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Gasless Endoscopic Submandibular Gland Excision Through Hairline Approach

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Background: The aim of this study was to evaluate the therapeutic effect of gasless endoscopic submandibular gland excision through hairline approach and the safety, feasibility and practicability of this technique.

Methods: Twenty-five patients with submandibular gland lesions who underwent gasless endoscopic submandibular gland excision through hairline approach at the Department of Head and Neck Oncology of the West China Hospital of Stomatology from May 1st 2021 to May 31st 2022 were included in this prospective study. The variables were analyzed statistically with SPSS software version 23.0 (IBM Corp, Armonk, New York, USA).

Results: There was a female predominance (72%), female to male ratio was 2.6. The mean age was 30.6 ± 10.2 years (range: 11 to 52 year). All 25 cases of endoscopic submandibular gland excision through hairline approach were done without conversion to conventional approach. This approach was indicated in 14 cases (56%) for pleomorphic adenoma, 8 cases (32%) for chronic sialadenitis, 2 cases (8%) for adenoid cystic carcinoma, and 1 case (4%) for lymphadenitis. The incision length mean was 4.8 ± 0.4 mm (range: 4 to 5 mm); the operation duration mean was 100.6 ± 39.7 min (range: 51 to 197 min); the intraoperative bleeding mean was 13.2 ± 5.7 ml (range: 5 to 20 ml); the hospital length of stay mean was 4.5 ± 0.8 days (range: 3 to 6 days). The follow-up mean was 10 ± 3.4 months (range: 5 to 16 months). The patients were very satisfied with postoperative cosmetic result (score mean: 9.2 ± 1). No recurrence of disease and complications such as postoperative bleeding, hematoma, nerve damage, skin necrosis, infection, and hair loss occurred.

Conclusions: Gasless endoscopic submandibular gland excision through hairline approach is safe, feasible and practicable, resulting in a very satisfied cosmetic result without significant complications; the intraoperative bleeding is less, the operative field is clear, the operation duration decreases with accumulation of experience.

Key Words: Gasless endoscopic surgery, hairline incision, submandibular gland

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Submandibular glands (SMG) diseases are very common.[1] SMG excision may be indicated in cases of SMG tumors, cysts, sialolithiasis, sialadenitis, and chronic drooling (sialorrhea) not responsive to conservative treatment.[2–9] SMG excision is conventionally performed through a lateral transcutaneous cervical approach.[1,2,4,6,10,11] This conventional approach is safe, relatively simple and easy to perform; however, some complications such as unsatisfactory pathologic scars (particularly in patients with a history of hypertrophic scar or keloid formation), nerve injury (marginal mandibular branch of the facial nerve, lingual and hypoglossal nerves), infection, fibrosis, and hemorrhage may occur.[1,2,5,6,8–12] More visible scar on the facial and neck skin may impact the patient's social or psychological well-being as these regions play an important role in the beauty, self-esteem, and social interactions.[11,13,14]

Surgical incisions are unavoidable in patients requiring surgical removal of pathologic lesions,[13] the demands and concerns for better cosmetic results in patients undergoing head and neck surgery are increasing, especially in young patients, with a predominance of female; consequently, surgeons should consider the method and location of the incisions to make as surgical approach.[4,14,15] The ideal incisions should allow the surgeon to have an adequate access to lesions for its removal and guarantee a better postoperative esthetic outcome. This has led surgeons to perform incisions on hidden areas to minimize incision scars and use endoscopic or robotic techniques for removing pathologic lesions of the thyroid, parathyroid, parotid, and SMG.[13,14]

Besides the conventional lateral cervical approach for SMG excision, several endoscopic and non-endoscopic approaches were developed to improve the cosmetic results, such as intraoral approach, facelift approach or posterior retro-auricular hairline incision, submental approach, incision in the crease at

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the hyoid midline, video assisted or endoscopic-assisted retro-auricular approach, endoscopic-assisted hairline approach, and robotic retro-auricular approach or the trans-oral endoscopic approach.[4,6,8,9,11,12,16–18] In general, the extra-oral approaches for SMG excision allow good exposure of the surgical field, good control of bleeding, and present low risk of infection, nerve injury, and fistula formation than the intra-oral approach, in which lingual nerve paresis and limitation of tongue movement are often caused by scar contracture.[10,14,19,20]

The selection of the surgical approach is usually based on patient's individual characteristics and needs; surgeon's skills, experience and familiarity with the approach; and availability of necessary equipment and instrumentation.[7] As some patients worry about the postoperative incision scar, placing the skin incision on a hidden or less prominent site such as the hairline approach may reduce their worries of surgical procedures.[13,15] However, any modified approach should guarantee complete removal of the lesion with acceptable feasibility.[12,15]

Endoscopic techniques usually result in more favorable cosmetic outcomes and decrease the risk and rate of complications occurring in conventional approach.[5,14] Endoscopic surgery is becoming one of the standards and most preferred techniques in many surgical disciplines due to its several advantages. However, endoscopic SMG excision continues to be in the exploratory stage because of the complexity of the anatomy of this region and the surgical procedure.[12,14] There are few studies reporting endoscopic SMG excision in the literature and there are many variants of this surgical procedure that have been reported. The purpose of this study was to evaluate the therapeutic effect of gasless endoscopic submandibular gland excision through hairline approach and the safety, feasibility and practicability of this technique.

