



Neck dissection with harmonic instruments and electrocautery: a prospective comparative study

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Abstract

Background Harmonic instruments are becoming popular in head and neck surgeries. In this prospective, randomized study, the efficacy of the harmonic instruments and electrosurgical technique is compared.

Materials and methods A total of 48 patients undergoing unilateral neck dissection were divided into two groups. In one group, surgery was performed using conventional hemostatic instruments while in the other, only harmonic instruments were used. The two techniques were then compared with regard to intra- and post-operative blood loss, complications in operating time, drain, tracheotomy and nasogastric tube duration, and post-operative hospital stay.

Results Differences in operative time ($P = 0.647$), total suction drainage ($P = 0.362$) and time that drains ($P = 0.404$), nasogastric tube ($P = 0.378$), and tracheotomy ($P = 0.052$) were kept in place and proved not significant. The average blood loss during surgery was significantly greater in the CH group ($P = 0.003$) as the number of hemoclips and resorbable ligature used ($P = 0.002$).

Conclusions In contrast to what has been reported up to now, our study did not reveal a net advantage in the use of harmonic instruments with respect to classical instruments in terms of surgical outcome. On the contrary, harmonic tools had a higher complication rate (i.e., salivary fistula and lymphatic leak) probably due to the decreased ability of this instruments to permanently close glandular structures and lymphatic ducts. In these cases, a closure technique such as electrocautery or classic knot-tying should be used.

Keywords Harmonic scalpel · Neck dissection · Electrocautery · Harmonic blade · Surgical hemostasis

Introduction

Neck dissection has an important role when treating head and neck squamous cell carcinoma. Over the years, many

technical modifications have been introduced with the goal of preserving vital vascular and nervous structures, while still maintaining oncological radicality [1].

During neck dissection, controlled hemostasis is essential, and several studies have shown that the operative time and the amount of blood loss are connected to the clinical outcomes and the complications rate [2–4].

Many techniques have been introduced in order to reduce the blood loss and intra-operative time during neck dissection, including monopolar and bipolar cautery, radiofrequency ablator, and hemoclips.

Since its introduction in 1990, the Harmonic scalpel (Harmonic®, Ethicon Endo-Surgery, Germany) has become popular in head and neck surgeries [5]. Ultrasonic energy is used to cut and coagulate soft tissues. Its mechanism of action is based on the conversion of electrical energy into mechanical energy (ultrasonic vibration). The handset vibrates at a high frequency (55,000 cycles/s) with a maximum longitudinal displacement of 100 microns [2].

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In maxillofacial surgery, the primary advantage of using the Harmonic scalpel is that the surgical field remains bloodless, therefore facilitating surgery and decreasing operative time by consistently reducing ligatures or electric coagulation for hemostasis [2]. Currently, it is regularly used in head and neck surgery to perform procedures such as tonsillectomy, thyroidectomy, glossectomy, superficial parotidectomy, submandibular gland resection, surgical treatment of rhinophyma, rhytidectomy, resection of oral cavity tumors, elevation of pectoralis major myocutaneous flap [6], latissimus dorsi flap [7], radial forearm free flap, serratus free flap, myomucosal flap [8–10], fibula free flap, and endoscopic resection of the submandibular gland.

A small number of references in literature can be found [4, 11–13] which advocate the use of the Harmonic scalpel to perform neck dissections [2]. Furthermore, there is very limited data which compares the harmonic scalpel and conventional electrosurgical techniques. [1, 2, 4, 12–14].

In this prospective, randomized study, the efficacy of the harmonic instruments and electrosurgical technique is compared, with regard to intra- and post-operative blood loss, complications operating time, drain, tracheotomy and nasogastric tube duration, and post-operative hospital stay.

Materials and methods

A prospective, randomized study was conducted on 48 consecutive patients who underwent unilateral neck dissection for oral cancer treatment at the Maxillofacial Unit of the University Hospital of Sassari, between January 2017 and October 2019.

Patients who had received prior radiotherapy or neck surgery, who presented coagulation disorders, or who underwent a pull-through resection or free flap reconstructions were excluded from the study.

