



A Comparison of Harmonic Scalpel and Conventional Techniques for Thyroidectomy

Ripu Daman Arora¹ · S. D. Prajwal² · Karthik Nagaraja Rao² · Ambesh Singh² · Nitin M. Nagarkar³ · A. P. Abishek¹

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Abstract

Thyroidectomy is one of the most frequently performed surgeries. Conventional techniques using electrocautery carry the risk of tissue injury. Recently, there has been increased use of harmonic scalpels in thyroid surgery. The harmonic scalpel utilizes ultrasonic shears for cutting and coagulation, thus minimizing thermal injury. The objective of our study was to determine differences in operative duration, hypocalcemia, and RLN palsy. This single-center retrospective comparative study included consecutive patients undergoing hemithyroidectomies using the harmonic scalpel and conventional technique in the past one year ($n = 64$, harmonic group = 28 and conventional group = 36). The mean operative duration for the harmonic scalpel group was 70.4 min, vs. 81.31 min for the conventional technique group, and the difference in mean duration was found to be 10.84 min ($p = 0.027$). There was no statistically significant difference in the rates of hypocalcemia ($p = 0.751$) or RLN palsy ($p = 0.121$). None of the patients in either group developed permanent hypocalcemia or RLN palsy. The use of a harmonic scalpel during thyroidectomy is safe. The overall surgical duration was reduced when the harmonic scalpel was used, and the complication rates were comparable to those of the conventional technique, making it a non-inferior technique for surgical intervention in thyroidectomy and warranting harmonic scalpel consideration as a valuable addition to the armamentarium of thyroid surgeons.

Keywords Harmonic scalpel · Hemithyroidectomy · RLN palsy · Hypocalcemia

✉ S. D. Prajwal
prajwal.dange@gmail.com
Ripu Daman Arora
neelripu@gmail.com
Karthik Nagaraja Rao
karthik.nag.rao@gmail.com
Ambesh Singh
ambesh.singh26@gmail.com
Nitin M. Nagarkar
directoroffice@aiimsraipur.edu.in
A. P. Abishek
abishekap007@gmail.com

- ¹ Department of Otolaryngology and Head Neck Surgery, All India Institute of Medical Sciences, Raipur, Chhattisgarh, India
- ² Department of Head and Neck Oncology, All India Institute of Medical Sciences, Raipur, Chhattisgarh, India
- ³ All India Institute of Medical Sciences, Raipur, Chhattisgarh, India

Introduction

Thyroidectomy has evolved significantly over the past two centuries, transforming from a procedure with high mortality rates in the mid-eighteenth century to one of the most frequent operations in endocrine surgery. The standardization of thyroid surgery by pioneering surgeons, such as Kocher and Billroth, in the late nineteenth century was pivotal in improving patient outcomes and establishing the foundations of this surgical discipline [1].

In contemporary surgical practice, every surgeon performing thyroidectomy aspires to achieve a complication-free procedure. Several principles are crucial to attain this goal, including excellent anatomical exposure, precise dissection, and effective hemostasis. However, the selection of an ideal energy device for thyroidectomy that balances efficiency and safety remains elusive.

The conventional thyroidectomy technique often involves ligation of vessels and the use of electrocautery to achieve hemostasis. While electrocautery has proven effective in controlling bleeding during surgery, it carries

the potential risk of injuring surrounding tissues due to heat dispersion. This thermal spread can result in complications and prolonged operative duration, prompting the exploration of alternative techniques [2].