METHODS

Patients

Twenty-five patients who underwent gasless endoscopic SMG excision through hairline approach at the Department of Head and Neck Oncology of the West China Hospital of Stomatology of Sichuan University from May 1st 2021 to May 31st 2022 were included in this prospective study. The variables of interest were: gender, age, diagnosis, operation date, incision length, intra-operative bleeding, operation duration, postoperative complications (nerve injury or palsy that may involve marginal mandibular branch of the facial nerve, lingual nerve, hypoglossal nerve, or auricular great nerve, and other complications such as ear lobe paresthesia, hematoma, and skin necrosis), hospital length of stay, follow-up time, and the patients' satisfaction to the postoperative cosmetic result.

The inclusion criteria were: having submandibular gland lesion treated by gasless endoscopic SMG excision using hairline approach at our department during the period retained for this study; giving a free informed consent or agreement to participate in the study; presenting the variables needed for this study (from results of preoperative assessment and CT scanning that determine the diagnosis, extent and location of the lesions, to the intraoperative and postoperative variables). All patients who were medically contraindicated for surgery or general anesthesia, patients who had malignant tumor with high metastatic power (cases of neck lymph nodes metastasis, which requires concomitant neck dissection), previous neck surgery, preexisting facial nerve paresis; and patients who underwent prior radiotherapy, were all excluded from this study. The patients included in the study were followed-up regularly after surgery. Detailed demographic, clinical, and perioperative data are provided in Tables Supplemental 1, Supplemental Digital Content 1, http://links.lww.com/SCS/E972.

Patients' satisfaction with cosmetic results was measured on a scale of very satisfied (scores: 9 to 10), satisfied (scores: 7 to 8), Average (scores: 5 to 6), dissatisfied (scores: 3 to 4) and very dissatisfied (scores: 1 to 2). Each patient was invited to score the degree of satisfaction with postoperative cosmetic result. The assessment of safety, feasibility and practicability of our treatment approach was essentially based on intraoperative and postoperative variables, as well as patients' satisfaction.

SURGICAL PROCEDURE

Step 1: Preoperative Preparation and Incision Design

Preoperatively, Patient's hair over the surgical field is shaved to mark the designed incision and the projection (reflection) of the SMG on the skin surface. Under general anesthesia and nasotracheal intubation , the patient is placed in supine position on the operating table, with the head tilted about 75° to the healthy side (Fig. 1A). The neuromonitor is placed on the orbicularis oris and the sternal body (Fig. 1A). The surgical incision was made according to the preoperative design after routine disinfection and draping (Fig. 1B). To conceal the postoperative scar, the scalp incision is made 1 cm posterior to the hairline. Electrocautery is used to incise skin and subcutaneous tissue while lifting the flap with a 40 mm skin retractor (Fig. 1C). Operating skills and precautions: (1) The surgeon should make the incision while standing in an appropriate position, as this may affect the aesthetic outcome. As said before, the incision should be made 1 cm posterior to the hairline; the skin incision should not extend and cross the hairline. (2) The length of the incision must be balanced between the ease of operation and the aesthetic outcome. Too short incision will lead to the "chopstick effect" (the interference among multiple instruments), while too long incision may result in a poor aesthetic outcome.

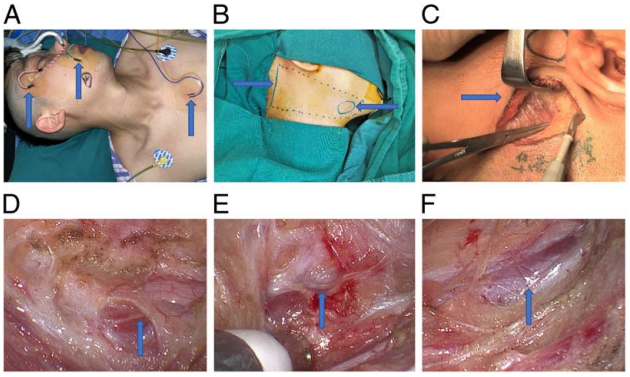

FIGURE 1. Preoperative preparation and intraoperative images (all the images are published with the patients' consent). (A) General anesthesia and nasotracheal intubation (horizontal arrow), placement of the positive terminals and searching units of the intraoperative facial nerve monitoring (vertical arrows). (B) Surgical incision design (left arrow) and projection (reflection) of the submandibular gland on the skin surface (right arrow). (C) Flap elevation and creation of surgical cavity. (D) Great auricular nerve. (E) Parotid lymph node. (F) Facial vein.

