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Harmonic scalpel versus conventional hemostasis: Impacts on thyroid surgery outcomes

Harmonik skalpele karşı geleneksel hemostaz: Tiroid cerrahisi sonuçları üzerine etkiler

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ABSTRACT

Objectives: This study aimed to compare the effectiveness and safety of the harmonic scalpel and traditional methods.

Patients and Methods: In this retrospective study data from 180 patients (132 females, 48 males; mean age: 49.1±14.2 years; range, 18 to 86 years) who underwent total thyroidectomy between January 2015 and December 2022 were analyzed. Age, sex, diagnosis, thyroid size, operative time, hospital stay, and complications were recorded. The patients were divided into two groups based on the hemostasis method: harmonic scalpel and conventional methods. All surgeries were performed under general anesthesia with the same surgical teams.

Results: The harmonic scalpel group demonstrated a lower incidence of hypocalcemia and shorter operation times compared to the conventional method group. No significant differences were found in vocal cord paralysis, hematoma, seroma, and wound infection rates between the groups. The harmonic scalpel was associated with a shorter mean hospital stay.

Conclusion: The harmonic scalpel presents itself as a viable alternative in thyroid surgery, offering shorter operation times and hospital stays with a reduced rate of hypocalcemia.

Keywords: Complications, harmonic scalpel, hemostasis, operating time, thyroidectomy.

ÖZ

Amaç: Bu çalışmada harmonik skalpel ile konvansiyonel yöntemlerin etkinliği ve güvenliği karşılaştırıldı.

Hastalar ve Yöntemler: Bu retrospektif çalışmada, Ocak 2015 ile Aralık 2022 tarihleri arasında total tiroidektomi uygulanan 180 hastanın (132 kadın, 48 erkek; ort. yaş: 49.1±14.2 yıl; dağılım, 18-86 yıl) verileri analiz edildi. Yaş, cinsiyet, tanı, tiroid boyutu, ameliyat süresi, hastanede kalış süresi ve komplikasyonlar kaydedildi. Hastalar hemostaz yöntemine göre iki gruba ayrıldı: harmonik skalpel ve konvansiyonel yöntemler. Tüm ameliyatlar genel anestezi altında ve aynı cerrahi ekiplerle gerçekleştirildi.

Bulgular: Harmonik skalpel grubunda, geleneksel yöntem grubuna kıyasla daha düşük hipokalsemi insidansı ve daha kısa ameliyat süresi görüldü. Gruplar arasında vokal kord paralizisi, hematom, seroma ve yara enfeksiyonu oranlarında anlamlı bir fark bulunmadı. Harmonik skalpel daha kısa ortalama hastanede kalış süresi ile ilişkilendirildi.

Sonuç: Harmonik skalpel, tiroid cerrahisinde daha kısa ameliyat süreleri ve hastanede kalış süreleri ile daha düşük hipokalsemi oranı sunan uygun bir alternatif olarak karşımıza çıkmaktadır.

Anahtar sözcükler: Komplikasyonlar, harmonik skalpel, hemostaz, ameliyat süresi, tiroidektomi.

In the late 19th century, Theodor Kocher and Theodor Billroth pioneered the field of thyroid surgery, setting the stage for its development. By the early 20th century, the essential guidelines for safely conducting thyroid surgery were already in place.[1] These guidelines include three fundamental steps: first, locating and tying off

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the blood vessels; second, identifying and safeguarding the laryngeal nerves and parathyroid glands. While the basic surgical tools have largely remained the same over time, significant advancements have been achieved regarding the management of vascular parts and the introduction of new coagulation techniques.

Bleeding, one of the most important postoperative risks of thyroid surgery, can lead to potentially life-threatening airway obstructions. Hemorrhage during a thyroidectomy can impede the visual field, impeding the surgical dissection of the recurrent laryngeal nerve and parathyroid glands. Effective vascular hemostasis achieved with traditional clamping and tying techniques has been attempted to be achieved more rapidly and effectively with new techniques. In recent years, advanced technologies, such as the harmonic scalpel, have been introduced for this purpose.[2] This technology uses high-frequency ultrasonic waves to cut tissues while stopping bleeding at the same time.[3] It has been reported that the use of the harmonic scalpel shortens the operation time in thyroid surgery, and this technology does not increase complication rates compared to traditional methods.[4-6] These findings contribute to the prominence of the harmonic scalpel as an effective and safe alternative in thyroid surgery.

The study aimed to analyze the effectiveness and safety of two different techniques, the harmonic scalpel and conventional hemostasis methods, in patients who underwent total thyroidectomy to help determine the role and potential benefits of utilizing the harmonic scalpel in thyroidectomy procedures.