In recent years, the harmonic scalpel has emerged as a promising tool for thyroidectomy, offering potential advantages over conventional techniques. Introduced in 1990, the harmonic scalpel (Ethicon Endo-Surgery, Inc., Cincinnati, OH) utilizes ultrasonic energy to precisely cut and coagulate tissues to achieve simultaneous tissue dissection and hemostasis. Operating at a frequency of 55.5 kHz, this device transmits vibrations that generate a coagulum, effectively seals vessels, and ensures optimal hemostasis. One of the key advantages of the harmonic scalpel is its ability to minimize thermal spread. At temperatures ranging from 50 to 100 °C, the device achieves hemostasis without dispersing excessive heat, thereby reducing the risk of injury to surrounding tissues [3, 4]. This characteristic not only contributes to improved patient safety but also has the potential to decrease the operating time and postoperative complications associated with thyroid surgery.

This study aimed to evaluate the surgical efficiency of the harmonic scalpel compared to conventional thyroidectomy techniques. The primary outcomes of interest were operative duration, temporary hypocalcemia, and recurrent laryngeal nerve (RLN) palsy. By systematically assessing these parameters, we sought to provide valuable insights into the comparative effectiveness of these surgical approaches, thereby enhancing patient care.

Methods

This single-center retrospective comparative study included consecutive patients who underwent hemithyroidectomies using the harmonic scalpel and conventional techniques in the past year.

Protocol of Workup and Surgery at the Institution

This retrospective study of prospectively maintained patient data was conducted at the All India Institute of Medical Sciences, Raipur, India. Data were collected from the hospital repository by reviewing the original records of all the patients who underwent hemithyroidectomy between February 2021 and February 2022. All the patients underwent ultrasound examination of the neck and FNAC of the thyroid nodule. A video laryngoscopic examination was performed preoperatively to assess vocal cord movement. Preoperative calcium levels were also assessed.

Study Inclusion and Exclusion Criteria

All patients aged > 18y and undergoing hemithyroidectomies using either a harmonic scalpel or the conventional method were included in the study. Written and informed consent was taken from all the participating patients. Patients undergoing total thyroidectomy, central compartment neck dissection, preoperative hypocalcemia prior to surgery, and patients who were reported as having malignancy in postoperative HPR were excluded. The Institutional ethical clearance was exempted for retrospective study with deidentified patient data. All research methods were carried out in compliance with the 2013 revision of the 1964 Declaration of Helsinki's ethical guidelines.

Surgical Procedure

Standard surgical steps for hemithyroidectomy were followed. The upper, middle, and inferior vessels in patients who underwent conventional surgery were split after being tied with standard ligatures (polyglactin 910, 2/0, and 3/0, if needed; Vicryl™, Ethicon Endo-Surgery). Open shear scissor grip HAR9F (HARMONIC FOCUS® + Shears, Ethicon Endo-Surgery) was used to divide the upper, middle, and inferior vessels in patients who underwent harmonic scalpel surgery. Figure 1 shows the use of a harmonic scalpel for dissection close to the RLN. To guarantee minimum thermal damage, we employed a harmonic scalpel with active shear-up and inactive shear close to the tissue.

Review of Patients' Data Repository

All relevant clinicopathological data, including age, sex, and preoperative calcium level, were obtained. Calcium levels were measured 6, 12, and 24 h postoperatively. Postoperative Hypocalcemia was defined as a serum calcium level less than the institutional lower limit (< 8.7 mg/dL) [5] and/or any signs or symptoms of hypocalcemia (e.g., perioral numbness, digital paresthesia, or positive Trousseau's sign). A flexible video laryngoscopic examination was performed immediately after extubation to identify vocal cord movements. The patients were assessed after two weeks in the outpatient department, and a video laryngoscopic examination was performed to assess vocal cord mobility.