Step 2: Flap Elevation and Creation of Surgical Cavity (working space)

After incising the skin, the 40mm skin retractor is replaced with a thyroid retractor, the gap between the muscle and subcutaneous fat is separated with a long-head electric knife along the superficial surface of the sternocleidomastoid muscle (Fig. 1B). Skin hook with the suspension hook is replaced to complete dissection under the endoscope. The anterior border of sternocleidomastoid muscle is then separated along the demarcated area with an ultrasonic scalpel. Because the great auricular nerve arises from the second and third cervical nerves and is the largest branch of the cervical plexus cutaneous, we must pay special attention when approaching the sternocleidomastoid muscle in order to identify and preserve the great auricular nerve (Fig. 1D) and external jugular vein. To reduce numbness near the auricle after surgery, the great auricular nerve and the skin are then lifted together with a retractor. Furthermore, the muscular investing of the sternocleidomastoid muscle should be preserved as much as possible to reduce the postoperative dyskinesia. On dissection of the flap forward, a lymph node may appear in the lower pole of the parotid gland (Fig. 1E), which is significant reference for spatial positioning value. To complete the creation of the surgical cavity or working space, the deep side of the platysma is separated until it reaches the front edge of the submandibular gland. Operating skills and precautions: 1) Because the mandibular angle on the affected side may become an obstruction during the creation of the surgical cavity, when placing the patient position the mandibular angle on the affected side must be raised. 2) During separation or dissection, damage to the external jugular vein or greater auricular nerve should be avoided. 3) The surgical cavity should be kept in a consistent width for the entire length of the cavity. Additionally, the surgical cavity should remain in constant width along the entire length of the cavity because a narrow cavity will form a cone, limiting the field of vision for subsequent operations, and a wide cavity will violate the minimally invasive principle, increasing trauma and lengthening the patient's recovery time.

Step 3: Position of the Submandibular Gland

Because the vision under the endoscope differs greatly from that of open surgery, it is easy to become disoriented, making the location of the submandibular gland difficult. The facial vein may be located too close to the submandibular gland during anatomical dissection. The facial vein runs through the deep surface of the platysma muscle and the superficial surface of the buccinator muscle and masseter muscle. After crossing the superficial layer of the deep cervical fascia, it will pass through the superficial surface of the submandibular gland obliquely backward and downward. So due to this relationship between the facial vein and the submandibular gland, we use the facial vein as a guide to locate the submandibular gland. The facial vein is easily found after entering the deep surface of the platysma (Fig. 1F). When the fascia on the surface of the facial vein is opened and separated bluntly, the deep submandibular gland capsule is visible under light reflection. Operating skills and precautions: Take care to prevent damage to the vein when separating the fascia of the facial vein.

Step 4: Exposure of the Posterior and Lower Boundary of the Submandibular Gland

A vascular clip is used to secure the facial vein, and its proximal end is coagulated and cut with an ultrasonic scalpel (Fig. 2A). Because the posterior and inferior boundaries of the SMG do not have any anatomical structures that require special attention, and the capsule is dense, sharp and blunt separations should be performed next to the SMG until the posterior belly of the digastric muscle, which is the base of the SMG, is visible. Operating skills and precautions: The separation should be maintained close to the submandibular gland capsule, and digastric muscle and the adjacent connective tissues should be actively protected.

Step 5: Exposure of the Upper Boundary of the Submandibular Gland

After exposing the posterior and lower boundaries of the SMG, the upper boundary is turned, and then begins the separation of the upper boundary of the SMG where there are important anatomical structures. The marginal mandibular branch of the facial nerve must be correctly identified and protected (Fig. 2B). Probes can be used to identify nerves so that when the probe touches the nerve, the electrical signal of the muscle changes on the neuromonitor (nerve monitor) and a prompt tone sounds may be heard. In our technique, the submandibular gland's capsule is separated while the marginal mandibular branch of the facial nerve is protected by superficial fascial tissue. Following the exposing of the distal ends of the facial artery and vein to a sufficient length, they are clamped with a vascular clip (Fig. 2A and C), coagulated, and cut with an ultrasonic scalpel. After managing blood vessels and nerves, there is only some connective tissue left in the upper boundary of the SMG, which can be exposed by careful blunt and sharp separation. Operating skills and precautions: When separating with an ultrasonic scalpel near the nerve, do not place the heated part of the ultrasonic scalpel close to the nerve to avoid nerve damage.