The patients were randomly divided into two groups:

- Harmonic scalpel (HS) group, in which the operation was performed entirely using the Harmonic scalpel and focus and no other hemostatic tools.
- Conventional hemostasis (CH) group: in which the operation was performed using monopolar and bipolar diathermy.

In both groups, when necessary, complete hemostasis was achieved using resorbable ligatures and hemoclips.

All the patients selected to participate in the study underwent a detailed clinical examination of the primary and the metastatic neck nodes. A biopsy of the primary lesion and head, neck, and chest CT scan was done to stage the patients enrolled in the study. All patients were operated on by the same experienced oncologic surgeon. The decision concerning modified radical or

selective neck dissections was based on clinical staging. A transverse neck incision was used, centered on the mid-portion of the sternocleidomastoid muscle, followed by a standard selective or comprehensive neck dissection. In all cases of selective neck dissection, levels I (A and B), II (A and B), III, and IV have been resected. In case of comprehensive neck dissection, surgical removal of level V (A and B) lymph nodes has been associated.

Hemostasis was obtained with bipolar and electrocautery in the conventional group and with the HS in the other group (Video 1). Non-resorbables 2/0 and 3/0 ligatures and hemoclips were as well used in both groups, when necessary. Two 18FR suction drains were placed following neck dissection.

Outcomes of the study included operative time; number of resorbable ligature and hemoclips used; intra-operative blood loss; total fluid drainage; time the drains, the nasogastric tube, and tracheotomy were kept in place; hospital stay; and incidence of intra-operative (major vessel laceration, major nerve injury, penetration into adjacent vital structures such as trachea or esophagus) and post-operative complications (hemorrhage, hematoma, seroma, chylous leakage, and neurologic complications). Other data collected were as follows: patient's age, gender, tumor site, and the type of neck dissection (comprehensive or selective).

The operative time and the intra-operative blood loss were recorded, starting from the cutaneous incision until the removal of the surgical specimen. Suction drainage was used to evaluate the overall amount of blood loss after the procedure and to assess the actual difference between the groups.

The study was approved by the University of Sassari Ethical Committee and conducted in accordance with the Helsinki Declaration of 1973 as revised in 1983. All the patients enrolled in this study signed informed consent.

Data collected were analyzed with the Statistical Package for the Social Sciences (IBM SPSS 24.0.0, SPSS Inc., Chicago, IL, USA). Clinical data collection and analysis were performed by a blinded researcher.

Descriptive statistics for quantitative variables are given as the mean \pm SD. The parameters were compared for two groups by Student's *t* tests (if normal) and Mann-Whitney *U* test (if skewed and other ordinal data). The statistical significance level in all tests was set at $P \leq 0.05$ with a 95% confidence interval.

Results

The total number of cases studied was 48. 24 (50 %) patients undergoing neck dissection with the conventional surgical technique and 24 (50 %) patients with the Harmonic instruments. Clinical and pathological correlations of the primary tumor are shown in Table 1. Both the Harmonic scalpel (HS) group and control group (CH) were homogenous and

comparable with regard to age, sex, BMI, TNM staging, histology of tumor, type of neck dissection, and number of lymph nodes harvested.

A framework summary of clinical outcomes is reported in Table 2. Operative time is longer in the CH group compared with the HS group but it resulted statistically insignificant (71.2 ± 27.2 vs 69.1 ± 22.5 min, respectively; $P = 0.647$). The average blood loss during surgery was significantly greater in the CH group (HS group 225 ± 112.2 mL vs CH group 351.2 ± 101.3 mL, $P = 0.003$). The number of hemoclips and resorbable ligature used was significantly greater in the CH group (HS group 6 ± 3 vs CH group 13 ± 8 , $P = 0.002$). The total suction drainage volume was, on average, slightly higher in the HS group. The difference was insignificant, however (HS group 375 ± 202.22 mL vs CH group 398.25 ± 230.96 mL; $P = 0.362$). Regarding the time that drains ($P = 0.404$), nasogastric tube ($P = 0.378$) and tracheotomy ($P = 0.052$) were removed, and no significant differences were observed between the two groups. Finally, neither of the groups presented significant intra-operative complications. In terms of post-operative complications, only one case occurred in the CH group (salivary fistula) and 7 cases in the HS group (2 lymphatic leaks which required a second operation to repair and 5 salivary fistula).

