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Esophageal Motility Changes after Thyroidectomy; Possible Associations with Postoperative Voice and Swallowing Disorders: Preliminary Results

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Abstract

Objective. Swallowing and voice impairment are common after thyroidectomy. We evaluated short-term functional changes in esophageal motility in a series of patients who had undergone total thyroidectomy. Several studies have investigated these symptoms by means of interviews or questionnaires.

Study Design. Prospective study.

Setting. Academic research.

Materials and Methods. Thirty-six consenting patients were prospectively recruited. Eligibility criteria were thyroid volume $\leq$60 mL, benign disease, and age between 18 and 65 years. Exclusion criteria were previous neck surgery, severe thyroiditis, hyperthyroidism, and pre- or postoperative vocal cord palsy. Voice impairment score, swallowing impairment score, lower esophageal sphincter pressure, esophageal motility, upper esophageal pressure, and coordination were evaluated preoperatively and 30 to 45 days after surgery.

Results. Postoperative swallowing impairment (appearance or worsening of dysphagia) was found in 20% of patients and voice impairment in more than 30%. Both preoperative and postoperative esophageal motility were similar. All patients showed an average decrease of 25% in upper esophageal pressure, although the pressure was within normal range. Swallowing alterations were associated with upper esophageal incoordination ($P < .03$), and proximal acid reflux was significantly associated with voice impairment ($P < .02$).

Conclusion. After uncomplicated thyroidectomy, decreased upper esophageal pressure may explain both pharyngeal (dysphagia) and laryngeal (vocal impairment) exposure to acid. In the future, proton pump inhibitor therapy protocols should be evaluated.

Keywords

thyroidectomy, dysphagia, voice impairment

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Thyroidectomy is a widely practiced procedure.[1,2] Subjective aerodigestive symptoms such as voice and swallowing impairment are fairly common adverse consequences of thyroidectomy[3] and are usually imputed to laryngeal nerve injury.[4,5] Both the superior laryngeal nerve (SLN) and recurrent laryngeal nerve (RLN) are involved in swallowing. The internal branch of the SLN provides sensation to the supraglottic space and vocal cords, and injury can cause dysphagia and aspiration,[1] while the external branch is the motor nerve to the cricothyroid muscle, which provides tension to the vocal cords.[6] The RLN provides for all the intrinsic laryngeal muscles except the cricothyroid muscle.[7] Although the anterior branch of the RLN, which is involved in swallowing disorders as well as voice impairment,[8] seems to show intense electrophysiologic activity on stimulation during nerve monitoring,[9] the posterior branches of the nerve may provide motility to the cricopharyngeus muscle. In fact, patients with unilateral inferior laryngeal nerve palsy complain of swallowing disorders in about 30% of cases.[3,10,11] The inability to close the glottis completely could explain the

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association between swallowing impairment and RLN injury.[11] However, in most cases, these disorders appear after uncomplicated procedures.[11-13] The most reported symptoms are hoarseness, sensation of a ''lump,'' a foreign body, a ''too-tightly-buttoned shirt collar,'' sensation of being strangled, cough, effort, and/or obstacle during swallowing.[2,3,12,13] These are usually transient and occur in the first week after thyroid surgery,[13] although they are occasionally reported long after the operation.[11] The possible causes are orotracheal intubation, surgical trauma, scar and surgical site adhesions, and psychological reaction to the operation.[3,11-13] It has been hypothesized that injuries to the extrinsic perithyroidal neural plexus, which innervates the pharynx, to the thin anastomoses connecting the RLN and the external branch of the SLN, or to the sympathetic cervical chain with both the RLN and SLN, are involved in swallowing disorders.[3,12]

To date, postthyroidectomy voice changes have been widely studied, but only a few studies have examined postthyroidectomy swallowing impairment[11-13] by means of interviews and/or questionnaires. This prospective study is the first to specifically examine some functional changes in esophageal motility after thyroidectomy in a short period of observation. It should be completed with subsequent patient evaluations at 6 to 12 months.

