Sutureless thyroidectomy for controlled toxic goiter: a single-institute experience

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Background
Total thyroidectomy for controlled toxic goiter is usually associated with more bleeding because of high vascularity of the toxic gland. Several new instruments were developed as hemostatic tools (harmonic scalpel; LigaSure) during total thyroidectomy as an alternative to conventional hemostatic methods. This study aimed to compare the use of Harmonic Focus Scalpel to conventional hemostatic technique (classic suture ligation with standard bipolar diathermy forceps) in patients with controlled toxic goiter undergoing total thyroidectomy regarding operative time, intraoperative complications, postoperative complications, postoperative hospital stay, and return to normal daily activities.

Patients and methods
The present study included 50 patients with a diagnosis of controlled toxic goiter who underwent total thyroidectomy at the Department of Surgery, Medical Research Institute Hospital, Alexandria University. Candidates were randomized into two groups: group A, in which patients underwent total thyroidectomy using Harmonic Focus Scalpel, and group B, in which patients underwent total thyroidectomy using classic suture ligation and standard reusable bipolar diathermy.

Results
There was no significant difference between both groups regarding preoperative data (age, sex, comorbidities, and type of thyrotoxicosis). The operative time was significantly shorter in group A patients compared with group B patients ($P<0.001$). Both groups were comparable to each other with regard to intraoperative blood loss, postoperative transient and permanent vocal cord paresis, transient and permanent hypocalcemia, postoperative hematomas and bleeding requiring surgery, hospital stay, timing of drain removal, and return to normal daily activities.

Conclusion
Harmonic Focus Scalpel can be used safely and effectively as a hemostatic tool instead of conventional hemostatic techniques in total thyroidectomy for controlled toxic goiter.

Keywords:
harmonic scalpel, hypocalcemia, sutureless thyroidectomy, toxic goiter, vocal cord paresis

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Introduction

Total thyroidectomy is the most commonly performed operation in the field of endocrine gland surgery. It is the optimum treatment for many thyroid disorders [1,2]. Thyroidectomy in thyrotoxic patients has a special difficulty because of high vascularity of the thyroid gland with an increased risk of intraoperative and postoperative bleeding [3,4]. During thyroid surgery, traditional hemostasis is performed through suture ligation with clamp-and-tie technique with or without electrocoagulation. Clamp-and-tie technique is time-consuming; moreover, slippage of ligature may occur. Electrocoagulation is associated with heat dispersion and increased risk of injury to important nearby structures [5,6]. The introduction of harmonic scalpel (HS) in the early 1990s was a great technical advance [7]. It coagulates and cuts vessels and tissues at the same time without the need for classic suture ligation [8]. The mechanism of action depends on the use of ultrasound vibration of a blade at 55 Hz over a distance of 80 μm. In the present study, we compared the use of Harmonic Focus Scalpel with conventional hemostatic technique (classic suture ligation with standard bipolar diathermy forceps) in total thyroidectomy for patients with controlled toxic goiter regarding operative time, intraoperative complications, postoperative complications, postoperative hospital stay, and return to normal daily activities.

Study design

This was a prospective randomized controlled study. The present study included 50 patients with a diagnosis of controlled toxic goiter who underwent total thyroidectomy

at the Department of Surgery, Medical Research Institute Hospital, Alexandria University. Patients were considered eligible for the study after thorough history taking, clinical examination, laboratory investigations (routine tests, thyroid function tests, and plasma calcium level) and radiologic evaluation (neck ultrasonography). All patients received antithyroid drugs, and were euthyroid and normocalcemic before surgery. Preoperative indirect laryngoscopy was performed for each patient in the study before surgery for assessment of vocal cord mobility. Patients were divided into two groups: group A (25 patients who underwent total thyroidectomy using Harmonic Focus Scalpel) and group B (25 patients who underwent total thyroidectomy using classic suture ligation and standard reusable bipolar diathermy for hemostasis). Patients with recurrent toxic goiter, preoperative hypocalcemia, vocal cord disorders, and those with uncontrolled thyrotoxicosis were excluded from the study.

Ethics

All patients signed an informed consent before inclusion in the study. This consent was approved by our institution's ethics committee and included thorough information about the surgery and the possible complications.