Discussion

Throughout surgical history, different methods of cutting and coagulation were assessed. These methods attempt to reduce complications by shortening operative time, improving the

surgeon’s comfort, and reducing morbidity. Controlled hemostasis is essential in surgery for neck dissection [15].

The Harmonic scalpel has four effects on the tissues: coaptation, coagulation, cutting, and cavitation. The active blade vibration breaks down the hydrogens bonds caused by defragging of the proteins. These proteins are transformed into a “glue” that seals the smaller vessels. The friction creates a secondary heat which causes protein denaturation. The Harmonic scalpel causes little lateral spread of coagulation, but it increases when the vibration is activated over 4 or 5 s. With the vibration of the active terminal, very rapid changes of pressure are produced in the tissues causing vaporization of intra- and inter-cellular water at a low temperature. This subsequently causes separation of the anatomical planes (Fig. 1), thus facilitating visualization and surgical dissection at temperatures between 60 and 80 °C. The Harmonic scalpel, the laser scalpel, and electrocautery induce oblitative coagulation at high temperatures (150–400 °C). The heat produced is directly proportional to the power level and length of time. The effects of the Harmonic scalpel on the tissues can be controlled by varying the energy level, tissue tension, pressure applied when closing the scissors, and the type of terminal. With higher energy, faster cutting is achieved with less hemostasis result. With a lower power level, hemostasis is more intense, but the cutting is slower. The more tension is put on the tissues, the quicker the speed is when cutting [2].

In literature, few studies have been carried out which compare the efficacy of harmonic instruments to traditional techniques of performing neck dissection. Miccoli et al. [13] compared the use of the HS in a group of 37 patients who underwent thyroidectomy and lateral neck dissection for thyroid carcinoma. A significantly lower operative time and

Table 1 Patients general characteristics

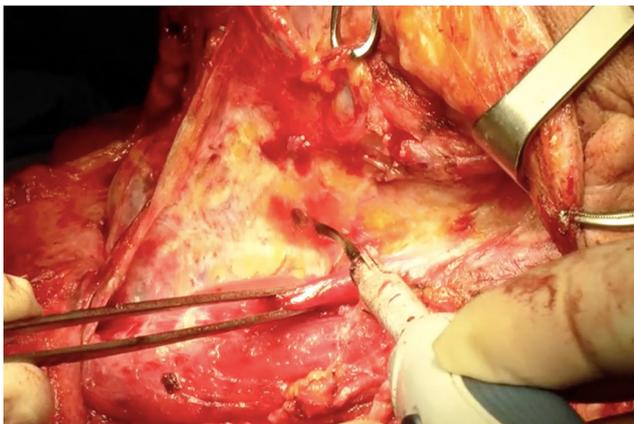
	Harmonic group	Conventional hemostasis	P value
Age	63.3 ± 11.9	61.6 ± 10.2	0.673
Gender (M:F)	17:7	16:8	0.952
BMI	26.3 ± 3.4	28.1 ± 4.5	0.874
Tumor size			
T1	0	1	0.615
T2	15	16	
T3	9	7	
T4	0	0	
Tumor histology			
Squamous cell carcinoma	24	23	1
Adenoid cystic carcinoma	0	1	
Type of neck dissection			
Modified radical	5	5	1
Selective	19	19	
No. of lymph nodes harvested			
Modified radical	33.4 ± 3.6	34 ± 4	0.841
Selective	25.7 ± 3.5	24.7 ± 3.3	0.298