Materials and Methods

From January 2010 to September 2011, all patients between the ages 18 and 65 years scheduled for total thyroidectomy because of the presence of a thyroid nodule or a multinodular goiter detected by palpation and/or imaging were considered eligible for this study. We established the following exclusion criteria: total thyroid volume $\geq$60 mL, evidence of malignancy (need for central and/or lateral neck dissection), previous neck surgery, severe thyroiditis, hyperthyroidism, pre- or postoperative vocal cord palsy, previous laryngeal disease requiring surgical treatment, pulmonary diseases, and smoking habit. Thyroid volume was calculated preoperatively with the following ultrasound criteria: ld $\times$ td $\times$ th $\times$ 0.5 (ld: longitudinal diameter of the single lobe; td: transversal diameter; th: lobe thickness; 0.5 is a correction factor used to transform the obtained amount from parallelepiped into an ellipsoid). The calculation of the lobe volume was made separately and the values added up later. The workup of the thyroid nodule(s) was established according to American Thyroid Association guidelines.[14] If a fine needle aspiration biopsy was performed, the sample undergoing cytologic examination was classified according to the Bethesda system,[15] and patients with nodules counted in the V or VI diagnostic category were excluded. The patients showing an antithyroid antibody pattern (TPO Ab–Tg Ab), indicating the presence of Hashimoto's thyroiditis, were also excluded in the presence of the following coexisting ultrasonographic signs: coarsened parenchymal echo texture, glandular parenchyma hypoechoic compared with a normal one, and fibrotic septations producing a pseudolobulated appearance of the parenchyma. Four weeks after surgery, all patients underwent fT3-fT4 and thyroid-stimulating hormone (TSH) examinations. The patients showing a TSH out of the normal range (0.3-3 mUI/L) were excluded from the study. All patients underwent a fiber-optic laryngoscopy before and 24 hours after surgery. If vocal cord palsy was found, the patient was excluded from the study. Patients with postoperative hematoma or hypocalcemia (calcium value $\leq$8 mg% and/or need for additional calcium therapy) persisting 4 weeks after surgery were also excluded.

Table 1. Demographic data.

Age, y	
Range	26-65
Mean (SD)	48.6 (10.6)
Sex, No.	
Male	10
Female	26
Technique, No.	
Conventional	20
Open mini-incision	7
MIVAT	9

Abbreviation: MIVAT, mini invasive video-assisted thyroidectomy.

Thirty-six patients (26 women, 10 men), with a mean (SD) age of 48.6 (10.6) years (range, 26-65 years), were recruited for the study after they accepted to participate by signing an informed consent. Patients' demographic characteristics are reported in **Table 1**. Sixteen patients refused to participate in the study. Institutional Ethics Committee (Comitato Bioetico A.O.U.P.) approval was also obtained. All patients were operated on by the same surgical team (2 surgeons among G.G., G.S., and N.C.P. for each procedure). All surgical procedures were total bilateral extracapsular thyroidectomies. Treatment of the upper pedicle was done by moving the upper thyroid pole laterally, exploring the intercricothyroidal space to avoid any injury to a low-situated nerve, and separately ligating the branches of the superior thyroid artery as low as possible. The recurrent laryngeal nerve was prepared from this access in the neck to its entrance into the larynx. An energy-based surgical instrument was used only for carrying out minimally invasive procedures, performed in 16 cases, of which 9 were mini invasive video-assisted thyroidectomy (MIVAT) for thyroid volume less than 25 mL and 7 minimal-incision (3.5 cm or less) thyroidectomies (MIT) for thyroid volume between 25 and 40 mL. The 20 conventional techniques were done with the knot-tying technique. No nerve monitoring was done.

Patient Assessment

Voice and swallowing functions were examined by means of 2 specific questionnaires available in the literature[11,12]: the voice impairment score (VIS; Appendix 1, available at otojournal.org) and swallowing impairment score (SIS; online Appendix 2). The VIS varied from 0 (no voice impairment) to 40 (maximum voice impairment). The SIS varied from 0 (no swallowing impairment) to 20 (highest swallowing impairment). These questionnaires,[11,12] although not validated in other studies or in a healthy population,

were specifically designed to analyze a spectrum of symptoms reported by patients (online Appendixes 1 and 2). Both VIS and SIS questionnaires were administered in the preoperative period and 30 to 45 days after surgery. No objective evaluation of voice disorders was done.