Statistical Analysis

The Statistical Package for the Social Sciences (SPSS) software (version 24.0) was used to conduct statistical analyses (SPSS, Inc., an IBM Company, Chicago, Illinois, USA). Descriptive statistics were used to summarize demographic

Fig. 1 Dissection using a harmonic scalpel close to the recurrent laryngeal nerve, arrow showing the recurrent laryngeal nerve

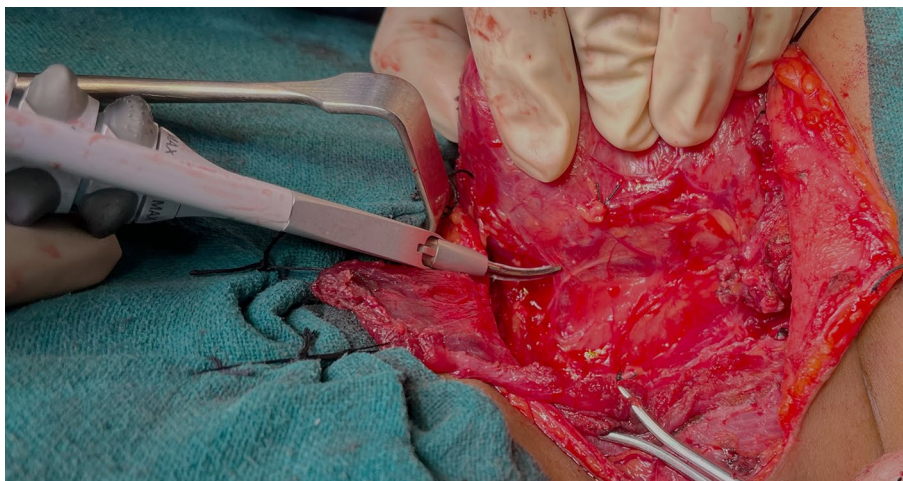


Table 1 Demographic distribution

		Harmonic Frequency	Conventional Frequency
Gender	Male	3 (10.71%)	6 (16.66%)
	Female	25 (89.29%)	30 (83.34%)
Age (in years)		42.53 ± 12.73	36.36 ± 11.03
Laterality	Right	16	24
	Left	12	12

data. The Pearson χ^2 test was used to determine the statistical significance between the variables in the two groups.

Results

The study sample consisted of 64 patients who underwent hemithyroidectomy, with 28 patients undergoing surgery using a harmonic scalpel and 36 patients undergoing surgery using conventional techniques.

Among the patients who underwent thyroidectomy using a harmonic scalpel, there were 3 males and 25 females. Among the patients who underwent thyroidectomy using the conventional technique, there were 6 and 30 male and female patients, respectively (Table 1).

The average age of patients undergoing surgery in the harmonic scalpel and the conventional technique groups was 42.53 ± 12.73 years and 36.36 ± 11.03 years, respectively (Table 1).

Among the patients who underwent hemithyroidectomy, 40 and 24 underwent surgery on the right and left sides, respectively (Table 1).

The mean operative duration for the harmonic scalpel group was 70.4 min, versus 81.31 min for the conventional technique group. The Levene statistical test was applied to test the equality of variance between the two groups, and

Table 2 Distribution of patients with hypocalcemia and RLN injury

		Harmonic	Conventional	Total	<i>p</i> Value
Mean Operative duration (in mins)		70.4	81.3		0.027*
Hypocalcemia	Yes	3	3	6	0.751
	No	25	33	58	
RLN injury	Yes	0	3	3	0.121
	No	28	33	61	
Total		28	36	64	

the difference in mean duration was found to be 10.84 min between the harmonic scalpel and the conventional technique, and the difference was found to be statistically significant ($p = 0.027$) (Table 2).

Three patients in the harmonic scalpel and conventional groups experienced temporary hypocalcemia, with 10.7% and 8.3% of patients, respectively. The Pearson χ^2 test showed $p = 0.751$, which was not statistically significant. None of the patients in either group had permanent hypocalcemia (Table 2).

None of the patients in the harmonic group experienced vocal cord palsy, but three patients in the conventional technique group (8.3%) of the conventional group had temporary RLN palsy. The Pearson χ^2 test showed $p = 0.121$, which was not statistically significant. All patients were followed up after two weeks, and all three patients had complete recovery, and the bilateral vocal cords were mobile (Table 2).