Step 6: Exposure of the Deep Surface of the Submandibular Gland

After exposing the posterior, lower, and upper boundaries, the SMG can be lifted from back to front, revealing the SMG's deep surface. The most important anatomical structure of the deep surface of the SMG can be seen when the fascia tissue is separated. To treat the deep surface of the SMG, the proximal end of the facial artery is clamped, coagulated, and cut, and the remaining fascia tissue is separated. Operating skills and precautions: When we expose the facial artery, we must take our time because clamping the artery with a vascular clip is difficult (Fig. 2C). We begin by completely removing some fascia tissue

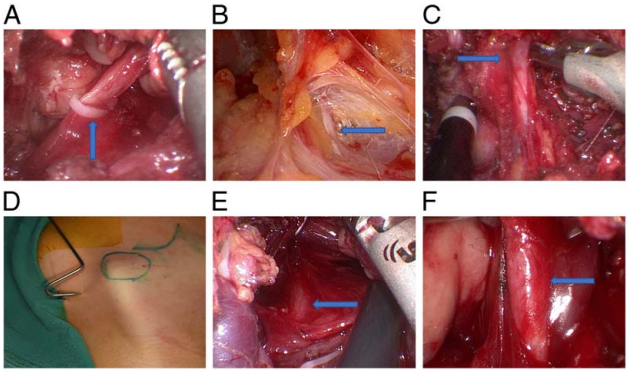

FIGURE 2. Intraoperative images. (A) Facial vein clamped with a vascular clip. (B) Marginal mandibular branch of the facial nerve. (C) Facial artery being clamped with a vascular clip. (D) Skin or Percutaneous punctural retractor location. (E) Lingual nerve. (F) Wharton duct.

around the facial vein; when the facial artery is sufficiently exposed, then we can easily clamp it with the vascular clip.

Step 7: Exposure of the Anterior Surface of the Submandibular Gland

The mylohyoid muscle can be seen after reaching the anterior surface of the SMG when the deep surface of the gland is exposed. After the fascia tissue is separated, the lingual nerve and Wharton duct can be seen in the deep surface of the mylohyoid muscle. The mylohyoid muscle is then retracted using a specific percutaneous punctural retractor (Fig. 2D) to expose the lingual nerve (Fig. 2E) and Wharton duct (Fig. 2F). After exposing the SMG duct (Wharton duct), it is properly clamped and cut more posteriorly to prevent a salivary fistula after the operation. After cutting the duct, slowly separate the remaining fascia tissue from the superficial to the deep surface of the mylohyoid muscle, and the SMG can be completely removed (Fig. 3A). To completely stop the bleeding, a large amount of normal saline solution is used to irrigate the surgical cavity. Neuromonitor probe is used then to check for any further facial nerve damage. Following a thorough examination of the surgical cavity and structures, the wound is closed with a subcuticular suture and a negative pressure drainage tube is placed (Fig. 3B). Finally, the bandage is applied to the surgical area to compress it. The punctural scar left by percutaneous punctural retractor (Fig. 3C,D) and the hairline scar (Fig. 3E,F) show good cosmetic result. Operating skills and precautions: 1) Keep the integrity of the SMG to prevent tumor damage. 2) If there are some minute vessels, such as tonsil artery, etc., it can be coagulated by the ultrasonic scalpel. 3) Pay close attention to the protection of the lingual nerve trunk.

Statistical Analysis

SPSS software version 23.0 (IBM Corp, Armonk, New York, USA) was used for data analysis. Mean and standard deviation (SD) were generated for continuous variables, while the categorical variables were presented as frequencies with percentages.

Ethical Approval

The present study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). All patients were informed about the risks and benefits of the technique as well as the possibility of intraoperative conversion to conventional cervical approach. The informed consent was obtained from all the patients. The protocol for the present prospective clinical study was approved by the Ethic committee and Institutional Review Board of West China Hospital of Stomatology (No. WCHSIRB-D-2020-311-R1).

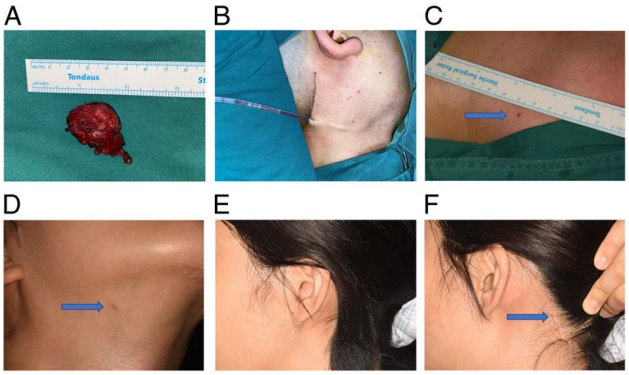

FIGURE 3. Post submandibular gland excision and Follow-up images. (A) The excised submandibular gland. (B) Wound closure with subcuticular suture and placement of negative pressure drainage tube. (C) and (D) Punctural scar barely visible. (E) and (F) Hairline incision hidden by hair.

