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ORIGINAL ARTICLE

A Comparative Study Between Harmonic Scalpel and Classical Knot Tying in Total Thyroidectomy

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ABSTRACT

Background: Total thyroidectomy is the most common endocrine surgery performed in hospitals worldwide. Thyroid gland is a highly vascularized structure and has a rich supply therefore; delicate techniques must be used in its excision. Classical techniques have been used for decades with adequate outcomes but have been associated with numerous dismal complications. The use of harmonic scalpel in thyroid surgery made a breakthrough by decreasing these complications. This study aims to compare two techniques (Harmonic scalpel vs. Classical techniques) by measuring the differences in duration of operative time, amount of blood loss, and other inadvertent complications.

Methods: This is a prospective observational cross-sectional study in which 80 patients were included and operated on at Azadi Teaching Hospital, Kirkuk, Iraq. They were divided into two equal groups, group harmonic scalpel (40 patients) that had total thyroidectomy by harmonic scalpel and group classical techniques (40 patients) that had total thyroidectomy by classical techniques by means of electrocautery and knot-tying.

Results: Harmonic scalpel group showed a significant reduction in operative time (p value = 0.004), amount of intra-operative blood loss (p value <0.001), postoperative fluid drainage (p value <0.001) while there were no significant differences between the two groups in risk of laryngeal nerve injury or length of hospital stay.

Conclusion: Focused harmonic scalpel was an effective and reliable technique in performing safe total thyroidectomies and had the advantages over other classical techniques in reducing the operative time, amount of intra-operative blood loss, postoperative fluid drainage with parallel other postoperative complications.

Key words: Harmonic scalpel; Conventional techniques; Total thyroidectomy.

INTRODUCTION

Thyroidectomy became an adequate and safe procedure near the beginning of 20th century with emergence of antiseptic techniques, general anesthesia and hemostatic methods. Newer approaches and techniques were introduced which became the fundamentals for safe and prudent thyroid surgery practiced by trained general and endocrine specialist surgeons [1, 2].

The following terminologies are appropriate to describe thyroid surgery: Total thyroidectomy (TT), is the excision of all the visible thyroidal tissues; Near-total thyroidectomy, is the resection of all thyroidal tissues except for a small remnant (less than 1 g) on only one side near recurrent laryngeal nerve (RLN) at the Berry's ligament; Subtotal thyroidectomy, excision of thyroidal tissues while leaving remnants bilaterally [3].

Total thyroidectomy has become the standard procedure for many surgeons in the last two decades as it eliminates the risk of redo operations from recurrences as well as it does not increase inadvertent complications in skilled hands [4].

Since the thyroid gland is highly vascular and has a rich blood supply, hemostasis is paramount during the procedure for effective identification of the surrounding structures such as laryngeal nerves and parathyroid glands and to obtain merely a bloodless field. Most of these bleeders and oozes are from the parenchyma and thyroidal vessels [5, 6].

Conventional hemostasis is achieved through classical methods in forms of ligation by sutures as in clamp and knot tying, electrocauterization, or a combination of the two. None of them have appealing results in the modern surgical era because the former prolongs operative time and has the probability of knot slipping. The latter has its own repercussions due to its potential for injuring the adjacent structures through heat flux and dispersion [7].

Meticulous hemostasis became a necessity in thyroid surgery with innovation of newer surgical technical devices such as bipolar diathermy, ultrasonic shearing, and harmonic vessel sealing devices [8].

HS shearing device was first invented in 1998. It uses ultrasonic energy at a vibration rate of 55.5 kHz in a dissection method called "Ultrasicon". It has two blades; one is active which delivers high shearing force and the other inactive holding tissue in place. It has the capability of simultaneous coagulation and cutting for vessels of up to 5 mm in diameter by denaturation of coagulated protein by pressure and then denaturation of H+ bonds by shearing forces. It causes less lateral thermal injury (1-3 mm versus 3-6 mm wide for bipolar diathermy) and generates lower temperature (50-1000 C versus 150-4000 C for electrocautery). It also has the advantage of excluding the patient as a part of the current circuit, no any neuromuscular stimulation and lesser degree of smoke generation among all other devices [9–12].

