

Video-Assisted Thyroidectomy Significantly Reduces the Risk of Early Postthyroidectomy Voice and Swallowing Symptoms

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Abstract

Background Voice and swallowing symptoms are frequently reported after thyroidectomy even in absence of objective voice alterations. We evaluated the influence of the video-assisted approach on voice and swallowing outcome of thyroidectomy.

Methods Sixty-five patients undergoing total thyroidectomy (TT) were recruited. Eligibility criteria were: nodule size ≤ 30 mm, thyroid volume ≤ 30 ml, no previous neck surgery. Exclusion criteria were: younger than aged 18 years and older than aged 75 years, vocal fold paralysis, history of voice, laryngeal or pulmonary diseases, malignancy other than papillary thyroid carcinoma. Patients were randomized for video-assisted (VAT) or conventional (CT) thyroidectomy. Videostrobolaryngoscopy (VSL), acoustic voice analysis (AVA), and maximum phonation time (MPT) evaluation were performed preoperatively and 3 months after TT. Subjective evaluation of voice (voice impairment score = VIS) and swallowing (swallowing impairment score = SIS) were obtained preoperatively, 1 week, 1 month, and 3 months after TT.

Results Fifty-three patients completed the postoperative evaluation: 29 in the VAT group, and 24 in the CT group. No laryngeal nerves injury was shown at postoperative VSL. Mean postoperative MPT, F_0 , F_{low} , F_{high} , and the number of semitones were significantly reduced in the CT group but not in the VAT group. Mean VIS 3 months after surgery was significantly higher than preoperatively in CT group but not in the VAT group. Mean SIS was significantly decreased 1 and 3 months after VAT but not after CT.

Conclusions The incidence and the severity of early voice and swallowing postthyroidectomy symptoms are significantly reduced in patients who undergo VAT compared with conventional surgery.

Introduction

Phonatory and swallowing alterations after thyroidectomy are well-known outcomes of laryngeal nerve injury [1–4]. However, most of the voice and swallowing symptoms that occur after thyroidectomy are self-limited and not related to impaired nerve function [3–10]. Even if these symptoms do not translate always into objective findings and they often are neglected by the physicians [8], their presence elicits anxiety among patients if they are uninformed about the risks. Several causes have been postulated, including orotracheal intubation [3], modification of the vascular supply and venous drainage of the larynx [6], cricothyroid dysfunction [3, 4, 6], laryngotracheal fixation with impairment of vertical movement [3, 5–7], strap muscles malfunction caused by denervation or direct injury (e.g. section) [5–7], local pain in the neck [8], intraoperative injury of the fine anastomotic branches connecting the

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inferior or recurrent laryngeal nerve (RLN) and the external branch of the superior laryngeal nerve (EBSLN) and/or one of their anastomosis with the sympathetic cervical chain [2, 8], and psychological reaction to the operation [6, 8]. Regardless of the cause, these postthyroidectomy vocal and swallowing changes are reported frequently and can dramatically reduce a patient's quality of life [8].

On the other hand, if in recent years more attention has been paid to subjective symptoms and functional consequences after thyroidectomy, several minimally invasive approaches to thyroidectomy have been developed and gained wide diffusion during the last decade, mainly to improve the cosmetic result of conventional thyroidectomy (CT) [11–17]. Among them, video-assisted thyroidectomy (VAT) has been demonstrated in several comparative study and large series to have significant advantages over CT in terms of cosmetic result, postoperative pain, and patients satisfaction with the postoperative outcome, while characterizing by results similar to conventional surgery in terms of complications rate and completeness of the surgical resection, despite the still limited indications [18–27].

Moreover, because the video-assisted approach reduces the trauma of thyroidectomy, one should suppose that it could imply in some way a reduction in the swallowing and phonatory consequences of thyroidectomy. This prospective study was designed to evaluate whether the video-assisted approach has some influence on phonatory and swallowing outcome of thyroidectomy.