PATIENTS AND METHODS

The retrospective study included 180 patients (132 females, 48 males; mean age: 49.1±14.2 years; range, 18 to 86 years) who underwent total thyroidectomy in the otolaryngology department of the Ümraniye Training and Research Hospital between January 2015 and December 2022. Patients' age, sex, diagnosis, thyroid size, operative time, hospital stay, and complications were recorded. The operations were performed by the same surgical team with considerable experience. Patients with thyroid lobectomy, central or lateral neck dissection, pregnant patients, patients under 18 years of age, and patients with bleeding diathesis were excluded. The patients were classified into two distinct groups. The first group was defined as the group in which bleeding control was performed with the harmonic scalpel. The second group was defined as the group in which conventional methods (tying and knotting; suturing) were used for hemostasis.

All surgeries were performed under general anesthesia with endotracheal intubation. Nerve monitoring was used in all cases (NIM-Response 3.0; Medtronic, Minneapolis, MN, USA). Patients were positioned after a support was placed under the shoulder. A 4- to 6-cm horizontal incision was made at the level corresponding to the middle of the imaginary line between the jugular notch and the thyroid laryngeal prominence. The subplatysmal flap was lifted. Strep muscles were excised. The thyroid was visualized. Upper middle and lower thyroid vessels were separated with harmonic scalpel or conventional methods. The thyroid was medialized. The recurrent laryngeal nerve was visualized and protected, and the vessels in the Berry ligament were ligated. In total thyroidectomies, the same procedure was performed for the contralateral side.

Statistical analysis

Data were analyzed using IBM SPSS version 28.0 software (IBM Corp., Armonk, NY, USA). Data were expressed as mean±standard deviation, median (min-max), or frequency and percentage. The Kolmogorov-Smirnov test was employed to assess the distribution of the variables. For quantitative data comparison, the study utilized the independent samples t-test and the Mann-Whitney U test. Qualitative data comparisons were made using the chi-square test. A p-value <0.05 was considered statistically significant.

RESULTS

Eighty-six (47.8%) patients were operated on for simple multinodular goiter (MNG), 21 (11.7%) for toxic MNG, 32 (17.8%) for Graves' disease, and 41 (22.8%) for differentiated thyroid cancer. Vocal cord paralysis developed in 15 (8.3%) patients, of which only two (1.1%) were permanent. Hypocalcemia was observed in 47 (26.1%) patients and became permanent in only two (1.1%) patients. Five (2.8%) patients developed hematoma, and three (1.7%) patients developed seroma. Tracheal injury was not observed in this study group. While wound site infection was observed in only one (0.6%) patient, tracheal injury was not observed in any patient. Harmonic scalpel was used for hemostasis in 89 (49.4%) patients, and conventional methods were used in 91 (50.6%) patients. The mean duration of the operation was 122±26.4 min, while the mean length of hospital stay was 2.4±0.7 days (Table 1).

The mean age of the group operated on with the harmonic scalpel was 48.2±14.5 years, while the mean age of the group operated on with the conventional method was 50.0±14.0 years. The

Table 1
Demographic and clinical characteristics of the patients

	n	%	Mean±SD	Median	Min-Max
Age (year)			49.1±14.2	51.0	18.0-86.0
Sex					
Male	48	26.7			
Female	132	73.3			
Indication					
Simple MNG	86	47.8			
Toxic MNG	21	11.7			
Graves	32	17.8			
Differentiated thyroid cancer	41	22.8			
Vocal cord					
(–)	165	91.7			
(+)	15	8.3			
Permanent	2	1.1			
Temporal	13	7.2			
Hypocalcemia					
(–)	133	73.9			
(+)	47	26.1			
Permanent	2	1.1			
Temporal	45	25.0			
Hematoma					
(–)	175	97.2			
(+)	5	2.8			
Seroma					
(–)	177	98.3			
(+)	3	1.7			
Tracheal injury					
(–)	180	100			
(+)	0	0.0			
Scar infection					
(–)	179	99.4			
(+)	1	0.6			
Harmonic scalpel	89	49.4			
Conventional	91	50.6			
Surgery time (min)			122±26.4	124	75.0-180
Hospitalization duration (day)			2.4±0.7	2.0	2.0-6.0

SD: Standard deviation; MNG: Multinodular goiter.

mean age did not differ significantly between the two groups (p=0.392). In regard to sex distribution, 29.2% of the harmonic scalpel group consisted of males, while 24.2% of the conventional treatment group were male. The sex distribution did not show any statistically significant difference between the two groups (p=0.445).

