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A comparison of the harmonic scalpel, coblation, bipolar, and cold knife tonsillectomy methods in adult patients

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The study was approved by the Clinical Research Ethics Committee of Kutahya Health Sciences University, Faculty of Medicine (approval number: 2020-01/03).
All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

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No conflict of interest was declared by the authors.

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Abstract

Background/Aim: Tonsillectomy is one of the widely performed surgical procedures by otolaryngologists. Today, many new surgical instruments are used in tonsil surgery to reduce postoperative morbidity. This study aimed to compare intraoperative blood loss, operating time, postoperative pain, and bleeding between harmonic scalpel tonsillectomy, coblation tonsillectomy, bipolar tonsillectomy, and cold dissection tonsillectomy in adult patients.

Methods: This prospective cohort study population comprised 96 adult patients aged 18-60 years (mean age: 34.9 (10.7) years) who were operated on for chronic tonsillitis. The amount of bleeding and the operation time were calculated intraoperatively. Postoperative pain level was evaluated using a Visual Analogue Scale (VAS) at the sixth postoperative hour and on postoperative days 1, 2, 3, and 7.

Results: In the harmonic scalpel group, the mean volume of intraoperative bleeding (2.7 (1.5) ml) and the mean operation time (8.8 (3.0) min) were significantly lower compared to the other groups ($P<0.001$, $P<0.001$ respectively). Secondary bleeding was detected in 10 patients but there was no significant difference in the post-tonsillectomy bleeding rates between the four groups ($P=0.86$). Pain scores at the sixth postoperative hour were similar and significantly lower in the harmonic scalpel, coblation, and bipolar groups compared with the cold dissection group ($P<0.001$). The postoperative pain scores were significantly higher in the harmonic scalpel group compared to the cold dissection group on postoperative days 3 and 7 ($P=0.03$, $P=0.02$ respectively).

Conclusion: Less bleeding during surgery, shorter operation time, and less pain in the early postoperative period are the advantages of Harmonic scalpel tonsillectomy. Also, it does not increase the rate of secondary bleeding but its benefit for late period pain is lower compared to the cold knife method. The harmonic scalpel is a practical and reliable method in adult tonsil surgery.

Keywords: Tonsillectomy, Harmonic scalpel, Coblation, Cold knife tonsillectomy, Bipolar dissection, Postoperative pain

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Introduction

Tonsillectomy is one of the most common surgeries which has been performed for over 3000 years. Various surgical devices were invented to increase the reliability and efficacy of tonsil surgery. Tonsillectomy, ligature, galvanocautery, electrocautery, cold steel dissection, NdYag and KTP lasers, bipolar diathermy, microdissection needle, coblation, and harmonic scalpel tonsillectomy methods are currently used [1]. The harmonic scalpel (HS) devices have a generator, a handpiece, a blade system, and a foot pedal. The high frequency (55.5 Hz) vibration of the hand-piece blades generates a heat of 50-100^{0}C that cuts and coagulates the tissue simultaneously. This low temperature causes minimal tissue damage. The HS transfers mechanical energy to the tissue, causing protein denaturation, which results in coagulum that seals small blood vessels, thereby providing hemostasis [2, 3]. The Coblation technique involves passing radiofrequency energy through a saline solution. The intercellular bonds of tissues are broken by sodium ions at a low temperature (60°C), which causes less postoperative pain [4]. Bipolar diathermy scissors cut and coagulate the tissue simultaneously [5]. The temperature of the cautery can reach 300-400 degrees; therefore, it may cause more pain and inconvenience after the surgery [6].

The cold dissection method is considered the gold standard. This technique causes mechanical injury and preserves maximum oral mucosa when compared to thermal injury. Postoperative healing is quicker, with less postoperative pain and delayed bleeding, but the operation time and the amount of intraoperative bleeding increase because of the lack of simultaneous homeostasis [7].

This study aimed to compare intraoperative (operating time, blood loss) and postoperative (bleeding and pain) important parameters of the harmonic scalpel, coblation, bipolar, and traditional cold knife tonsillectomy methods in adult patients.