MATERIALS AND METHODS

This study is a prospective observational cross-sectional study comparing harmonic scalpel (HS) and conventional techniques (CT) for TT. It was conducted at Azadi Teaching Hospital, Kirkuk City over a period of 10 months from 1st of March 2021 till 10th of January 2022. The study enrolled 80 patients who were planned for TT in the elective operating rooms on the 1st floor of the hospital by multiple general surgeons.

The patients were divided equally into two groups: the HS group (40 patients) in whom the harmonic scalpel was used for hemostasis and the CT group (40 patients) in whom conventional techniques such as knot tying and electrocautery were used.

All the patients were included in this study regardless of their provisional pathology and those who were excluded from the research were the following: Previous neck surgery, recurrent goiter, retrosternal goiters, necessity for central or lateral lymph node (LN) dissection, patients who underwent previous subtotal or near-total thyroidectomy, previous neck irradiation, patients who were treated previously with radioactive iodine, patients with known or documented blood dyscrasias and preoperative vocal cord palsy.

A detailed questionnaire was designed to collect demographic information as well as peri-operative data such as (the type of technique which is used whether HS or CT, duration of surgery in minutes from incision of skin till closure, intraoperative blood loss in ml, any postoperative hoarseness or stridor for laryngeal injuries, postoperative fluid drainage in the first 24 hours, operation date and discharge date).

The HS we used in this study is called the LOTUS system from the BOWA (a medical device regulation certified company). It has special characteristics over other ultrasonic shearing devices which are crucial for safe, effective hemostasis, especially in thyroid surgery. One of these characteristics is its generation of oscillatory frequency at a rate of (36 kHz versus 55 kHz with other ordinary shearing devices) and generation of torsional energy which reduces energy from getting separated at the tip of the blades compared with other conventional longitudinal scalpels (11 We used the working length of 176 mm for open TT.

The patients underwent TT whether with HS or CT randomly

according to each surgeon's preference. For measuring the intra-operative time in minutes from the beginning of the incision till closure, we used a digital stop watch. To estimate the amount of intraoperative blood loss uniformly, we used for the all the patients same sterile surgical gauze swabs and in two dimensions (45x45 cm - 6ply and 20x10 cm - 8ply) and each one of them was measured and weighed for the amount of blood carrying capacity by measuring the dry and soaked weights for each of them on multiple occasions with same readings by a brand new accurate digital scale (SCA-301) with a new battery. The scale itself has been compared with another digital scale and both of them had the same accurate readings. The scale measured the weight of surgical gauze in Ounce (oz) and has been converted to Milliliters (ml).

Statistical analysis of the data was carried out using SPSS 26 (Statistical Package for Social Sciences 26). Numerical data were expressed as mean and standard deviation (SD) while categorical data were expressed as frequency and percentage. A p value of ≤ 0.05 was considered to be statistically significant.

RESULTS

This study included 80 cases with 72 (90%) females and 8 (10%) males. The age range was between 16 and 66 years with a mean age of 40.3±11.5 years. Half of the cases (40) were operated on by using HS while the other half (40) were operated on by CT with conventional knot tying and electrocautery.

Regarding the duration of the operative time, the duration of the surgery from skin incision till skin closure was estimated to be (30 – 120) minutes in both HC and CT with a mean of 62.2±20 for HS and 75.7±20.4 for CT, comparison between both techniques regarding the duration of surgery showed a mean difference of 13.5 minutes with p value of 0.004 which is statistically significant and details are in **(Table 1)**.

The intra-operative blood loss was significantly lower in the HC method than the CT method with a mean difference of 66.8 ml and a p value of < 0.0001, details are in **(Table 1)**.

