectomy: the evolution of surgical technique. ANZ J Surg 73:761–768
3. Koyuncu A, Dokmetas HS, Turan M et al (2003) Comparison of different thyroidectomy techniques for benign thyroid disease. Endocr J 50:723–727
4. Bliss RD, Gauger PG, Delbridge LW (2000) Surgeon's approach to the thyroid gland: surgical anatomy and the importance of technique. World J Surg 24(8):891–897
5. Kekis PB, Smith SGT, Lynn JA et al (2007) Complications in endocrine surgery. In: Hakim NS, Papalois VE (eds) Surgical complications. Diagnosis and treatment. Imperial College Press, London, pp 505–566
6. Voutilainen PE, Haglund CH (2000) Ultrasonically activated shears in thyroidectomies: a randomized trial. Ann Surg 231:322–328
7. Ortega J, Sala C, Flor B et al (2004) Efficacy and cost-effectiveness of the Ultracision harmonic scalpel in thyroid surgery: an analysis of 200 cases in a randomized trial. J Laparoendosc Adv Surg Tech A 14:9–12
8. Manouras A, Markogiannakis H, Koutras AS et al (2008) Thyroid surgery: comparison between the electrothermal bipolar vessel sealing system, harmonic scalpel, and classic suture ligation. Am J Surg 195(1):382–384
9. Sartori PV, De Fina S, Colombo G et al (2008) Ligasure versus Ultracision in thyroid surgery: a prospective randomized study. Langenbecks Arch Surg 393:655–658
10. Hallgrimsson P, Lovén L, Westerdahl J et al (2008) Use of the harmonic scalpel versus conventional haemostatic techniques in patients with Grave disease undergoing total thyroidectomy: a prospective randomised controlled trial. Langenbecks Arch Surg 393:675–680
11. Miccoli P, Berti P, Dionigi GL et al (2006) Randomized controlled trial of harmonic scalpel use during thyroidectomy. Arch Otolaryngol Head Neck Surg 132(10):1069–1073
12. Lombardi CP, Raffaelli M, Cicchetti A et al (2008) The use of "harmonic scalpel" versus "knot tying" for conventional "open" thyroidectomy: results of a prospective randomized study. Langenbecks Arch Surg 393:627–631
13. Maheswaran I, Isla A, Lynn J et al (2007) Haemostasis in endocrine surgery. In: Hakim NS, Canelo R (eds) Haemostasis in surgery. Imperial College Press, London, pp 189–211
14. Reeve T, Thompson NW (2000) Complications of thyroid surgery: how to avoid them, how to manage them, and observations on their possible effect on the whole patient. World J Surg 24(8):971–975
15. Rosato L, Avenia N, Bernante P et al (2004) Complications of thyroid surgery: analysis of a multicentric study on 14, 934

patients operated on in Italy over 5 years. World J Surg 28:271–276
16. Kennedy JS, Stranahan PL, Taylor KD et al (1998) High-burst-strength, feedback-controlled bipolar vessel sealing. Surg Endosc 12(6):876–878
17. Carlander J, Johansson K, Lindstrom S et al (2005) Comparison of experimental nerve injury caused by ultrasonically activated scalpel and electrosurgery. Br J Surg 92(6):772–777
18. Diamantis T, Kontos M, Arvelakis A et al (2006) Comparison of monopolar electrocoagulation, bipolar electrocoagulation, Ultracision, and Ligasure. Surg Today 36(10):908–913
19. Anonymous. Ultracision Harmonic Scalpel user's manual. Ehticon Endosurgery, Cincinnati 2001
20. McCarus SD (1996) Physiologic mechanism of the ultrasonically activated scalpel. J Am Assoc Gynecol Laparosc 3:601–608
21. Gertsch P, Pelloni A, Guerra A, Krpo A (2000) Initial experience with the harmonic scalpel in liver surgery. Hepatogastroenterology 47:763–766
22. Ohtsuka T, Wolf RK, Wurnig P et al (1998) Thoracoscopic limited pericardial resection with an ultrasonic scalpel. Ann Thorac Surg 65:855–856
23. Aoki T, Kaseda S (1999) Thoracoscopic resection of the lung with the ultrasonic scalpel. Ann Thorac Surg 67:1181–1183
24. Amaral JF (1994) The experimental development of an ultrasonically activated scalpel for laparoscopic use. Surg Laparosc Endosc 4:92–99
25. Maruta F, Sugiyama A, Matsushita K et al (1999) Use of the Harmonic Scalpel in open abdominoperineal surgery for rectal carcinoma. Dis Colon Rectum 42:540–542
26. Karvounaris DC, Antonopolous V, Psarras K et al (2006) Efficacy and safety of ultrasonically activated shears in thyroid surgery. Head Neck 28:1028–1031
27. Miccoli P, Materazzi G, Miccoli M et al (2010) Evaluation of a new ultrasonic device in thyroid surgery: comparative randomized study. Am J Surg 199:736–740
28. Prgomet D, Janjanin S, Bilić M et al (2009) A prospective observational study of 363 cases operated with three different harmonic scalpels. Eur Arch Otorhinolaryngol 266(12): 1965–1970
29. Marchesi M, Biffoni M, Cresti R et al (2003) Ultrasonic scalpel in thyroid surgery. Chir Ital 55(2):299–308
30. Grodski S, Serpell J (2008) Evidence for the role of perioperative PTH measurement after total thyroidectomy as a predictor of hypocalcemia. World J Surg 32(7):1367–1373
31. Gentileschi P, Gacek IA, Manzelli A et al (2008) Early (1 hour) post-operative parathyroid hormone (PTH) measurement predicts hypocalcaemia after thyroidectomy: a prospective case-control single-institution study. Chir Ital 60(4):519–528
32. Wong C, Price S, Scott-Coombes D (2006) Hypocalcaemia and parathyroid hormone assay following total thyroidectomy: predicting the future. World J Surg 30(5):825–832