Materials and methods

This prospective cohort study was carried out per the Declaration of Helsinki and approved by the Kutahya Health Sciences University Clinical Research Ethics Committee (decision no: 2020-01/3, dated: 08.01.2020). Among 96 patients who had tonsillectomy for a diagnosis of chronic tonsillitis during January 2020 to June 2021, 58 patients (60.4%) were male, 38 (39.6%) patients were female, and the mean age was 34.9 (10.7) years (range: 18-60 years). The study only included adult patients who were operated on under general anesthesia. The study exclusion criteria were being aged <18 years, having acute tonsillitis, coagulopathy, previous peritonsillar abscess, tonsil neoplasms, and craniofacial anomalies. All operations were performed by two surgeons using a harmonic scalpel on 26 patients (27.1%), the cold knife technique on 25 (24%), the bipolar tonsillectomy method on 23 (22.9%), and coblation tonsillectomy on 22 (26%). Operation time was calculated from the incision to the end of complete hemostasis. Intraoperative bleeding was calculated from the surgical aspirator, blood suction bottle, and by weighing gauze packing. Sterile 0.9% NaCl solution was used for irrigation and NaCl was excluded when bleeding was calculated. Bipolar electrocautery was used in 5 of 26 (19.2%) patients in the harmonic scalpel group and 7 of 22 (31.8%) patients in the coblation group for further hemostasis. Bipolar diathermy was used in all patients in the cold dissection group and the bipolar dissection group. The VAS (0=no pain and 10=most severe pain) was given to the patients to express their pain levels at postoperative 6 h, and on postoperative days 1, 2, 3, and 7. They were asked to bring it with them during the 1st-week controls. All patients stayed in the hospital overnight for observation and 50 mg/kg amoxicillin and 10 mg/kg paracetamol were started for 1 week. All patients were followed up closely for postoperative bleeding.

Statistical analysis

The data were statistically analyzed with SPSS for Windows, vn.23.0 software (Statistical Package for Social Sciences for Windows; IBM, Armonk, NY, USA). The results were shown as mean (standard deviation (SD)) and number (n) and percentage (%). Categorical variables were compared with a paired t-test. Variation analysis test (ANOVA) was used to compare multiple subgroups. A value of $P<0.05$ was considered statistically significant.

Results

Ninety-six adult patients, 58 (60.4%) males, 38 (39.6%) females, with a mean age of 34.9 (10.7) years, were evaluated for intraoperative bleeding, operative time, postoperative bleeding, and postoperative pain. The four groups were matched in terms of age and gender distribution.

Intraoperative bleeding

The mean volume of intraoperative bleeding was 2.7 (1.5) ml (range, 0-5 ml) in the harmonic scalpel group, 40.3 (22.5) ml (range, 20-90 ml) in the cold dissection group, 53.2 (38.5) ml (range, 1-150 ml) in the coblation group, and 24.3 (9.7) ml (range, 10-45 ml) in the bipolar dissection group (Table 1). The amount of bleeding was significantly lower in the harmonic scalpel group compared to the cold dissection, bipolar dissection, and coblation groups ($P<0.001$, $P<0.001$, $P<0.001$ respectively), and in the bipolar dissection group compared to the cold dissection and coblation groups ($P=0.03$, $P=0.01$ respectively). There was no significant difference between the coblation and the cold dissection groups in terms of mean intraoperative bleeding volume ($P=0.16$).

Table 1: Mean and standard deviation variables of four tonsillectomy techniques

	Harmonic Scalpel tonsillectomy mean (SD) (n=26)	Coblation tonsillectomy mean (SD) (n=22)	Bipolar Dissection tonsillectomy mean (SD) (n=23)	Cold Dissection tonsillectomy mean (SD) (n=25)	*P*-value
Operation time (min)	8.8(3.0)	23.7(4.6)	31.6(11.5)	26.1(6.1)	<0.001
Intraoperative bleeding (cc)	2.7(1.5)	53.2(38.5)	24.3(9.7)	40.3(22.5)	<0.001
Postoperative bleeding rate	7.7%	13.6%	13%	8%	0.86

SD: standard deviation. $P<0.05$: Statistically significant

Postoperative pain

VAS was used to determine postoperative pain levels. The mean VAS scores at the 6th postoperative hour and the first, second, third, and seventh postoperative days were 4.3 (2.5), 4.7 (2.1), 4.6 (2.4), 4.1 (1.8), and 4.0 (2.9), respectively, in the harmonic scalpel group, 5.8 (2.7), 4.5 (2.5), 3.6 (1.9), 3.0 (2.2), and 2.7 (2.6), respectively, in the coblation group, 5.0 (2.2), 4.2 (2.1), 3.9 (2.3), 3.5 (1.7), and 2.6 (3.0), respectively, in the

bipolar dissection tonsillectomy group, 7.5 (1.5), 5.2 (1.5), 4.0 (1.2), 2.6 (1.5), and 1.6 (1.7), respectively, in the cold dissection group.