Materials and methods

Patients who underwent total thyroidectomy (TT) between July and December 2006 and who were suitable for the video-assisted approach (nodule size ≤ 30 mm, thyroid volume ≤ 30 ml, no previous neck surgery) were considered eligible for this study based on the approved protocol of the Institutional Review Board. Exclusion criteria included younger than aged 18 years or older than aged 75 years, previous vocal fold paralysis, history of voice or laryngeal diseases requiring therapy, speech disorders or pulmonary diseases, and malignancy other than papillary thyroid carcinoma. Patients with postthyroidectomy evidence of RLN or EBSLN palsy also were excluded from the study protocol. All the eligible patients were asked to accept to participate in the study by signing an informed consent.

Among 285 patients who underwent TT during this period, 72 were considered eligible for VAT and 65 accepted to participate in the study. All the participating patients were randomised for VAT (VAT group) or CT (CT group). The medical records of the participating patients

were prospectively collected and the data stored in a specifically designed database.

Surgical procedure

All the surgical procedures were performed by an experienced endocrine surgeon or by a resident operating under supervision. TT is defined as total bilateral extracapsular thyroidectomy. Surgical techniques for both conventional and video-assisted thyroidectomy have been described previously [8, 24, 28].

Patients' assessment

Vocal and swallowing function were assessed with videostrobolaryngoscopy (VSL), acoustic analysis, patient subjective voice, and swallowing evaluation. The assessment protocol was planned as following: the VSL was performed the day before surgery, the second postoperative day, and 3 months after operation; acoustic analysis was performed before the operation and again 3 months after the operation; patients' subjective voice and swallowing evaluation were performed preoperatively, 1 week, 1 month, and 3 months after surgery.

Videostrobolaryngoscopy

VSL was performed by using a 70° rigid laryngoscope with Kay Elemetrics model RLS 9100 B (Lincoln Park, NJ) to assess vocal folds motion impairment (indicative of RLN injury), as well as bowing, inferior displacement of vocal fold, regularity and symmetry of the mucosal travelling wave, and degree of glottic closure (all indicative of EBSLN injury).

Acoustic voice analysis

Objective voice analysis was performed by Multi-Dimensional Voice Program (MDVP-model 5105) and Voice Range Profile program (VRP-model 4326) using the Computerized Speech Lab (model 4300B; Kay Elemetrics), recording with a Shure model SM48 microphone (Evanston, IL) positioned at an angle of 45° at a distance of 20 cm from the patient's mouth. The microphone saturation input was fixed at 6/9 of CH1 and the environmental noise was <30 dB SPL. For MDVP analysis, a sustained vowel /a/, produced at a comfortable pitch and loudness level for at least 5 s, was recorded with a sampling rate of 50 KHz. We selected an interval of 3 s from the mid

portion of each vowel. The following parameters were analyzed: mean frequency (F_0 , Hz), noise-to-harmonic ratio (NHR), jitter (%), and shimmer (%). For VRP analysis, the patients were instructed to phonate using a sustained vowel /a/ as loud and as soft possible from the lowest to the highest frequencies. To obtain a voice range profile an automated procedure was used. Measurements derived from the VRP were the assessment of the lowest (F_{low}) and the highest (F_{high}) frequencies (Hz) and number of semitones. Finally, the maximum phonation time (MPT) was obtained by having the patient sustain the vowel /a/ for as long as possible on a single breath. The longest of three attempts was calculated as the MPT.

Subjective voice and swallowing evaluation

A series of questions related to the frequency of voice and swallowing abnormalities were asked to the patient by using two specifically designed questionnaires [8] (Tables 1 and 2). The scores resulting from these questionnaires were defined as voice impairment score (VIS) and swallowing impairment score (SIS). VIS varied from a minimum score of 0 (no voice alterations) to a maximum of 40 (highest voice impairment), and SIS ranged from a minimum of 0 (no swallowing alterations) to a maximum of 24 (highest swallowing impairment).

Statistical analysis

The data of the two groups of patients were analysed and compared. Statistical analysis was performed by using a commercially available statistic software package (SPSS 10.0 for Windows®, SPSS Inc., Chicago, IL). The chi-square test was used for categorical variables, and analysis

of variance (ANOVA) was used for continuous variables. $P < 0.05$ was considered significant.