RESULTS

There was a female predominance in 72% (18 out of 25 cases) with female to male ratio of 2.6. The mean age was 30.6 ± 10.2 years (range: 11 to 52 year). Gasless endoscopic excision of all 25 SMG was performed successfully, with no conversion to conventional approach in all patients; pleomorphic adenoma was diagnosed in 14 cases (56%), chronic sialadenitis in 8 cases (32%), adenoid cystic carcinoma in 2 cases (8%), and lymphadenitis in 1 case (4%). The incision length was ranged from 4 to 5 mm, with a mean of 4.8 ± 0.4 mm. The operation duration was ranged from 51 to 197 min, with a mean of 100.6 ± 39.7 min. The intraoperative bleeding was ranged from 5 to 20 ml, with a mean of 13.2 ± 5.7 ml. The hospital length of stay (LOS) was ranged from 3 to 6 days, with a mean of 4.5 ± 0.8 days. The follow-up was ranged from 5 to 16 months, with a mean of 10 ± 3.4 months (Tables Supplemental 1, Supplemental Digital Content 1, http://links.lww.com/SCS/E972 and 2, Supplemental Digital Content 1, http://links.lww.com/SCS/E972). A good cosmetic result was obtained as the scar was covered by hair; 15 patients were very satisfied with the postoperative cosmetic result, and 10 patients were satisfied with the cosmetic result. The patients' satisfaction scores mean was 9.2 ± 1, which shows that patients were very satisfied with postoperative cosmetic result (Tables Supplemental 1, Supplemental Digital Content 1, http://links.lww.com/SCS/E972 and 3, Supplemental Digital Content 1, http://links.lww.com/SCS/E972). No postoperative recurrence of disease and complications such as postoperative bleeding, hematoma, nerve damage (marginal mandibular branch of the facial nerve, the hypoglossal nerve, and the lingual nerve), skin necrosis, wound infection, and hair loss occurred (Tables Supplemental 2, Supplemental Digital Content 1, http://links.lww.com/SCS/E972).

DISCUSSION

The lateral cervical incision used in conventional SMG excision can result in visible and obvious scars. Although there is no aesthetic problem with the intraoral incision, it makes the wound more susceptible to infection by exposing it to the oral environment. The limitations of the traditional hairline or retroauricular approach such as a narrow surgical view and longer access may be compensated by the use of an endoscope, which provides a better magnified view, allowing clear identification and preservation of the capsule of the lesions, preventing any spillage or rupture of the tumor.[12,13,15] Endoscopic surgeries were initially limited to regions with natural cavities such as the peritoneal and pleural; later, the indications of endoscopic surgeries have been extended to regions without a natural cavity, because during the procedure surgeons are able to create surgical cavities to use as comfortable working space that facilitates the access to the lesion and its removal.[8,12,20–22]

The aim of this study was to evaluate the therapeutic effect of gasless endoscopic submandibular gland excision through hairline approach and the safety, feasibility and practicability of this technique. There was a female predominance (72%), with female to male ratio of 2.6. The age mean was 30.6 ± 10.2 years. The female predominance and young age in patients undergoing endoscopic surgery are consistent findings in the literature because they show more concern for cosmetic result than male and old patients. Kim et al reported female predominance among 27 cases (16/27) of endoscopic maxillofacial masses excision via hairline incision, with a mean age of 23.6 ± 9.4 years;[14] Woo et al reported female predominance

among 20 cases (15/20) of endoscopic SMG excision using hairline incision approach, with a mean age of 38.8 ± 15.0 years.[12] In contrast, Neves et al reported male predominance (61%) among 23 cases of endoscope-assisted retroauricular approach for SMG resection, with a mean age of 44.1 years;[11] Lira et al reported no sex predominance among 8 cases of endoscopic SMG excision via retro-auricular hairline incision.[23]

Endoscopic SMG excision through hairline approach offers several advantages, including its feasibility, the reduced tissue damage, improved cosmetics as scar is hidden by the auricle and hair; lower risk of perioperative complications such as bleeding, infection, and temporary or permanent nerves (marginal mandibular, lingual, or hypoglossal) damages; more rapid wound healing and early recovery; and less postoperative pain.[3,4,6,8,9,11,12,19,21,23] The magnification of the surgical field, which allows good visualization and illumination of the anatomical landmark and structures is one of the great advantages of endoscopic surgery as it facilitates careful dissection of these anatomic structures, making the procedure very safe.[2,4,5,8–11,19] Nevertheless, the view of structures can be confusing at the beginning of one's experience.[5]