Lower Esophageal Sphincter Pressure, Esophageal Motility, Upper Esophageal Sphincter Pressure, and Coordination

Lower esophageal sphincter (LES) pressure, esophageal motility, upper esophageal sphincter (UES) pressure, and coordination were evaluated with esophageal manometry, carried out preoperatively and 30 to 45 days after surgery. Drugs interfering with esophageal motility, such as calcium channel blockers or nitrates, were discontinued 3 days before the test. Patients were studied after an overnight fast using a Narco Bio System MMS 200 manometer (International Biomedical Inc, Austin, Texas) equipped with 8 electrodes connected to an International Biomedical Model 745-0100 (International Biomedical Inc, Austin, Texas) pneumo-hydraulic capillary infusion system with 8 perfusional channels. Arndorfer (Greendale, Wisconsin) multilumen manometric probes were used in various combinations with an open-end tip provided with 6 or 8 helical side holes spaced at 5 cm from one another. All probes were graduated (intervals of at least 1 cm) to allow measurements of catheter depth and the length of the sphincter. Position, pressure, length, and relaxation of the LES were measured by using the dynamic pull-through technique (normal LES pressure: 12-30 mm Hg). The LES and UES relaxation in response to swallowing was classified as complete when the LES and UES pressures decreased to the baseline pressure, absent when it did not change, and incomplete when it decreased but failed to reach the baseline value completely. **Figures 1A** and **1B** show a diagram of esophageal pressures around the UES in 1 of 2 patients in whom UES incoordination appeared de novo after thyroidectomy. The 3 tracks are traced by 3 different probes 5 cm distant from one another. The bottom numbers indicate the distance in centimeters of the first probe from the nostril. The peaks of the first track indicate the activity of hypopharyngeal muscles and correspond with the swallowing event. The second track represents the UES pressures: the positive peaks correspond to resting pressure, whereas the negative ones correspond to relaxations related to swallowing. The third track represents the muscular activity of the proximal esophagus. The UES pressure is calculated as the average of peaks of pressure.

Esophageal body function was assessed by giving 5 wet swallows of 5 mL of water at 30-second intervals. The speed and amplitude of the contractions were analyzed in the entire esophagus.

Concerning pH monitoring, performed at the time of postoperative control, acid-suppressing medications were discontinued 5 days (H2 blockers) or 7 days (proton pump inhibitors) before surgery. Gastroesophageal reflux was considered abnormal according to standard criteria of measurement or gastroesophageal reflux (DeMeester score).[16] Below the threshold of 14.7, the result was considered normal. We used the MICRODIGITRAPPER (Medtronic Functional Diagnostics, Shoreview, Minnesota), a pH-meter with an antimony disposable pH catheter equipped with 2 sensors spaced 15 cm apart. Ambulatory pH monitoring was done by placing a pH probe 5 cm above the upper border of the manometrically determined LES. The probes were calibrated in a standard buffer solution at pH 7.1 and 1.07 before *and* after monitoring. A pH software analysis program (pH software analysis program: Polygram 98 Diagnostic Workstation software; Medtronic Functional Diagnostics, Shoreview, Minnesota) was used to record, store, view, and analyze gastroesophageal pH data.

Videofluorography

Finally, all patients who underwent the pre- and postoperative manometric examination for inclusion in the study also underwent a videofluorographic examination, with the aim of identifying the presence of the following swallowing disorders: vocal cord and soft palate dysmotility; alterations in oral and pharyngeal swallowing phase, hyoid bone movement, epiglottic tilting, and esophageal clearing; and gastroesophageal reflux. All videofluorographies were carried out and assessments made by a single, experienced radiologist (G.L.R.) in a single setting, thus obviating the need to identify potential interobserver reliability. Given the short study period and the small number of procedures, we believe that no measurement of intraobserver reliability was necessary.

Statistical Analysis

Continuous variables were summarized as means and standard deviation. Differences in the means were evaluated by a paired Student *t* test. Wilcoxon signed-rank test was used for noncontinuous variables. A χ^2 test was applied to categorical variables. A *P* value of less than .05 was considered statistically significant. All *P* values were 2-tailed. All statistical analyses were done with SPSS 17.0 (SPSS, Inc, an IBM Company, Chicago, Illinois).

Results

The demographic data are summarized in **Table 1**. **Table 2** shows manometric findings. We observed a considerable frequency of both voice and swallowing disorders in the preoperative period: 20 patients (64%) had some symptoms of voice disorders, and 28 patients (78%) had some swallowing disorders, although in a few cases, these symptoms were mild or sporadic. **Figure 2** shows the VIS and SIS scores before and after thyroidectomy. Most of these patients improved after the operation; in fact, 30 to 45 days after surgery, we found only 15 patients (42%) with voice impairment and 20 (64%) with swallowing impairment. However, voice disorders in 12 patients (33.3%) and swallowing disorders in 7 patients (20%) worsened or appeared de novo (voice disorders in 8 patients and swallowing disorders in 5). The patients with a de novo appearance of voice disorders most frequently had severe impairment.