Results

Among the 65 recruited patients, 3 (4.6%) (1 in the VAT group and 2 in the CT group) experienced transient laryngeal nerve palsy, as documented by postoperative VSL, and were excluded from this study. All these patients recovered within 1 month after surgery.

Nine additional patients (13.8%) refused to undergo follow-up examinations because of the absence of any symptoms 1 month after the operation, and/or they lived too far from the hospital.

Fifty-three patients (81.5%) completed the 3-month follow-up evaluation and were included in the study: 29 in the VAT group, and 24 in the CT group.

The demographic, clinical, and pathologic characteristics of both groups are reported in Table 3. The results of preoperative acoustic voice analysis and subjective voice and swallowing evaluation are reported in Table 4.

None of the patients demonstrated any vocal fold movement limitation and/or signs of palsy of the EBSLN before surgery, on the second postoperative day or 3 months after the operation according to the VSL data.

VAT group

Three months after surgery the mean MPT was not significantly different from the preoperative (Table 5). No significant differences were found among the pre- and postoperative mean values of the MDVP and VRP parameters before and after TT ($P > 0.05$; Table 5).

Table 1 Subjective voice evaluation—questionnaire

	Never 0	Nearly never 1	Sometimes 2	Often 3	Always 4
1. My voice is hoarse					
2. My voice is breathy and weak					
3. I have difficulty in singing and yelling					
4. The pitch of my voice is lowered					
5. My voice is monotonous					
6. I run out of air when I talk					
7. My voice changes during the day					
8. I use a great effort to speak					
9. The clarity of my voice is unpredictable					
10. I feel vocal fatigue					
Voice Impairment Score (VIS) = Total					

Each individual's voice impairment score (VIS) was the sum of all responses in the questionnaire; the possible score range was 0–40

Table 2 Subjective swallowing evaluation—questionnaire

	Never 0	Nearly never 1	Sometimes 2	Often 3	Always 4
1. I use a great effort to swallow					
2. I feel a throat obstacle during swallowing					
3. I feel pharyngeal annoyance during bolus transit					
4. I cough during bolus transit					
5. I feel sensation of foreign body in pharynx					
6. I have some difficulties for fluid swallowing					
Swallowing Impairment Score (SIS) = Total					

Each individual's swallowing impairment score (SIS) was the sum of all responses in the questionnaire; the possible score range was 0–24

Table 3 Comparison of demographic, clinical, and pathologic characteristics of patients who underwent conventional (CT group) and video-assisted (VAT group) total thyroidectomy

	VAT group	CT group	P-Value
Number	29	24	
Age $\pm$ SD* (year)	43.5 $\pm$ 14.2	50.2 $\pm$ 14.5	NS
(range)	(24–64)	(26–72)	
Sex (males/females)	6/23	6/18	NS
Preoperative diagnosis			NS
Papillary carcinoma	3	7	
Follicular nodule	9	6	
Multinodular goiter	15	10	
Graves' disease	2	1	
Operative time $\pm$ SD (min)	63.6 $\pm$ 22.2	89.1 $\pm$ 20.3	NS
(range)	(35–120)	(60–120)	
Nodule size $\pm$ SD (mm)	22.7 $\pm$ 6.4	22.9 $\pm$ 6	NS
(range)	(7–30)	(9–30)	
Final histology			NS
Benign goiter	21	17	
Papillary carcinoma	8	7	

SD, standard deviation; NS, not significant

Twenty-three patients (79.3%) presented with voice symptoms preoperatively. One week after TT, the same patients still presented one or more voice symptoms. Four patients reporting preoperative voice symptoms showed early (1 month) postoperative improvement after VAT, with complete stable (at 2 months) regression of voice discomfort. The mean VIS was significantly increased 1 week and 1 month after surgery ($P < 0.05$; Table 6). After an initial impairment, VIS showed a trend to return to preoperative levels at follow-up controls. Three months after surgery, VIS was still higher than preoperatively, but the difference was not significant ($P = NS$).