Discussion

The harmonic scalpel was initially used in laparoscopic surgery to cut and coagulate the tissue simultaneously, which led to reduced postoperative complications [6, 7]. This early

success in laparoscopic surgery led to its adoption in other surgical fields.

In our study, the mean operative durations for the harmonic scalpel and conventional technique group were 70.4 and 81.31 min ($p=0.027$), respectively. The difference in mean duration was found to be 10.84 min between the harmonic scalpel and the conventional technique, which was statistically significant. The longer operative time in the conventional technique is due to the time spent in ligating both ends of the vessel and cutting in-between when compared to the harmonic scalpel, which cuts and coagulates soft tissue simultaneously. A meta-analysis conducted by Revelli et al. [8] showed a 25.49 min reduction in operative time when a harmonic scalpel was used, but this study included only cases of total thyroidectomy. In total thyroidectomy, there are twice the number of vessels that need to be ligated compared to hemithyroidectomy. Hence, there is a greater reduction in operative time when using a harmonic scalpel to seal these vessels than when using the conventional method in total thyroidectomy.

Hypocalcemia is one of the most common complications of thyroid surgery [9]. The incidence of transient hypocalcemia following thyroid surgery varies in the literature, ranging from 1.7 to 68% [10, 11]. The cause of hypocalcemia after hemithyroidectomy is debatable. According to some authors, maintaining appropriate parathyroid gland function only requires one functional gland [12]. However, some authors contend that the restoration of normal function necessitates the presence of at least three parathyroid glands [13]. Post-thyroidectomy hypocalcemia arises because of parathyroid removal, devascularization, venous congestion, and damage, which induces a state of transient hypoparathyroidism [14]. In our study, three patients in each group had transient hypocalcemia: 10.7% and 8.3% ($p=0.751$) of patients in the harmonic scalpel and conventional groups, respectively. Venous congestion and edema may result from dissection carried around the parathyroid glands and attempts to separate the RLN in this region. Venous stasis and edema slow down the action of the parathyroid gland and may result in temporary hypoparathyroidism [15]. The lateral thermal damage produced by the harmonic scalpel is less than that produced by electrocautery, hence reducing the inadvertent damage to the vessels supplying the parathyroid gland and reducing the chance of hypoparathyroidism.

In our study, no patients in the harmonic group experienced recurrent laryngeal nerve injury, while three patients (8.3%) in the conventional group had RLN injury ($p=0.121$), which was similar to the study conducted by Butskiy et al. [16], in which 9% of patients had temporary vocal cord palsy. The lateral thermal damage depends on the setting in which the harmonic scalpel is used [17]. There is varied distance lateral thermal damage produced by using the harmonic scalpel in various power settings; when used

in output power 3 and output power 5 produces lateral thermal damage to distances of 0.904 mm and 1.274 mm, respectively [18]. RLN injury did not occur if the device was used ≥ 2 mm from the nerve [19]. The jaw width of the harmonic scalpel is 2.24 mm which should also be kept in mind while working around vital structures, as inadvertent direct contact of the active shears with adjacent structures can easily cause tissue damage.

Conclusion

Thus, the use of a harmonic scalpel in thyroidectomy is safe. The overall surgical duration was reduced when harmonic scalpel was used, and the complication rates with respect to hypocalcaemia and RLN palsy were comparable to the conventional technique, making it a non-inferior technique for surgical intervention in thyroidectomy, warranting harmonic scalpel consideration as a valuable addition to the armamentarium of thyroid surgeons.

Author contribution statement PD and RDA: Concept, Design, Literature search, Writing; PD and KNR: Concept, Analysis and/or interpretation; PD and KNR: Analysis and/or interpretation; PD, KNR, AS and AAP: Literature search, Writing; NMN and RDA: Supervision, Critical review.

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Declarations

Conflict of interest Authors are having no financial interests that are directly or indirectly related to the work submitted for publication.

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