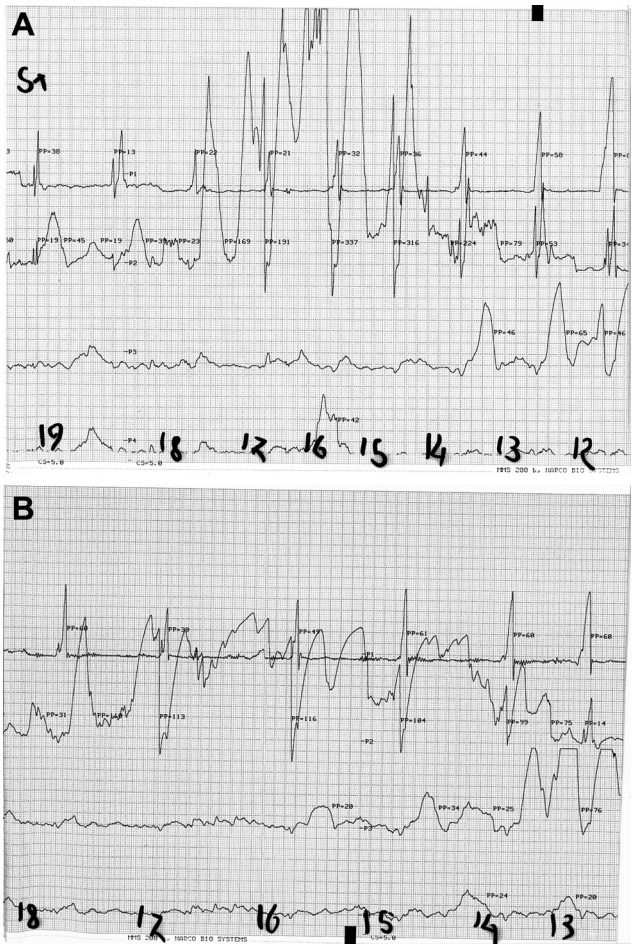

Figure 1. (A) Manometric findings of upper esophageal sphincter (UES) prethyroidectomy in 1 patient. (B) Manometric findings of UES postthyroidectomy in the same patient. Resting UES pressure (second track) is lower compared with the preoperative record. Fourth track represents muscular activity 5 cm below the proximal esophagus.

Thyroidectomy did not significantly influence LES pressure (P = .8). Both preoperative and postoperative esophageal body motility were similar (P = .4). All patients showed a significant decrease in UES pressure, although it was within normal range (P < .001).

Interestingly, the patients in whom UES incoordination appeared de novo after thyroidectomy (only 2) had a mean difference between pre- and postoperative UES pressure of 47.5 mm Hg. Both patients showed a worsening SIS, although there was little change in the VIS. The 34 patients with unvaried coordination from the pre- to the postoperative period had a difference in pressure of 21.6 mm Hg.

Swallowing impairment was significantly associated with UES incoordination (**Table 3**), whereas voice disorders were significantly associated with proximal acid reflux (**Table 4**). Videofluorography did not identify a specific motor pattern, and the association between disorders and symptoms was unclear. Altogether, we found epiglottic tilting asymmetry in 2 patients, esophageal dyskinesia in 14, and gastroesophageal reflux in 13. No association between thyroid volume or technique (MIVAT, MIT, conventional), symptoms, and manometric data was found.

Discussion

Our study confirmed the association found in the literature between uncomplicated thyroidectomy and changes in voice and swallowing. It is well known that patients undergoing thyroidectomy have several symptoms that cause neck discomfort unrelated to vocal cord function.[3] These symptoms are frequently reported during postoperative consultations and can lead to anxiety, complaints, and dissatisfaction with the surgical procedure, although no surgical complications are clearly verifiable. In fact, several studies[1,3-5,10-13] have evaluated these symptoms, and 2 studies[12,13] analyzed objective parameters related to voice impairment. To date, no studies concerning instrumental evaluation of postthyroidectomy esophageal motility have been published.

In our study, changes in voice and swallowing included various symptoms investigated with the VIS and SIS questionnaires. These symptoms usually resolve in a few weeks or months, although they can persist for some time. The presumed causes are orotracheal intubation, changes in

Table 2. Manometric findings (paired Student *t* test).