The number of patients complaining for swallowing symptoms was similar preoperatively and 1 week after surgery, respectively: 24 (82.8%) and 25 patients (86.2%). One month after surgery, the referred swallowing discomfort was reported in 16 of 29 patients (55.2%). Three months after surgery, only 8 of 29 patients (27.6%) still referred swallowing symptoms. After an initial not significant worsening 1 week after TT, the mean SIS was significantly and progressively reduced 1 month and 3 months after surgery ($P < 0.05$; Table 7).

Table 4 Comparison of preoperative acoustic voice analysis (AVA) results and subjective parameters of patients who underwent conventional (CT group) and video-assisted (VAT group) total thyroidectomy

	VAT group (mean $\pm$ SD)	CT group (mean $\pm$ SD)	P-Value
MPT (s)	20.41 $\pm$ 2.86	20.04 $\pm$ 4.88	NS
F_0 (Hz)	193.25 $\pm$ 47.98	185.74 $\pm$ 47.54	NS
Jitter (%)	0.7 $\pm$ 0.37	0.89 $\pm$ 0.69	NS
Shimmer (%)	3.83 $\pm$ 2.26	3.98 $\pm$ 1.53	NS
NHR (dB)	0.13 $\pm$ 0.03	0.13 $\pm$ 0.03	NS
F_{low} (Hz)	158.15 $\pm$ 36.18	153.99 $\pm$ 39.36	NS
F_{high} (Hz)	436 $\pm$ 116.27	417.08 $\pm$ 71.65	NS
No. of semitones	18.76 $\pm$ 3.53	17.61 $\pm$ 4.87	NS
VIS	2.03 $\pm$ 1.76	3.04 $\pm$ 2.94	NS
SIS	3 $\pm$ 2.7	2.08 $\pm$ 2.22	NS

SD, standard deviation; NS, not significant; NHR, noise-to-harmonic ratio; MPT, maximum phonation time

Table 5 Comparison of preoperative and postoperative results of acoustic voice analysis in VAT group and CT group

	VAT group			CT group		
	Preoperative (mean $\pm$ SD)	3 months (mean $\pm$ SD)	PO <i>P</i> - Value	Preoperative (mean $\pm$ SD)	3 months (mean $\pm$ SD)	PO <i>P</i> - Value
MPT (s)	20.41 $\pm$ 2.86	20.03 $\pm$ 2.29	NS	20.04 $\pm$ 4.88	15.36 $\pm$ 3.57	<0.05
F_0 (Hz)	193.25 $\pm$ 47.98	191.1 $\pm$ 38.03	NS	185.74 $\pm$ 47.54	169.2 $\pm$ 42.33	<0.05
NHR (dB)	0.13 $\pm$ 0.03	0.13 $\pm$ 0.02	NS	0.13 $\pm$ 0.03	0.13 $\pm$ 0.02	NS
Jitter (%)	0.7 $\pm$ 0.37	0.65 $\pm$ 0.26	NS	0.89 $\pm$ 0.69	0.68 $\pm$ 0.4	NS
Shimmer (%)	3.83 $\pm$ 2.26	3.73 $\pm$ 1.27	NS	3.98 $\pm$ 1.53	3.98 $\pm$ 1.42	NS
F_{low} (Hz)	158.15 $\pm$ 36.18	154.57 $\pm$ 29.97	NS	153.99 $\pm$ 39.36	134.55 $\pm$ 34.67	<0.05
F_{high} (Hz)	436 $\pm$ 116.27	420.27 $\pm$ 105.58	NS	417.08 $\pm$ 71.65	310.45 $\pm$ 55.21	<0.05
No. of semitones	18.76 $\pm$ 3.53	17.49 $\pm$ 3.57	NS	17.61 $\pm$ 4.87	14.08 $\pm$ 2.96	<0.05

SD, standard deviation; NS, not significant; NHR, noise-to-harmonic ratio; MPT, maximum phonation time; PO, postoperative

Table 6 Comparison of mean preoperative and postoperative VIS in VAT and CT groups