Endpoints

Primary endpoints

The primary end points were postoperative bleeding, permanent recurrent laryngeal nerve injury permanent hypocalcemia in the two groups of patients.

Secondary endpoints

Secondary endpoints included (i) operative and postoperative parameters (operative time, intraoperative blood loss, and postoperative complications), (ii) duration of hospital stay, (iii) and timing of return to normal daily activities.

Randomization method

Eligible candidates were randomized into two groups: group A (underwent total thyroidectomy using Harmonic Focus Scalpel) and group B (underwent total thyroidectomy using classic suturing and standard reusable bipolar diathermy). Randomization was done using computer-generated random numbers contained in sealed opaque envelopes. Randomization was performed during preoperative assessment (10 days before surgery).

Surgical techniques

All patients underwent total thyroidectomy under general anesthesia with endotracheal intubation. All patients were placed in supine position with neck extension. Neck extension was optimized through placement of a pillow behind the shoulders and a head ring for head support. A standard Kocher's incision, 5–8 cm in length, was used. Subplatysmal flaps were developed with separation of strap muscles in the midline using monopolar diathermy to expose the thyroid gland. In group A, Ultracision Harmonic Focus Scalpel (Ethicon EndoSurgery, Cincinnati, Ohio, USA) was used for simultaneous coagulation and cutting. In the present study, power level 2 was used when dividing larger vessels such as superior, inferior thyroid arteries and veins, whereas level 5 was used with smaller vessels such as capsular veins. No sutures were used in this group of patients. Superior thyroid vessels were divided in branches close to the gland to avoid damage to the external laryngeal nerve. In group B, hemostasis was performed using suture ligation with Vicryl 3/0 (polyglactin 910 suture, violet braided; Ethicon EndoSurgery) and reusable standard bipolar diathermy forceps with tips 1 mm in diameter, using the Force FX Electrosurgical Generator (Valleylab, Boulder, Colorado, USA) at a power setting of 10 W. Large vessels such as superior thyroid vessels, inferior thyroid vessels, and middle thyroid veins were ligated with Vicryl 3/0 (Ethicon EndoSurgery) and cut. All other vessels were cauterized using bipolar diathermy. Structures were lifted away from laryngeal nerves by spreading arteries underneath before cauterization to limit heat transmission to nerves; this technique was also used before the use of HS in group A patients. Closed negative suction drains [PRI-LOW-VAC (two XDrain/one xTrocar), 500 ml, number 12; Primed, Halberstadt, Medizintechnik, Germany] were used routinely for all patients in the study (only one limb of the drain was used), strap muscles were approximated using Vicryl 3/0 (Ethicon EndoSurgery) and platysma muscle was repaired using Vicryl 3/0. The skin was closed with subcuticular sutures using Monocryl 4/0 (poliglecaprone 25 suture, undyed monofilament; Ethicon EndoSurgery).

Postoperative course

Operative data of each patient were recorded with stressing upon operative time, intraoperative blood loss and intraoperative complications. The used gauzes were weighted before and after use to estimate the amount of intraoperative blood loss (1 g was considered to be equal to 1 ml of blood). Furthermore, if suction was used, the amount of suctioned blood was also recorded. Postoperative data recording included assessment of postoperative complications, time of drain removal, hospital stay, and time of return to normal daily activities. All patients underwent vocal cord examination using

indirect laryngoscopy on the night of the same operative day. Follow-up of patients with vocal cord injury was performed every month for detection of return of vocal cord mobility. Persistence of vocal cord injury for more than 6 months was defined as permanent vocal cord injury [9]. In the current study, calcium infusion was given routinely in the first postoperative day followed by prophylactic oral calcium plus vitamin D for 2 weeks [10–12]. Postoperative serum calcium was measured only if the patient developed hypocalcemic symptoms. Patients with hypocalcemia were followed up with serum calcium monthly for 6 months for possibility of return of normal serum calcium level after which the patient was considered to have permanent hypocalcemia. Hypocalcemia was defined as serum calcium less than 8.5 mg/dl (lower limit of our institutional reference range) [13] with development of hypocalcemic symptoms [14–16]. Permanent hypocalcemia was defined as persistence of hypocalcemia with need for calcium sup plementation lasting for 6 months or more [13]. Bleeding and hematomas were detected clinically. Drains were removed when the amount of discharge is 15 ml or less and the color is mainly serous, and patients were discharged from the hospital after removal of their drains.