There have been many controversies regarding the indications of endoscopic SMG excision through hairline approach. Several authors contraindicate endoscopic SMG excision through hairline approach in cases of malignant lesions as well as non-endoscopic SMG excision, supporting that cosmetic outcome should be considered as second goal after complete tumor removal with safe surgical margins (more radical surgery), which constitutes the primary goal.[3,5,6,12,14,15] Improving cosmetic results should never compromise accurate tumor removal.[12] Incomplete tumor removal will lead to the recurrence of the lesion; additionally, this hairline approach doesn't allow to perform accurately the neck dissection that is required in the majority of malignant lesions,[5,6] due to limited view and access of the central or lower compartment of the neck. Some authors [6,12,15] recommend the conversion to conventional approach by extending the lower end of the hairline incision to the posterior and lower neck in case of diagnosis of malignancy by intraoperative frozen biopsy.

According to many authors,[3,5,6,12,14,15] chronic sialadenitis or severely infected gland can lead to difficult dissection of the gland with surrounding tissues due to their high degree of adhesion and existence of fibrosis; consequently it may be considered as relative contraindication for an inexperienced surgeon in order to avoid the occurrence of serious complications due to nerve and vascular damages by traction injury. Komatsuzaki et al considered the intraglandular sialolithiasis as main indication for endoscopic SMG excision,[3] while Hamza and Khalil, in contrast, considered sialadenitis as main indication; however;[22] all these authors contraindicated this technique in cases of any SMG tumor, whether benign or malignant, due to the risk of tumor rupture and spillage of tumor cells during dissection.[3,22] According to Song et al, the main indications of endoscopic SMG excision via hairline incision include intraparenchymal SMG sialolithiasis and a benign tumor confined inside the SMG; the authors consider any malignant SMG tumor as a contraindication for this approach.[10] Chen et al reported inflammatory diseases and benign tumors as indications of endoscopic SMG excision.[6] In the study of Kim et al, SMG benign masses were the indications of endoscopic SMG excision through hairline incision; malignant and inflammation lesions were the contraindications.[14]

In our study, endoscopic SMG excision through hairline approach was indicated in 14 cases (56%) for pleomorphic adenoma (PA), 8 cases (32%) for chronic sialadenitis (CS), 2 cases (8%) for adenoid cystic carcinoma (ACC), and 1 case (4%) for lymphadenitis (LA). Gasless endoscopic excision of all 25 SMG was performed successfully, with no conversion to conventional approach in all patients. The final histopathological examinations confirmed the preoperative diagnosis and oncologic safety margins were free of tumor in all cases of tumors. Lira et al reported PA as first indication (3/8), followed by sialadenitis (2/8), and confirmed the use of this approach in one case of malignant tumor diagnosed as cribiform ACC.[23] Neves et al reported also PA as first indication (53%), followed by sialadenitis (31%), and confirmed the use of this approach in 4 cases of malignant tumors (16%), especially 1 case of ACC, 2 cases of mucoepidermoid carcinoma, and 1 case of oncocytic carcinoma, which were all resected with free oncologic safety margins.[11] Lee et al reported the use of this approach for SMG PA (14/19) and CS (5/19).[15] Song et al reported a case of endoscopic resection of SMG trough a posterior hairline incision indicated for SMG PA.[10] In contrast, Woo et al reported salivary stones as first indication of endoscopic SMG excision using hairline incision approach (10/20), followed by Warthin's tumor (6/20) and PA (4/20).[12]

Regarding SMG excision for benign tumors, the use of retroauricular or hairline approach is recommended only in case of non-large benign tumors, because the removal of large benign SMG tumors by this approach may be associated to the risk of tumor spillage.[6] The most common tumor of the SMG is PA; a pseudocapsule is usually formed around the adenoma in the normal tissue due to the slow compression of expanding tumor to the circumferential tissue of the gland.[24] To avoid intraoperative tumor rupture and spreading of tumor cells in normal tissues, which increase the risk of recurrence of PA, an avascular plane rounding the pseudocapsule should be well located as well as the SMG capsule, and an extracapsular (exocapsular) dissection (between the capsule and the circumferential tissue under magnification of the endoscope) should be achieved for complete removal of SMG and tumor, as well as satellite nodules and pseudopodia of the tumor.[4,5,24]