Table 2 Clinical results

	Harmonic group	Conventional hemostasis group	<i>P</i> value
Operative time	69.1 ± 22.5 min	71.2 ± 27.2 min	0.647
No. of resorbable ligature and hemoclips	6 ± 3	13 ± 8	0.002
Intraoperative blood loss	225 ± 112.2 mL	351.2 ± 101.3 mL	0.003
Tracheotomy	11.56 ± 10.33 days	7.55 ± 3.32 days	0.052
Length of drain stay	5.66 ± 1.63 days	5.55 ± 1.5 days	0.404
Total drain output	375 ± 202.22 mL	398.25 ± 230.96	0.362
Length of nasogastric tube stay	15.86 ± 10.31 days	15 ± 7.18 days	0.378
Hospital stay	22.17 ± 12.52 days	18.75 ± 8.08 days	0.151

suction drainage volume in the HS group was found. A study by Walen et al. [4] demonstrated the impact of the HS in patients with head and neck squamous cell carcinoma that required selective neck dissection (levels I–IV). They demonstrated that the HS significantly reduced intra-operative blood loss but had no effect on operative time, post-operative drain output, or complication rate. Agcaoglu et al. [15] compared 47 patients who underwent neck dissection with harmonic or knot-tying hemostasis; it was found that operative time and blood loss was significantly lower in the HS group. Other more recent studies [1, 2, 14, 16] have similar results, revealing a reduction in operative time, a decrease in the intra-operative blood loss, and post-operation drainage volume in the HS group.

In contrast to the majority of the above-mentioned studies, our study did not reveal a significant reduction in operative time in the HS group. In past studies, only Verma et al. [16] and Walen et al. [4] reported that the use of harmonic instruments did not have an impact on the operative time. This piece of data could be correlated to the fact that in our clinical records, in contrast to what has been reported in the majority of the previous studies, the entire neck dissection has been performed with the use of harmonic instruments. In fact, in all the other studies, the elevation of the cervical skin flap is performed with the monopolar scalpel also in the HS group.

**Fig. 1.** Internal jugular vein dissection with harmonic scalpel

On the contrary, in this trial, also the skin flap harvesting was carried out with harmonic blades that resulted somewhat expensive in terms of operative time.

The HS group revealed a significant reduction in intra-operative blood loss. However, from a clinical perspective, this difference, just over 100 mL, is not really that meaningful. Unlike previous studies, in our case, we did not report a reduction in the drainage volume and operative time; rather, they were always greater than the CH group. The differences, however, were not statistically significant.

It is important to notice that the HS operative time was much longer in the firsts cases treated with this device that requires a consistent learning curve to be used with the same ease of a standard electrocautery. This clearly affects the average HS operative time. In a bigger sample, the HS average operative time will probably shorten significantly. The time the tracheotomy and the nasogastric tube were kept in place had never been analyzed in previous studies, and there were no significant differences between the two groups. Regarding the length of the hospital stay, similar to the findings of Verma et al. [16], there were no significant differences between the two groups. In contrast to the findings of previous studies [1, 15], it is interesting to note a high rate of post-operative complications in the HS group. In particular, 5 patients presented salivary fistula and two patients (25% of the left comprehensive neck dissection of our cases) presented lymphatic leaks. It is possible this is due to the decreased ability of the harmonic instruments to permanently close glandular structures and lymphatic ducts. In these cases, a closure technique such as electrocautery or classic knot-tying should be used.

Conclusions

There are still relatively few studies in literature which compare the efficacy of harmonic instruments in neck dissection. In contrast to what has been reported up to now, our study did not reveal a net advantage in the use of harmonic instruments with respect to classical instruments in terms of surgical outcome. Twenty-four patients in each arm is a reasonable

number to make a clinically meaningful point. However, there is a risk we have rejected, i.e., any association between CH and HS techniques and surgical outcomes due to statistical type 2 error. We therefore believe that it would be important to further evaluate this correlation in larger multicenter study.

Furthermore, this study presents the limitation of not analyzing the functional results regarding the outcome of the surgery. It should be investigated if the use of harmonic instruments allow for a better recovery of function, skin sensitivity, and range of movement of the neck and arm, thus permitting a better quality of life, as previously suggested [3]. These parameters are currently our object of observation in homogeneous cases of patients and will be the subject of future studies. However, on the basis of the results of this study, the harmonic instruments did not present a significantly better surgical outcome than the classical electrocoagulation. On the contrary, harmonic tools had a higher complication rate (i.e., salivary fistula and lymphatic leak) probably due to the decreased ability of this instruments to permanently close glandular structures and lymphatic ducts. In these cases, a closure technique such as electrocautery or classic knot-tying should be used.

Compliance with ethical standards

Conflicts of interest The authors declare that they have no conflicts of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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