Follow-up

All patients were followed up at 7 days, 1 month, and 6 months after the operation at the outpatient clinic for assessment of complications and return to normal daily activities. Patients with hypocalcemia or vocal cord dysfunction were followed up every month for better assessment.

Results

There was no significant difference between both groups regarding preoperative data, as shown in Table 1. The operative time was significantly shorter in group A patients compared with group B patients, as shown in Table 2 ($P<0.001$). No statistically significant difference was found between both groups regarding intraoperative blood loss, number of identified parathyroid glands, and weight of thyroid glands, as shown in Table 2. There were no intraoperative major vascular (carotid artery or internal jugular vein) or visceral injury (esophagus and trachea) in either group. There was no significant difference between both groups regarding postoperative complications (transient and permanent vocal cord paresis, transient and permanent hypocalcemia, and postoperative hematomas), timing of drain removal, postoperative hospital stay, and return to normal daily activities, as shown in Table 3. In group A, two (8%) patients developed postoperative hematomas, which were mild and resolved with conservative treatment [hot fomentation, Extrauma Forte Gel (topical r-hirudin 420 IU) and oral antibiotic]. In group B, postoperative hematomas occurred in three (12%) patients: two (8%) patients developed mild hematomas after removal of their drains and were managed conservatively and one (4%) patient presented with suffocation, cyanosis, and large hematoma about 6 h after operation; this patient was reoperated urgently for control of bleeding and to secure the patent airway – the source of bleeding was slippage of ligature from the anterior branch of the superior thyroid artery. Figure 1 shows Harmonic Focus Scalpel shear and its use in total thyroidectomy for a patient with controlled multinodular toxic goiter in the present study.

Table 1 Preoperative assessment of both groups

	Group A (n=25)	Group B (n=25)	Test of significance	P
Age (years)				
Minimum–maximum	21–57	25–55	t=0.205	0.839
Mean±SD	39.6±10.8	39±11.3		
Sex				
Male	3 (12)	4 (16)	χ^2=0.166	^{FE}P=1.000
Female	22 (88)	21 (84)		
Type of thyrotoxicosis				
Graves' disease	15 (60)	15 (60)	χ^2=0.162	^{MC}P=1.000
Toxic multinodular goiter	8 (32)	8 (32)		
Solitary toxic goiter	2 (8)	2 (8)		
Normocalcemia	25 (100)	25 (100)	–	–
Euthyroid	25 (100)	25 (100)	–	–
Comorbidities				
Hypertension	3 (12)	4 (16)	χ^2=0.166	^{FE}P=1.000
DM	3 (12)	2 (8)	χ^2=0.222	^{FE}P=1.000
Cardiac	1 (4)	0 (0)	χ^2=1.020	^{FE}P=1.000

Qualitative data were described as n (%) and was compared using χ^2, Monte–Carlo, or Fisher's exact test. Normally quantitative data were expressed as mean±SD and compared using Student's t-test. DM, diabetes mellitus; FE, Fisher's exact test.

Table 2 Operative data of both groups

	Group A (*n*=25)	Group B (*n*=25)	Test of significance	*P*
Operative time (min)				
Minimum–maximum	60–120	45–140	*t*=3.797*	<0.001*
Mean±SD	76.9±15.1	97.3±22.1		
Operative bleeding (ml)				
Median (minimum–maximum)	90 (40–220)	80 (40–250)	*Z*=0.146	0.884
Mean±SD	103.1±52.3	102.3±54.6		
Number of identified parathyroid glands				
Median (minimum–maximum)	3 (2–5)	4 (2–5)	*Z*=0.609	0.543
Mean±SD	3.4±0.9	3.5±0.8		
Weight of thyroid glands (g)				
Median (minimum–maximum)	60 (20–120)	50 (20–120)	*Z*=0.243	0.808
Mean±SD	61.6±26.9	60.4±29.5		

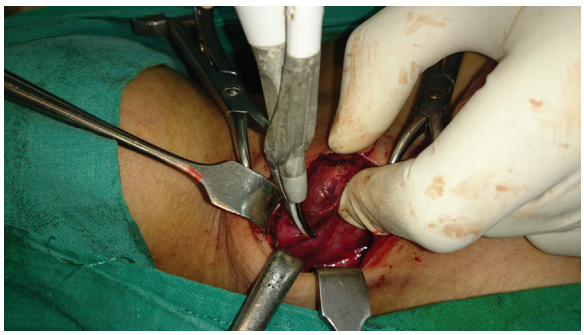
Normally quantitative data were expressed as mean±SD and compared using Student's *t*-test, whereas abnormally distributed data were expressed using median (minimum–maximum) and were compared using Mann–Whitney test. *Statistically significant at $P \leq 0.05$.