	Preoperative	Postoperative	*P* Value
UES pressure, mm Hg, mean (SD) (normal range, 50-150 mm Hg)	91.8 (17.7)	68.6 (9.5)	<.001
UES motility, No.			.046
Normal	27	34	
Dysmotility	9	2	
Esophageal motility, No.			.4
Normal	18	22	
Dysmotility	18	14	
LES pressure, No.			.8
Normotonic	23	21	
Hypertonic	13	15	

Abbreviations: LES, lower esophageal sphincter; UES, upper esophageal sphincter.

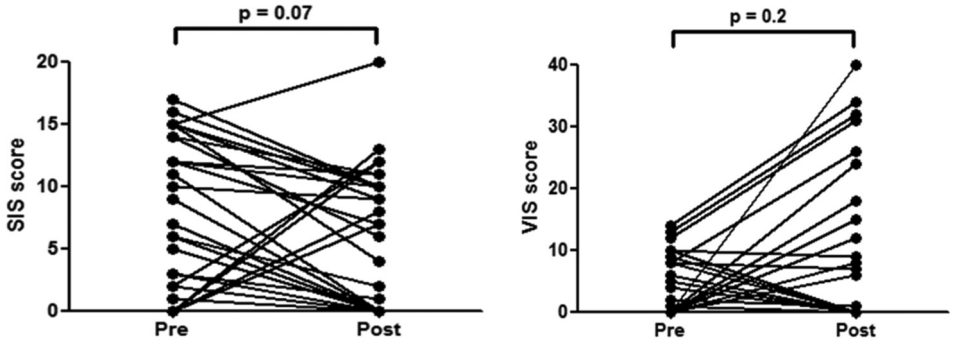

Figure 2. Wilcoxon signed-rank test of voice impairment score (VIS) and swallowing impairment score (SIS) before and after thyroidectomy.

Table 3. Upper esophageal sphincter coordination and postoperative swallowing impairment.

Swallowing Impairment	Coordination	Incoordination	Total	*P* Value
Yes	2	5	7	.03
No	29	0	29	

Table 4. Voice and postoperative reflux.

Reflux	Voice Impairment	No Symptoms	Total	*P* Value
Yes	7	4	11	.02
No	5	20	25	

laryngeal vascular supply and drainage, cricothyroid dysfunction, adhesions between the tissular layers in the surgical site, denervation of strap muscles, postoperative neck pain, and psychological distress.[11] Evidence of a significant association between voice and swallowing impairment suggests a common origin. The symptoms may be a consequence of damage to fine anastomoses between branches of superior and inferior laryngeal nerves and the sympathetic cervical plexus, a hypothesis that has been recently investigated.[3] Anatomic studies have carefully described these anastomoses,[17-19] of which the ansa galeni is the best known. Other minor branches, together with other nerve fibers arising from both the somatic and autonomous cervical systems, participate in pharyngeal and laryngeal innervation.[3] These thin structures can be damaged during thyroidectomy, and this may explain the contemporaneous appearance of both symptoms. Nevertheless, it is difficult to explain the consistent decrease in UES pressures after thyroidectomy found in our study. This decrease had a maximum spread of 60 mm Hg and a minimum one of 5 mm Hg, with an average of 25%. Although the pressures usually did not arrive at pathologic levels and remained within normal range, this decrease merits an attempt at explanation.

In our opinion, this relevant decrease in UES pressure is likely related to surgical trauma to the extrinsic laryngeal muscles, although further evidence will be needed to determine whether this damage is transient or permanent.

Further interesting results of our study are the significant association between swallowing alterations and UES incoordination, as well as between proximal acid reflux and voice impairment. It is well known that voice and swallowing disorders are frequently associated, although swallowing symptoms tend to persist longer than voice alterations.[11] The association between appearance or worsening of gastroesophageal reflux and thyroid surgery has been well documented,[2] but the factors involved are not clear. The changes in UES coordination that we found may be a consequence of UES exposure to proximal acid reflux, which is promoted by a postoperative decrease in pressure. In our study, this interpretation seems to be well supported by the association of severe UES pressure decrease and appearance of de novo UES incoordination.

No differences in LES pressures in the pre- and postoperative period were found, although postoperative voice impairment was associated with high acid reflux, and this association is difficult to explain. An increase in transient LES relaxation may be involved, but this would be verifiable only with high-resolution manometry or an impedance pH test,[20] neither of which was done in our study.