Postoperative pain scores of the harmonic scalpel, coblation, and bipolar dissection groups were similar (Table 2).

Table 2: Pain levels after tonsillectomy (mean (SD))

	Pain score 6 h	Pain score day 1	Pain score day 2	Pain score day 3	Pain score day 7
Harmonic Scalpel tonsillectomy	4.3(2.5)	4.7(2.1)	4.6(2.4)	4.1(1.8)	4.0(2.9)
Coblation tonsillectomy	5.8(2.7)	4.5(2.5)	3.6(1.9)	3.0(2.2)	2.7(2.6)
Bipolar Dissection tonsillectomy	5.0(2.2)	4.2(2.1)	3.9(2.3)	3.5(1.7)	2.6(3.0)
Cold Dissection tonsillectomy	7.5(1.5)	5.2(1.5)	4.0(1.2)	2.6(1.5)	1.6(1.7)
P-value	<0.001	0.41	0.38	0.02	0.02

SD: standard deviation. $P<0.05$: Statistically significant

The postoperative pain scores were significantly lower in the harmonic scalpel, bipolar and coblation groups compared to the cold dissection group at the 6th postoperative hour ($P<0.001$, $P<0.001$, $P=0.01$ respectively), and in the cold dissection group compared to the harmonic scalpel group on postoperative days 3 and 7 ($P=0.03$, $P=0.02$ respectively).

The mean operation times

The mean operating time was 8.8 (3.0) min (range, 4-17 min**)** in the harmonic scalpel group, 26.1 (6.1) min (range, 15-40 min) in the cold dissection group, 23.7 (4.6) min (range, 13-30 min) in the coblation group, and 31.6 (11.5) min (range, 19-60 min) in the bipolar dissection group (Table 1). It was significantly shorter in the harmonic scalpel group compared to the cold dissection, bipolar dissection, and coblation groups ($P<0.001$ for all), and in the coblation and cold dissection groups compared to the bipolar dissection group ($P<0.001$, $P=0.04$ respectively), while it was similar between the coblation group and the cold dissection group ($P=0.14$).

Postoperative bleeding

Primary bleeding was not observed after tonsillectomy. Secondary bleeding was observed at a rate of 7.7% (2/26) in the harmonic scalpel group, 13.6% (3/22) in the coblation group, 8% (2/25) in the cold dissection group, and 13% (3/23) in the bipolar dissection group (Table 1). There was no significant difference between the groups in terms of bleeding rates after tonsillectomy.

Discussion

Tonsillectomy is one of the most frequently performed surgeries in both children and adults all over the world. Absolute indications for tonsillectomy are tonsillar cancer, tonsillar hypertrophy due to severe airway obstruction, and persistent tonsillar hemorrhage. The relative indications include chronic tonsillitis, recurrent acute tonsillitis, phlegmon, or repetitive peritonsillar abscess [8]. Unlike pediatric tonsillectomy, chronic infection is the most common indication for adult tonsillectomy [9]. In the present study, all adult patients underwent tonsillectomy with complete removal of all tonsillar tissue, due to chronic tonsillitis.

A few studies are comparing the harmonic scalpel and cold knife tonsillectomy methods in adults. In a single-blinded randomized clinical trial, Karimi et al. [10] compared cold dissection and harmonic scalpel tonsillectomy and reported that the mean volume of intraoperative bleeding was significantly lower with 9.59 ml on the harmonic scalpel side compared to 74.38 ml on the cold dissection side. The mean operation time was significantly shorter when using the harmonic scalpel, with 427.63 (196.32) secs compared to 747.84 (271.88) secs. On the first day after surgery, the mean pain level was significantly lower on the harmonic scalpel side and similar on the seventh postoperative day. There was no significant difference in terms of postoperative bleeding rates.

Similarly, in the current study, the mean volume of intraoperative bleeding and the mean operation time were significantly lower in the harmonic scalpel group compared to the cold dissection group. There was no primary bleeding after tonsillectomy and there was no significant difference between the groups in terms of secondary bleeding rates. Akural et al. [11] compared the harmonic scalpel and blunt dissection methods to find that perioperative blood loss was significantly lower on the side where the harmonic scalpel was used. Electrocoagulation was used in all cases on the dissection side, but it was required in only half of the cases on the harmonic scalpel side. Pain scores were significantly higher on the blunt dissection side at the 10th postoperative hour, but in the second postoperative week, the pain scores and level of otalgia were significantly higher on the harmonic scalpel side. They suggested that increased pain intensity and otalgia during the second week after Harmonic scalpel tonsillectomy may be due to a slower healing rate on the Harmonic scalpel. Similarly, the mean VAS scores of our patients in the harmonic scalpel tonsillectomy group were lower in the early postoperative period and higher during the late postoperative period, compared to the patients in the cold knife group.