There was no significant difference in the distribution of indications between the two groups; the distribution of simple MNG, toxic MNG, Graves' disease, and differentiated thyroid cancer was similar (p>0.05). The incidence of vocal cord paralysis was 6.7% in the harmonic scalpel group and 9.9% in the conventional treatment group. There was no

Table 2
Comparison of clinical outcomes between harmonic scalpel and conventional method

	Harmonic scalpel				Conventional methods				
	n	%	Mean±SD	Median	n	%	Mean±SD	Median	*p*
Age (year)			48.2±14.5	49.0			50.0±14.0	52.0	0.392*
Sex									0.445†
Male	26	29.2			22	24.2			
Female	63	70.8			69	75.8			
Indication									0.896†
Simple MNG	42	47.2			44	48.4			
Toxic MNG	9	10.1			12	13.2			
Graves	17	19.1			15	16.5			
DTC	21	23.6			20	22.0			
Vocal cord									0.445†
(–)	83	93.3			82	90.1			
(+)	6	6.7			9	9.9			
Permanent	1	1.1			1	1.1			
Temporal	5	5.6			8	8.8			
Hypocalcemia									0.005†
(–)	74	83.1			59	64.8			
(+)	15	16.9			32	35.2			
Permanent	1	1.1			1	1.1			
Temporal	14	15.7			31	34.1			
Hematoma									0.668†
(–)	87	97.8			88	96.7			
(+)	2	2.2			3	3.3			
Seroma									1.000†
(–)	88	98.9			89	97.8			
(+)	1	1.1			2	2.2			
Tracheal injury									1.000†
(–)	89	100			91	100			
(+)	0	0.0			0	0.0			
Scar infection									1.000†
(–)	89	100			90	98.9			
(+)	0	0.0			1	1.1			
Surgery time (min)			110±22.0	107			134±24.5	135	**0.000**‡
Hospitalization duration (day)			2.2±0.6	2.0			2.5±0.8	2.0	**0.006**‡

SD: Standard deviation; MNG: Multinodular goiter; DTC: Differentiated thyroid cancer; * Independent sample t test; ‡ Mann-Whitney U test; † Chi-square test.

statistically significant difference between these rates (p=0.445), as shown in Table 2.

However, the incidence of hypocalcemia was 16.9% in the harmonic scalpel group, while it was 35.2% in the conventional treatment group. There was a significant difference between these two groups in terms of hypocalcemia (p=0.005). There was no significant difference between the two groups in terms of hematoma, seroma, and wound infection rates (p>0.05).

In the harmonic scalpel group, the mean duration of surgery was 110±22.0 min, while it was 134±24.5 min in the conventional treatment group. The duration of surgery in the harmonic scalpel group was found to be significantly shorter than in the conventional treatment group (p<0.05). The duration of mean hospital stay differed significantly between the two groups (2.2±0.6 *vs.* 2.5±0.8 days for the harmonic scalpel and the conventional treatment groups,

respectively; p=0.006). The harmonic scalpel group exhibited a shorter mean hospital stay.

DISCUSSION

This study compared the efficacy and safety of harmonic scalpel and conventional hemostasis methods in total thyroidectomy, demonstrating that effectively implementing the harmonic scalpel technique decreases the likelihood of hypocalcemia, substantially decreases the duration of the surgical procedure, and minimizes the duration of hospitalization.

In recent years, the harmonic scalpel has become a widely preferred tool in surgical procedures. This technology uses high-frequency sound waves to cut tissue while simultaneously stopping bleeding. Ultrasonic coagulation produced by harmonic scalpel is similar to electrocautery in that it seals the vessels and forms a coagulum of denatured proteins that stops bleeding. However, the process of denaturing proteins is different. While both electrocautery and laser denature proteins by heating the tissue, harmonic scalpel delivers mechanical energy through ultrasonic vibrations to denature proteins. This process occurs by breaking tertiary hydrogen bonds in proteins.[3] The cutting mechanisms of the harmonic scalpel include cavitational fragmentation and mechanical shear, which occurs by vibrating over a distance of 80 µm at a frequency of 55.5 kHz.[7] Harmonic scalpel cuts can seal arteries with a mean diameter of 3.8 mm (range 2.8 to 3.9) and veins with a mean diameter of 9.9 mm (range 7.0 to 12.8). Harmonic scalpel also produces a smaller area of lateral thermal damage than bipolar cautery.[8]

Harmonic scalpel has found a successful application in otolaryngology. The primary application of harmonic scalpel in the otolaryngology literature is for tonsillectomy and thyroidectomy.[9,10] A study utilizing the harmonic scalpel for the removal of tongue and soft palate cancer revealed that the histopathologic margins remained undamaged, with minimal thermal damage to surrounding tissues.[11] In a study describing the use of harmonic scalpel in submandibular gland surgery, the authors found that the use of harmonic did not increase complications.[12] However, they emphasized that the operation time was prolonged compared to the classical method. Utilizing the harmonic scalpel throughout parotidectomy reduces hemorrhage and decreases the duration of the surgery.[13] Prgomet et al.[14] evaluated the use of harmonic scalpel in thyroidectomy, parotidectomy, and tonsillectomy and found that harmonic scalpel shortened the operation time and allowed surgery with a shorter incision of 1.5 cm in thyroidectomies but did not provide any additional benefit in terms of complications and pain.