VIS	Preoperative (mean $\pm$ SD)	1 week PO (mean $\pm$ SD)	1 month PO (mean $\pm$ SD)	3 months PO (mean $\pm$ SD)	<i>P</i> -Value*
VAT group	2.03 $\pm$ 1.76	4.93 $\pm$ 4.39	4.07 $\pm$ 4.65	3.66 $\pm$ 4.12***	<0.05
CT group	3.04 $\pm$ 2.94	15.76 $\pm$ 7.89	14.68 $\pm$ 8.15	8.32 $\pm$ 6.77	<0.05
<i>P</i> **	NS	<0.05	<0.05	<0.05	

SD, standard deviation; NS, not significant; PO, postoperative

* Significance of the difference among the results obtained at the different time points for each group

** Significance of the difference between VAT group and CT group

*** Mean VIS 3 months after VAT did not significantly differ from the preoperative ($P = NS$)

Table 7 Comparison of mean preoperative and postoperative SIS in VAT and CT groups

SIS	Preoperative (mean $\pm$ SD)	1 week PO (mean $\pm$ SD)	1 month PO (mean $\pm$ SD)	3 months PO (mean $\pm$ SD)	<i>P</i> -Value*
VAT group	3 $\pm$ 2.7 ^a	3.93 $\pm$ 3.21 ^a	1.69 $\pm$ 1.63	1.24 $\pm$ 1.21	<0.05
CT group	2.08 $\pm$ 2.22 ^b	5.64 $\pm$ 3.44 ^b	2.68 $\pm$ 2.56	2 $\pm$ 3.24	NS
<i>P</i> **	NS	< 0.05	0.05	NS	

PO, postoperative; SD, standard deviation; NS, not significant

* Significance of the difference among the results obtained at the different time points for each group

** Significance of the difference between VAT group and CT group

^a Mean SIS 1 week after VAT was not significantly different than preoperatively ($P = NS$)

^b Mean SIS 1 week after CT was significantly different than preoperatively ($P < 0.001$)

Conventional group

Mean MPT and mean F_0 were significantly reduced 3 months after TT (Table 5). VRP analysis showed a significant reduction of the F_{low} , F_{high} , and the number of semitones 3 months after TT (Table 5).

Fifteen patients (62.5%) presented with voice symptoms preoperatively. One week and 1 month after TT, nearly all the patients referred one or more voice symptoms (23/24, 95.8%). Among these, two patients experienced resolution of voice discomfort at 3 months after surgery. The mean VIS was significantly increased 1 week, 1 month, and

3 months after surgery ($P < 0.05$; Table 6). After an early postoperative impairment, VIS showed a decreasing trend, even if 3 months after surgery VIS was still significantly higher than in the preoperative period (Table 6).

The number of patients complaining of swallowing symptoms was the same preoperatively as well as 1 week, 1 month, and 3 months after surgery (13/24, 54.1%). The mean SIS showed a significant increase 1 week after surgery (5.64 $\pm$ 3.44 vs. 2.08 $\pm$ 2.22; $P < 0.05$; Table 7). After an initial impairment, SIS showed a trend to return to preoperative levels at follow-up controls. One month after surgery, SIS was still higher than preoperatively, but the

difference was not significant ($P = \text{NS}$). Three months after surgery the mean SIS was slightly decreased with respect to preoperative control ($P = \text{NS}$; Table 7).

Comparison between CT and VAT groups

No significant differences were found between the two groups concerning demographic, clinical and pathologic characteristics (Table 3). The results obtained preoperatively with the MDVP and VRP analyses and the mean MPT were similar for both groups, as well as preoperative mean VIS and SIS ($P = \text{NS}$; Table 4). Three months after surgery, patients of the CT group showed significantly lower F_0 (169.2 ± 42.33 vs. 191.1 ± 38.03 ; $P < 0.05$), F_{high} (310.45 ± 55.21 vs. 420.27 ± 105.58 ; $P < 0.05$), F_{low} (134.55 ± 34.67 vs. 154.57 ± 29.97 ; $P < 0.05$), number of semitones (14.08 ± 2.96 vs. 17.49 ± 3.57 ; $P < 0.05$) and MPT (15.36 ± 3.57 vs. 20.03 ± 2.29 ; $P < 0.05$; Table 5).