The post-operative fluid loss was significantly higher in CT method than the HS method with a mean difference of 39.1 ml and the p value was < 0.001, details are in **(Table 1)**.

The duration of hospital stay post-operatively was one day in the majority of the cases except for three cases whose hospital stay duration was two days for two cases and 10 days for the third case, two days because of the surgeon's preference and 10 days due to the sequelae of the recurrent laryngeal nerve injury. The hospital stay duration in relation to the technique type was statistically insignificant with a p value of 0.2.

Regarding the correlation between the duration of surgery and post-operative fluid drainage (POFD) and intra-operative blood loss (IOBL), Pearson's correlation was used with r value of one (1) indicating the presence of positive correlation between the duration of surgery and both post-operative fluid drainage and intra-operative blood loss with a p value of 0.004 and <0.001 respectively which is statistically significant showing that with increasing duration of surgery, POFD and IOBL increase as well and this is illustrated in **(Figure 1,2)**.Out of 80 cases, 78 cases were discharged home uneventfully while two cases encountered complications, one of them had nerve injury while the other died on day zero of the operation due to cardiac complications.

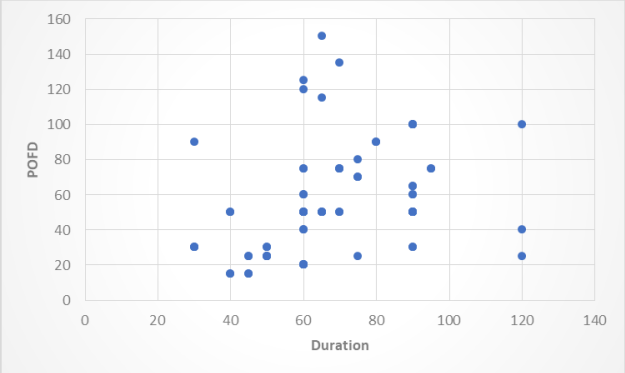

Figure 1. Correlation between postoperative fluid drainage (POFD) and the duration of surgery

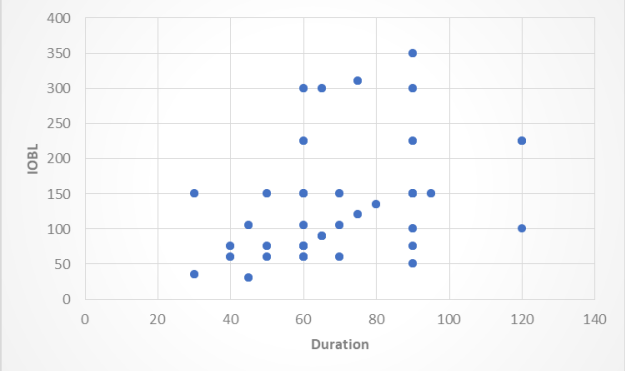

Figure 2. Correlation between intra-operative blood loss (IOBL) and the duration of surgery

DISCUSSION

Thyroid gland is highly vascularized structure that requires division of its branches before full mobilization and excision. Classical way of hemostasis in form of controlling the two ends of the vessel by knot-tying and sharp cutting with scis-

Table 1. Comparison of different parameters between HS and CT techniques.

Parameters	Mean ± SD HS	CT	Range HS	CT	P value*
Operative time (mintues)	62.2±20	75.7±20.4	30-120	30-120	**0.004**
Intra-operative blood loss (ml)	103.1±58.3	170±91.8	30-225	50-350	**<0.001**
Post-operative fluid drainage (ml)	35.6±15.3	74.7±29.5	15-60	40-150	**<0.001**