Table 3 Postoperative data of both groups

	Group A (*n*=25)	Group B (*n*=25)	Test of significance	*P*
Postoperative complications				
Recurrent laryngeal nerve injury				
Transient	1 (4)	1 (4)	χ^2=0.000	^{FE}P=1.000
Permanent	1 (4)	0 (0)	χ^2=1.020	^{FE}P=1.000
Hypocalcemia				
Transient	4 (16)	3 (12)	χ^2=0.166	^{FE}P=1.000
Permanent	1 (4)	1 (4)	χ^2=0.000	^{FE}P=1.000
Hematoma	2 (8)	3 (12)	χ^2=0.222	^{FE}P=1.000
Drain removal (h)				
Median (minimum–maximum)	48 (24–72)	48 (24–72)	*Z*=0.951	0.342
Mean±SD	42.3±14.3	38.4±13.9		
Hospital stay (days)				
Median (minimum–maximum)	2 (1–3)	2 (1–3)	*Z*=0.951	0.342
Mean±SD	1.8±0.60	1.6±0.6		
Return to normal daily activities (days)				
Median (minimum–maximum)	10 (7–21)	9 (7–21)	*Z*=1.326	0.185
Mean±SD	11.4±3.7	10.6±3.9		

Qualitative data were described as *n* (%) and were compared using χ^2 or Fisher's exact test. Abnormally distributed data were expressed using median (minimum–maximum) and were compared using Mann–Whitney test. FE, Fisher's exact test.

Figure 1



A 45-year-old female patient with controlled multinodular toxic goiter during total thyroidectomy using Harmonic Focus Scalpel.

Discussion

In the present study, the use of Harmonic Focus Scalpel significantly reduced operative time compared with conventional hemostatic tools ($P<0.001$), which was also reported by Hallgrimsson *et al.* [17]. In the study by Hallgrimsson *et al.* [17], all patients had a diagnosis of Graves' disease, were euthyroid before surgery and underwent total thyroidectomy. This study included 27 patients in the HS group and 24 patients in the conventional group. The two groups were comparable to each other regarding recorded preoperative variables. The operating time was shorter in the HS group (median: 121 min; range: 84–213 min) compared with the conventional group (median: 172 min; range: 66–268 min; P=0.011). Contin *et al.* [18], in a meta-analysis of 35 studies, discovered that operating time for thyroidectomy using harmonic devices was significantly shorter compared with conventional techniques. Significant faster operative time with the use of HS was also confirmed by