In the present study, the incision length mean was 4.8 ± 0.4 mm (range: 4 to 5 mm); the operation duration mean was 100.6 ± 39.7 min (range: 51 to 197 min); the intraoperative bleeding mean was 13.2 ± 5.7 ml (range: 5 to 20 ml); the hospital LOS mean was 4.5 ± 0.8 days (range: 3 to 6 days). The follow-up mean was 10 ± 3.4 months (range: 5 to 16 months). The patients were very satisfied with postoperative cosmetic result (score mean: 9.2 ± 1). No complications such as postoperative bleeding, hematoma, nerve damage, skin necrosis, wound infection, and hair loss occurred among our patients. To date, no recurrence of disease was encountered. Woo et al reported the mean length of the scalp incision of 55.2 ± 5.62 mm (range: 50 to 65 mm), all the tumor cases had resection margins free of tumor; the average operating time was 82.5 ± 18.5 min (range: 60 to 110 min); blood loss was minimal; the average follow-up was 16.2 months, with one case of temporary facial nerve palsy that recovered within two months, two cases of postoperative numbness in the ear lobe that disappeared within three months; and the mean patient satisfaction score for the hairline incision scar was 9.77 ± 0.57 points (range: 8 to 10 points).[12] Neves et al reported an operation duration mean of 86.4 min (range 75 to 300 min), slightly higher in cases of malignant tumors due to the histopathological characteristics of the primary tumor; the hospital LOS mean was 1.2 days (range 1 to 4 days); there were 10 cases of postoperative marginal nerve paresis and 1 case of seroma, without surgical site infections or systemic complications; the mean follow-up time was 27.8 months (range 4 to 47 mo).[11] Song et al reported an operation time of 84 minutes, without wound-related complica-

tions and nerves damage; the patient was discharged on the 5th postoperative day, and the patient was satisfied with the excellent cosmetic result.[10]

During endoscopic SMG excision through hairline approach, we must pay special attention when approaching the sternocleidomastoid muscle (SCMM) in order to identify and preserve the great auricular nerve (GAN) and external jugular vein (EJV). To reduce numbness near the auricle or in the ear lobe after surgery, the GAN and the skin were then lifted together with a retractor. To reduce postoperative dyskinesia, the muscular investing of the SCMM should be preserved as much as possible. Lee et al suggested also the sub-GAN dissection through the potential plane between the GAN and SCMM;[25] this allows a direct and wide exposure of the posterior third of the SMG called "the vascular pole," because it contains both the facial artery and vein.[2] Since the endoscopic SMG excision through hairline approach is performed at the posterior side of the SMG, an adequate exposure of the posterior portion of the SMG is extremely important for a more effective exposure and identification of key anatomic structures adjacent to SMG.[25]

After creation of working space through skin incision and subcutaneous preparation, the space can be maintained by carbon dioxide (CO2) insufflation (balloons are inflated with CO2 in the sub-platysmal space to exert a considerable pressure in all directions) or with the use of specific retractor device for mechanical upward elevation of the skin flap while introducing the endoscope for gasless endoscopic surgery. The gasless endoscopic SMG excision used in our study allows the avoidance of complications associated to CO2 insufflation during creation and maintaining of working space in the neck, including massive subcutaneous emphysema, hypercarbia, CO2 embolization, pneumothorax, risk of occluding the carotid artery leading to some types of arrhythmias, and risk of increased intracranial pressure due to jugular vein collapses.[4,5,7,10,21,22]

In our technique, the endoscopic surgical instruments used were manipulated without any difficulty by two surgeons during each procedure: main operator and assistant. The assistant maintained the operative view by holding the endoscope inside the surgical cavity or working space created, which was maintained with a specific retractor fixed to a specific suspension hook system without need of third surgeon hand to hold it. Vessels were clamped using vascular clips and SMG excision was performed with an ultrasonic scalpel by the main operator. Sometimes it may be difficult to manipulate the instruments in this narrow space with possibility of collisions between the main operator and the assistant.[23] Endoscopic surgery instruments should be used carefully and any improper traction must be avoided because of the high risk of bleeding and nerves damage.[12,15,19]

Although the dissection of the SMG is usually performed with the ultrasonic scalpel for the most part of the procedure, bipolar or monopolar electrocautery may be also used, especially during the creation of working space and skin flap elevation.[10] Advantages of using the ultrasonic scalpel include reduction of the risk of thermal injury to the marginal mandibular nerve and other tissue damage with almost no electrical energy transmission to the patient compared to monopolar or bipolar electrocautery.[7,10,19] The ultrasonic scalpel provides good hemostasis and minimizes injury to important structures and it is more effective in preventing bleeding than stopping bleeding.[10] Because the hemostatic action of the ultrasonic scalpel is progressive and slower than unipolar or bipolar electrocautery, in case of error, its effects are partially reversible at the beginning.[7,19] Additionally, ultrasonic scalpel provides better visualization of the operative field, with the absence of smoke, char, and odor.[10]