* Independent sample t-test, HS = Harmonic scalpel, CT= Conventional techniques

sors or electrocautery has been used for many years. Since TT is the most commonly performed endocrine surgery, new sophisticated techniques have emerged to ease this important procedure. Despite wide spreading of many newer techniques like (bipolar diathermy, clips and staples), these techniques did not offer the desirable results in the past few decades as they were inconvenient to this particular surgery. For example, bipolar diathermy does not give the surgeon full access to all the angles and staples and clips are costly and may dislodge, especially for the small vessels encountered in TT [13, 14]. The main mechanism of the HS, is by disrupting the proteinaceous hydrogen bonds at a comparatively lower temperature (80° C) resulting lesser tissue injury (<1.5 mm) compared with electrocautery and as a result of the relative lower temperature, the water within the tissue won't reach the boiling point making the collagen fibers and proteoglycans within the tissues denatured making a gelatinous glue like substance by mixing with interstitial and intracellular fluids [15]. Furthermore, using HS has offered shorter operative time and lesser bleeding as compared with classical techniques as supported by literatures [16].

In our study, we showed that the use of HS in TT is safe and it shortens the intra-operative time by almost (13.5 min) compared with CT for TT despite some of the operations done by the HS had larger glands. The amount of intra-operative blood loss and post-operative fluid drainage were less by (66.8 ml and 39.1 ml) respectively for the HS group while the risk of nerve injury and length of hospital stay in HS population showed no significant advantage over CT group. Regarding studies that have been done in Iraq, they observed some findings that were consistent with our study. Al-Dhahiry and Hameed [17], observed (20 min) reduction in operative time and (60 ml) reduction in post-operative fluid drainage in HS group while regarding nerve injury statistically significant difference has been observed and this may be due smaller number in each group. Ali and Mayali [18], observed (23 min) reduction in operative time and (30 ml) reduction in post-operative fluid drainage for HS group. Noori and Mohammad [19], observed in HS group (30 min) reduction in operative time, (16 ml) reduction in intra-operative blood loss, (22 ml) in postoperative fluid drainage and no significant difference in laryngeal nerve injury as compared with CT group. Regarding studies that has been conducted in other Arab countries, El-Sherpiny (11), observed in HS group (12 min) reduction in operative time, (14 ml) reduction in intra-operative blood loss and (17 ml) reduction in post-operative fluid drainage volume and also no significant difference in laryngeal nerve injury in both groups. Qasaimeh et al. [20], observed (24 min) reduction in operative time and blood loss was less in the HS group (P= 0.014) while Sultan et al [21], observed the followings in HS group: (42 min) reduction in operative time, decrease in postoperative fluid drainage at day 1 and no significant reduction in laryngeal nerve injury in both groups. Worldwide, Cannizzaro et al [22], Cheng et al [23], Ferri et al [24] and Kilic et al [25], showed significant decrease in total amount of operative time from skin incision till closure, reduction in blood loss intra-operatively, decrease in post-operative drainage volume and relatively shorter hospital stay. Uniformly, our study was consistent with most of studies except for length of hospital stay which could be due to differences in policies for discharging.

CONCLUSION

In conclusion, operative time was significantly less using HS over CT technique. IOBL and POFD were less using HS compared with CT while no difference in both laryngeal nerve injury occurrence and hospital stay duration between the two groups was noted.

RECOMMENDATION

We recommend the future researchers to use bigger sample size with longer study duration, more parameters to be included and longer follow up time.

ETHICAL DECLARATIONS

- **Acknowledgements**

  None.

- **Ethics Approval and Consent to Participate**

  This study was approved by the Local Scientific Council of the Iraqi Board of Medical Specialization of General Surgery, the concept of the study was discussed and verbal consent was taken from each participant.

- **Consent for Publication**

  Non.

- **Availability of Data and Material**

  The datasets are available from the corresponding author upon reasonable request.

- **Competing Interests**

  The authors declare that there is no conflict of interest.

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- **Authors' Contributions**

  All stated authors contributed significantly, directly, and intellectually to the work and consented it to be published.

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