The mean VIS was significantly higher in the CT group than in the VAT group 1 week, 1 month, and 3 months after surgery (Table 6). The mean SIS was significantly higher in the CT group than in the VAT group 1 week after surgery, but not 1 month and 3 months after surgery ($P = \text{NS}$; Table 7).

Discussion

The results of this study confirm that thyroidectomized patients frequently experience some vocal and swallowing changes, even in the absence of laryngeal nerve injuries. Their presence often elicits anxiety among patients especially if they are uninformed about the risks, even if these symptoms usually do not translate into objective findings [8].

In recent literature a large interest has been paid to the occurrence of these voice and swallowing impairments that are related to thyroidectomy in absence of laryngeal nerves injury, with particular attention to their prevalence, pathogenesis and functional, clinical, and medico-legal implications [1–10].

Voice symptoms have been more extensively evaluated. Voice alterations after otherwise uncomplicated thyroidectomy included a broad spectrum of symptoms and are usually temporary and resolve in a relatively short time period [8]. Because some objective voice changes have been demonstrated in symptomatic patients after TT, a routine comprehensive functional voice analysis has been suggested before and after thyroid surgery to provide an early diagnosis of postoperative vocal disturbances and timely voice rehabilitation [3, 6, 7]. However, some authors reported several discrepancies between subjective and objective voice changes in thyroidectomized patients [3, 6–8]. Indeed, noteworthy discordance between

objective deterioration in voice and subjective symptoms exists in approximately one-third of symptomatic patients [3, 7]. Moreover, our previous study demonstrated that most patients complained of vocal symptoms in the absence of any objective alteration of acoustic voice analysis (AVA) [8]. AVA parameters may remain unaltered even in symptomatic patients [8].

On the other hand, less attention has been paid to swallowing symptoms after thyroidectomy and only two studies have been published so far on this topic [2, 8]. However, it is well known that it is common for patients to experience discomfort during swallowing or occasional dysphagia after thyroidectomy [2, 8]. These symptoms usually resolve after a short period, but may persist long after surgery in approximately 30% of the patients [2]. Moreover, in some circumstances they have been reported more frequently and showed a tendency to persist longer than voice changes [8].

Until recent years, these symptoms have been usually neglected by physicians, because they do not imply any objectively demonstrated laryngeal nerves injury, although they should be regarded as a common consequence of thyroid surgery. Indeed, they can dramatically influence the quality of life of patients who undergo thyroidectomy, especially if they are professional voice users. For this reason, physicians should be aware of these subjective discomforts that commonly occur after thyroidectomy. Moreover, it could be worthwhile that patients are informed about their frequent presentation and reassured about the usually transient and self-limiting nature of these symptoms. We believe that, in the absence of any VSL demonstrable laryngeal nerves injury, the factors that could determine voice and swallowing disturbances are related mainly to the normal healing process, or at least in a small percentage of cases, even to some subclinical postoperative hematoma [8]. Moreover, a functional component related to local neck pain and an emotional and psychological reaction to the postoperative stress cannot be excluded [8].

The understanding of the exact prevalence and pathogenesis of these postthyroidectomy symptoms should represent the first step toward their prevention and treatment.

Because they seem mainly related to the normal healing process, we supposed that minimally invasive techniques, which are characterized by smaller incisions, less subcutaneous dissection, and reduced traction over the strap muscles, could have a role in preventing this complication of thyroidectomy. For this reason, we have evaluated the hypothesis that minimally invasive video-assisted thyroidectomy may have a role in preventing postthyroidectomy functional swallowing and voice impairments.

The results of this study strongly confirm the hypothesis. Indeed, patients who underwent VAT showed a better

postoperative outcome in terms of voice and swallowing impairment, as evaluated by AVA and subjective impairment evaluation scores.