There is a consensus in the literature on the usefulness of the harmonic scalpel in thyroid surgery. Parker et al.[15] reported that after starting to use the harmonic scalpel in thyroidectomy, operation times were reduced by 20 min in hemithyroidectomies and 13 min in total thyroidectomies. In another study comparing the use of harmonic scalpel with conventional techniques in thyroidectomy, it was reported that the complications were similar in harmonic scalpel and conventional methods, but the operation times were shortened with the use of harmonic scalpel.[16] A 2016 meta-analysis concluded that the use of harmonic scalpel in thyroidectomy shortened the operation time, reduced bleeding, and significantly reduced costs without a significant increase in complications.[6] In thyroid surgery, the process of cutting, ligating, and separating the large blood vessels of the thyroid takes a long time. In our study, we found that the application of harmonic scalpel shortened this procedure, in accordance with the mentioned literature.

The main complications of thyroid surgery are recurrent laryngeal nerve paralysis and hypocalcemia. There is a consensus in the literature that the use of harmonic scalpel is not superior in recurrent laryngeal nerve paralysis.[17-21] Our findings are similar to the literature. The risk of recurrent laryngeal nerve paralysis with harmonic scalpel appears to be similar to conventional methods. The situation seems to be slightly different regarding hypocalcemia. Some studies argue that the risk of hypocalcemia with harmonic scalpel is similar to conventional methods.[22-25] On the other hand, some studies argue that the use of harmonic scalpel reduces the risk of transient hypocalcemia.[5,26-29] The results of our study support the reduced risk of transient hypocalcemia. We hypothesize that the lower level of heat produced by the use of harmonic scalpel leads to less damage to the tissues, which decreases the likelihood of damage to the vessels in the parathyroid glands. This may contribute to preserving the functionality of the parathyroid glands and consequently lower the possibility of developing transient hypocalcemia.

The impact of harmonic scalpel use in thyroidectomy on the length of hospital stay varies between studies in the literature. While some studies show that the use of harmonic devices shortens the length of hospital stay,[6,18,30] others indicate that this method does not provide an advantage compared to conventional surgical techniques.[5,26,29] However, it is generally accepted that the use of harmonic

scalpel does not prolong hospital stay compared to conventional methods. In our study, we observed a shorter hospital stay with the use of harmonic scalpel, which we attribute to the lower incidence of transient hypocalcemia in patients using harmonic devices. Transient hypocalcemia leads to prolonged hospital stay. These findings provide important evidence that the use of harmonic devices may positively affect the postthyroidectomy process.

This study has some limitations. First, due to the nature of its retrospective design, data collection and interpretation were limited; prospective, randomized controlled trials may provide more reliable results. Second, the study's restricted scope, which was conducted exclusively in a single hospital, may restrict the overall applicability of the findings; this can be addressed by multicenter studies conducted in hospitals with different geographical and demographic characteristics. Third, the exclusion of certain patient groups (e.g., those undergoing central or lateral neck dissection and pregnant patients) raises questions about whether the results apply to all thyroidectomy patients. Fourth, the preferences of patients and surgeons may influence the method used, and this may affect the results of the study. Finally, another problem encountered in retrospective studies is missing or incorrectly recorded data and limitations that may affect the accuracy of the follow-up periods and data collection methods. These limitations should be taken into account in the evaluation of the findings of the study.

In conclusion, this study compared the efficacy and safety of Harmonic Scalpel and conventional hemostasis methods in total thyroidectomy. The findings show that the use of harmonic scalpel both shortens the operation time and reduces the length of hospital stay. A lower rate of hypocalcemia was observed in the harmonic scalpel group. These findings suggest that harmonic scalpel is both an effective and safe alternative in thyroid surgery. The widespread use of harmonic technology in surgical procedures has the potential to optimize surgical processes and improve patient outcomes. This study provides important evidence on how this technology can provide advantages in thyroidectomy procedures; shorter operation times and reduced risk of hypocalcemia may allow for faster patient recovery and more efficient use of hospital resources. Future prospective, randomized, controlled multicenter studies may confirm these findings in a larger patient population and more clearly define the role of the harmonic scalpel in thyroid surgery.

Ethics Committee Approval: The study protocol was approved by the Ümraniye Training and Research Hospital Ethics Committee (date: 10.08.2023, no: 290). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from each patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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