others [19,20]. Faster operative time with the use of Harmonic Focus Scalpel is expected, as it can be used for dissection, coagulation, and cutting so that it decreases the use, change of surgical instruments, and saves time of suturing, clipping, and cutting as in conventional thyroidectomy. In the present study, there was no significant difference between both groups regarding intraoperative blood loss. The same results were recorded by Hallgrimsson *et al.* [17] in their study as they found no difference in operative bleeding between both groups; blood loss in the HS group ranged between 16 and 279 ml, with a median of 69 ml, whereas in conventional thyroidectomy it ranged between 20 and 290 ml, with a median of 79 ml (P=0.42). Cheng *et al.* [21] conducted a meta-analysis of 14 randomized controlled studies comparing Harmonic Focus Scalpel with conventional hemostatic techniques in thyroidectomy; intraoperative blood loss was reported in six studies [22–27], mean intraoperative blood loss was 75.34 ml in the conventional technique compared with 29.84 ml in the Harmonic Focus Scalpel technique and mean intraoperative blood loss was statistically significantly reduced by 45.54 ml, a 60.4% decrease with the use of Harmonic Focus Scalpel compared with conventional hemostatic techniques in total thyroidectomy. Results of this meta-analysis were different from our results, and the mean intraoperative blood loss was significantly less regarding both HS and conventional hemostatic groups. Our explanation is that meta-analysis included different types of goiters (benign, malignant, toxic) and the percentage of toxic goiters is not declared in the study. It is well known that toxic thyroid is more vascular than the nontoxic gland, and thyroidectomy for toxic goiter is associated with more bleeding; moreover, this meta-analysis did not declare whether completely sutureless technique was used in the HS group or not, as hemostatic techniques using HS differ from one author to another. Some authors use ligatures or clips close to recurrent laryngeal nerve and parathyroid glands, and others use ligatures for ligation of upper pole and others use HS as the sole hemostatic tool without any ligatures or clips (completely sutureless technique). In our opinion, to avoid any bias the population of the study has to be homogeneous, and the technique of hemostasis and the indication for thyroidectomy have to be standardized. In the present study, there was no significant difference between both groups regarding transient and permanent vocal cord paresis. The same results were reported by other several studies [22–33]. The use of HS close to recurrent laryngeal nerve had been evaluated by several studies, which reported that the effect of harmonic use on the nerve is similar to the use of scalpel when used up to 2 mm away from the nerve [34]. Other studies reported that the use of HS was associated with an increased risk of transient vocal cord paresis compared with conventional techniques [17,35], but no difference regarding permanent vocal cord paresis was reported. This may be attributed to the lack of experience and familiarity of operating surgeons with the use of HS or improper dissection of recurrent laryngeal nerves. In the current study, there was no significant difference between both groups regarding transient and permanent hypocalcemia. Several authors [26,29,31–33] reported a lower rate of transient hypocalcemia associated with the use of HS compared with conventional techniques, with no significant difference between both groups regarding permanent hypocalcemia. Lower rate of transient hypocalcemia in these studies may be attributed to more shorter operative time, as hypocalcemia does not only result from unintended damage to the parathyroid glands or their blood supply but also as a systemic response to longer and more involved surgical procedures. Results of the present study regarding transient hypocalcemia were reported by other studies [20,22,24,27,30]. Hallgrimsson *et al.* [17] in their study reported a higher rate of transient hypocalcemia in the HS group compared with the conventional group, with no difference between both groups regarding persistent hypocalcemia. In our opinion, different results from one study to another regarding transient hypocalcemia may be attributed to experience of the surgeon and familiarity with the use of HS; moreover, the majority of the studies comparing HS with conventional hemostatic techniques in total thyroidectomy include a heterogeneous group of patients with different indications for total thyroidectomy, which may influence ease of the procedure, extent of surgical dissection, manipulations, and therefore influence transient hypocalcemia; moreover, certain thyroid pathologies such as toxic goiters may be associated with a higher incidence of hypocalcemia because of development of bone hunger syndrome [36–38]. Conventional hemostatic techniques used in different studies close to parathyroid glands vary greatly to include clamp-and-tie technique and electrocauterization (either bipolar or monopolar diathermy), and others use vascular clips; we believe that this difference may influence the incidence of transient hypocalcemia, as electrocauterization may be associated with heat transmission to parathyroid glands if not used cautiously. In the present study, there was no significant difference between both groups regarding incidence of postoperative hematomas or bleeding requiring surgery. The same results were reported by several studies [20,22,26,29–31,33]. In the current study, both groups were comparable to each other regarding postoperative hospital stay; the same results

were reported by other studies [20,23]. Several authors [24–26,32] reported a significant reduction in the length of postoperative hospital stay in the HS group compared with the conventional hemostatic technique group. These different results regarding postoperative hospital stay may be attributed to different results regarding overall operative and postoperative complications from one author to another.

Conclusion and recommendations

Meticulous hemostasis and proper dissection during total thyroidectomy is of utmost significance so as to avoid injury to important nearby structures and thus decrease morbidity of the procedure. Harmonic Focus Scalpel can be used safely and effectively as a hemostatic tool instead of conventional hemostatic techniques in total thyroidectomy for controlled toxic goiter with a significant reduction in operating time and without increase in overall operative and postoperative complications. Further studies with a larger number of patients are required to study the use of HS in patients with controlled toxic goiter and to calculate overall costs of the procedures when performed with HS.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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