Harmonic scalpel simultaneously cuts and coagulates the tissue. Less thermal damage occurs, and less electrocautery is required for hemostasis, thereby, it causes less pain during the early postoperative period. Also, the harmonic scalpel provides a clearer surgical field because of less intraoperative bleeding, so the surgery can be performed in a shorter time.

In a single-blinded prospective study of both adult and pediatric patients, Kamal et al. [3] compared the harmonic scalpel and conventional steel tonsillectomy and reported a mean operation time of 15 min for tonsillectomy with the harmonic scalpel and 20 min for the conventional steel tonsillectomy with no significant differences between the groups. However, intraoperative blood loss was 6.2 cc in the harmonic scalpel group, significantly less than the 49.4 ml in conventional steel tonsillectomy. Postoperative pain was lower and there was no major hemorrhage after tonsillectomy that required surgical attention in the harmonic scalpel group. In the current study, the amount of bleeding in the harmonic scalpel group was significantly lower than those in the cold dissection, coblation, and bipolar dissection groups.

Parsons et al. [12] reported less pain over 10 days in the coblation group compared to the harmonic scalpel and electrocautery groups. In the current study, postoperative pain scores were similar between the harmonic scalpel, coblation, and bipolar dissection groups. Basu et al. [13] reported that the postoperative secondary hemorrhage rate (7.8% vs. 1.5%) and intraoperative blood loss (125.62 (25.56) vs. 42.43 (5.31) ml) were significantly higher in the coblation group compared with the harmonic scalpel group. The diet recovery period was

insignificantly shorter and postoperative pain scores were insignificantly lower in the harmonic scalpel group. The mean operation time was significantly longer with 36.96 (4.83) min in the coblation group compared to 20.15 (4.49) min in the harmonic scalpel group. In the current study, the mean operation time was shorter, and the mean volume of intraoperative bleeding was significantly lower in the harmonic scalpel group than in the other groups.

Few publications in the literature compare the harmonic scalpel and bipolar tonsillectomy methods. A prospective randomized multi-unit study by Arbin et al. [14] reported that no significant differences were found in terms of post-tonsillectomy pain scores and the consumption of pain medication between the bipolar dissection and harmonic scalpel tonsillectomy techniques in both pediatric and adult patients. Sheahan et al. [15] compared the harmonic scalpel and bipolar diathermy methods and observed no significant differences in the post-tonsillectomy pain scores between the groups. On the harmonic scalpel side, an alternative technique of hemostasis was used to control bleeding in 14 of the 21 sides. They concluded that the use of harmonic scalpel tonsillectomy is a safe, effective technique, but substantial costs and difficulties of hemostasis may cause limited use of this instrument in tonsillectomy. In our study, postoperative pain scores were similar in the harmonic scalpel and bipolar dissection groups. Rescue electrocautery was used in 5 of 26 (19.2%) patients in the harmonic scalpel group.

The blade part of the Harmonic scalpel device is disposable. Thus, this method is expensive but reduces the transmission of Cruetzfield-Jacob disease [3]. While it can easily stop bleeding from the superficial veins during surgery, additional coagulation methods may be needed. Another disadvantage of harmonic scalpel tonsillectomy is that there is more pain on the 3rd and 7th postoperative days compared to the cold knife method. This may be due to a slower healing rate after harmonic scalpel tonsillectomy [11]. Short operation time reduces the duration of anesthesia and less pain in the early period may cause early discharge, therefore, surgery costs can be reduced. In addition, it does not increase the postoperative primary and secondary bleeding rates.

Limitations

The limitations of our study were the small number of patients and the lack of randomization. Additionally, all patients were operated on by two surgeons. Therefore, further randomized controlled trials with a larger number of patients should be performed by a single surgeon experienced in the current surgical techniques.

Conclusion

This study showed that harmonic scalpel tonsillectomy, easily learned and quickly applied by surgeons, provides a comfortable surgery with low intraoperative bleeding. Harmonic scalpel tonsillectomy is an effective, safe, and promising method in adult tonsil surgery.

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