Furthermore, since the postthyroidectomy UES always remains in a formally normal range, it seems reasonable to hypothesize that occasional and isolated refluxes, maybe even solely gaseous, may have a relaxing effect on what is a less effective upper sphincter. No pathophysiologic data are available concerning the mechanism that prompts esophageal reflux, and further studies will be needed to better understand any associations.

We are well aware of the fact that our study has some limitations. First, the absence of a laryngeal electromyographic examination with the aim of evaluating the injuries to laryngeal nerves may well be one limitation of our study. Nevertheless, the constant decrease in UES pressure in all our patients makes it highly doubtful that nerve injuries were the cause of swallowing and voice impairment. Moreover, we would like to emphasize that a number of our patients refused to undergo esophageal manometry and/or pH monitoring in the postoperative period because of the invasiveness of the procedures. This may have led us to overestimate the number of symptomatic patients and, as a possible consequence, the associated functional changes.

One study[2] emphasized the high incidence of both gastroesophageal reflux and goiter in the study population, as well as the frequent association between the two in the preoperative period, noting it is highly likely that ''swallowing disorders may have already been present, but clinically latent, until they became manifest as a result of the thyroidectomy.'' In our opinion, since at least one specific postthyroidectomy change in esophageal mechanisms involved in swallowing was clearly evident in our study, we believe that this statement should be reconsidered. However, the authors demonstrated with a videofluoroscopic swallowing study a de novo appearance of a laryngopharyngeal reflux, which may explain both voice and swallowing disorders and, at the same time, could be explained by changes in esophageal motility, coordination, and pressures.

In any case, the mechanisms regulating UES and LES, as well as esophageal motility, have not been completely clarified, and it seems possible that more mechanisms, perhaps even hormonal ones,[21,22] will be discovered.

Conclusion

Our study found that voice and swallowing disorders are very frequent in patients who have undergone thyroidectomy. These symptoms usually resolve uneventfully, but in some cases, they can worsen or reappear. The reasons behind this phenomenon are unclear: the only postthyroidectomy change that proved to be constant in all patients was a decrease in UES pressure. Our study also found significant associations between swallowing impairment and UES incoordination, as well as VIS impairment and proximal acid reflux. In most cases, a severe UES decrease matched a UES incoordination.

It is difficult to verify the flow of acid reflux through the LES and along the esophagus to the UES, and this lack of data is a limitation of our study.

It should be taken into account that both UES and LES, as well as esophageal motility, involve very complex and only partially explained mechanisms. The UES pressure changes may be a result of surgical trauma to the cricopharyngeus muscle and/or the pharyngeal and laryngeal neural plexus. The reasons for a decrease in LES pressure are more difficult to explain, and other mechanisms, perhaps even hormonal, may be involved. From this perspective, gastroesophageal reflux is one of most frequent human diseases whose pathophysiologic mechanisms are unknown. Treatment continues to be directed at the symptoms rather than the pathogenetic mechanisms.

In any case, patients undergoing thyroidectomy should be informed of these consequences, most of which are likely to be transient. However, in light of our findings, acid reflux may be one of the most important pathogenic factors that prompt symptoms of voice and swallowing impairment.

Further studies, including the assessment of impedance testing pre- and postoperatively, are necessary to confirm this hypothesis, although it seems reasonable to introduce perioperative proton pump inhibitor administration with the aim of potentially preventing voice and swallowing impairment.

Author Contributions

Gregorio Scerrino, contribution to conception and design, drafting the article and revising it critically for important intellectual content, final approval of the version to be published; **Angela Inviati**, acquisition of data, analysis and interpretation of data, drafting the article and revising it critically for important intellectual content; **Silvia Di Giovanni**, acquisition of data, analysis and interpretation of data, drafting the article and revising it critically for important intellectual content; **Nunzia Cinzia Paladino**, acquisition of data; **Valentina Di Paola**, acquisition of data; **Giuseppe Lo Re**, acquisition of data, analysis and interpretation of data, drafting the article and revising it critically for important intellectual content; **Piero Luigi Almasio**, acquisition of data, analysis and interpretation of data, drafting the article and revising it critically for important intellectual content; **Francesco Cupido**, acquisition of data, analysis and interpretation of data, drafting the article and revising it critically for important intellectual content; **Gaspare Gulotta**, final approval of the version to be published; **Sebastiano Bonventre**, final approval of the version to be published.

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Supplemental Material

Additional supporting information may be found at http://oto.sagepub.com/content/by/supplemental-data

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