The surgical area must be kept completely bloodless to avoid endoscopes getting opacified and the fascias, drenched of blood, and mask the structures below such as nerves and vessels.[19] An accurate blunt dissection accompanied by frequent hemostasis should be done during the whole procedure to keep the endoscope clean and the operating field bloodless.[19,21] Better visualization of the bleeding point and the utilization of the ultrasonic scalpel contribute to the less operative bleeding.[22] In case of SMG excision for sialoadenitis, the hemostatic phase can be longer due to high adhesion of the gland with surrounding tissues.[19]

The main disadvantage of endoscopic SMG excision through hairline or retrauricular approaches is the slightly longer duration of the operation, which may be acceptable because of the high cosmetic outcome of the procedure.[3–7,10–12,14,15,19] The longer operation duration in endoscopic SMG excision through hairline approach is due to the associated learning curve needed for surgeon to become familiar with the technique, the equipment setup time, the time spent in elevating the flap to create a comfortable working space, and the careful dissection required due to the type of disease and the location of SMG below the mandible, surrounded by several important nerves and vascular structures.[3,6,7,10,11,14] However, in their study, Lee et al showed no significant difference of operation duration between patients who underwent endoscopic SMG excision and those who underwent conventional SMG excision; the authors attributed the decrease in operation duration in endoscopic group by the accumulation of experience.[15] Many authors [4,5,11] confirmed this reduction of operation duration secondary to accumulation of experience. Other drawbacks of endoscopic techniques include the more expensive cost of surgical equipment and the technical skills required to surgical team.[5,7,19,23] According to some authors, another possible disadvantage of the retroauricular as well as hairline approach may be increased risk of recurrence of disease.[6] We support that this approach may be limited in removing large benign tumors of the SMG; and for highly malignant lesions, the hairline approach cannot be indicated because the exposed space is not enough to dissect the cervical lymph nodes in addition to SMG excision.

In this study, we summarized the procedure steps, surgical skills and precautions for gasless endoscopic SMG excision through hairline approach. Our approach provides the following advantages: (1) The scar is hidden behind the hairline (Fig. 3E,F), which provides a very satisfied cosmetic result to both patient and surgeon. (2) Endoscope technology provides adequate illumination and magnification of the surgical procedure. The operation is performed in a bloodless field, which allows for the identification of the blood vessels, nerves and other anatomical structures. Furthermore, it allows for effective dissection while minimizing tissue and blood vessel damage. (3) Our approach clearly identifies and saves the envelope of the lesion to prevent the tumor from rupturing. (4) No CO2 filling or complicated surgical robots are required; instead, gasless endoscopy is used, which is simple to practice and promote. (5) Nerves can be identified and protected using a nerve monitor (neuromonitor). (6) A percutaneous retractor (Fig. 2D) is used to lift the mylohyoid muscle, allowing better access to the lingual nerve and submandibular duct. This percutaneous retractor only needs to put a small hole in the skin (Fig. 3C, D), which will not affect the beauty after healing,

The main limitation of this study is the relatively small number of patients, which may influence the interpretation of our findings. However, this small number of patients is mainly justified by the rarity of this procedure. The second limitation is the follow-up duration that was shorter for the majority of

patients included in this study; consequently, we cannot confirm the definitive absence of recurrence, especially for pleomorphic adenoma as well as other long-term complications. It was reported in the literature that pleomorphic adenoma recurrence could occur 3 to 9 years after primary surgical removal, and some complications such as Frey syndrome could appear after a delay of 2 to 3 years (Kim et al, 2019). All our patients will continue regular follow-up, because a longer follow-up duration and a prospective comparative study between this approach and conventional approach with a large sample will be necessary to provide further information and determine the long-term postoperative outcomes of this approach.

CONCLUSIONS

Gasless endoscopic submandibular gland excision through hairline approach resulted in a very satisfied postoperative cosmetic result without complications usually found in conventional approach or other modified approaches of submandibular gland excision. The endoscopic surgery instruments when they are used carefully after creation of a comfortable working space allow good visibility of surgical field and safe submandibular gland excision without need of gas insufflation. Our findings confirmed the safety, feasibility and practicability of gasless endoscopic submandibular gland excision through hairline approach, as the intraoperative bleeding is less, the operative field is clear, the operation time is significantly shortened with accumulation of experience, and the postoperative recovery is quicker. As part of the advancement of endoscopic surgery, we have designed a shorter hairline incision and adopted a new type of retractor technology to make the surgery more convenient and decrease the operation duration. We hope that the detailed explanation of the surgical procedure provided in our study will improve understanding of this surgical technique and promote this new technology.

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