Preoperatively, the two groups showed similar AVA results and VIS and SIS scores (Table 4). Moreover, they showed no significant differences concerning the demographic and pathologic characteristics (Table 3). In other words, patients of the VAT and CT groups were preoperatively well comparable.

At follow-up evaluation, in the VAT group AVA results demonstrated no significant difference from the preoperative findings, whereas patients of the CT group showed a significant reduction of the mean MPT, F_0 , F_{low} , F_{high} , and the number of semitones (Table 5).

Previously published papers have already demonstrated that patients who undergo TT may show objective variation of AVA, with decrease in MPT [5], F_0 [4], and phonational frequency range [3] in the absence of laryngeal nerves injury.

Actually, the findings of this study demonstrate that CT resulted in objective modifications of the speaking voice that persisted at the 3-month follow up evaluation, whereas the postoperative AVA of patients of the VAT group showed no difference with the preoperative findings. In other words VAT seems to be able to reduce the risk of postthyroidectomy voice alterations compared with CT. Because no evidence of laryngeal nerves palsies was found at postoperative VSL, this could imply that the less extensive dissection, which characterizes the VAT, is responsible for a better voice outcome of thyroidectomy.

On the other hand, the modification that we observed in patients who underwent CT (i.e. reduction in the MPT, F_0 , F_{high} , F_{low} , and number of semitones) have been recently demonstrated to be related to an injury of the EBSLN [5, 29]. Despite in all the patients VSL evaluation showed no evidence of EBSLN injury, we cannot exclude a lesion of the EBSLN in this group of patients, because laryngeal electromyographic analysis to confirm its integrity was not performed. Indeed, we discussed the potential of employing electromyography with some of our patients before initiating the study, and noticed the general reluctance to participate in this invasive procedure.

Nonetheless, the absence of this phonatory modification in patients who underwent VAT could imply that the easy and better visualization of the EBSLN, thanks to the magnification of the endoscope, could result in a prevention of any EBSLN injury.

Subjective voice and swallowing evaluation demonstrated that patients who undergo thyroidectomy frequently complained of some voice and swallowing changes, independently from the technique used. These findings confirm previously published papers concerning the prevalence of

subjective symptoms that are far more common than objective voice alterations [2–8].

For subjective evaluation of voice and swallowing impairment, we used two specifically designed questionnaires that we proposed in a previously published paper [8] and slightly modified in the present study. They have the major limitation of not being validated in other studies or in the normal population. However, in our experience they demonstrated to be a useful tool to evaluate postthyroidectomy voice and swallowing impairment, because with simple questions, they provide an analysis of the spectrum of symptoms that patients usually report.

Even if voice and swallowing changes have been reported in both groups of patients, their comparison demonstrated significant advantages of VAT. Indeed, VIS evaluation showed that patients in VAT group have significant lower postoperative scores at each point time and show a trend to return more rapidly to the preoperative condition. A similar trend also was observed for the swallowing impairment. Patients who underwent VAT reported significantly lower scores 1 week and 1 month after surgery. Moreover, their preoperative symptoms have tendency to ameliorate in the postoperative period, with a SIS 3 months after surgery, which was significantly lower than the preoperative one. On the contrary, patients in the CT group after an initial postoperative significant impairment showed a tendency to return to the preoperative levels. In other words, voice and swallowing changes are significantly less important and show a tendency to recover more rapidly in patients who undergo VAT.

The reasons for this important finding should be searched in several causes. First of all, as supposed, the reduction of the surgical trauma of thyroidectomy seems to determine a better outcome. Nonetheless, the less extensive and more fine dissection of the thyroid bed, which characterizes VAT, could be responsible for a reduced risk of lesion of the perivisceral neural plexus, formed by small branches connecting the RLN and the EBSLN and the sympathetic chain, which has been considered involved in the pathogenesis of the postthyroidectomy aero-digestive symptoms by some [2, 8].

Finally, a functional component related to the reduced local neck pain and consequently reduced psychological reaction to the postoperative stress should be taken into account. It has been already demonstrated that VAT is characterized by significant less postoperative pain and higher patient satisfaction with the cosmetic result and the postoperative outcome [20]. The more favorable psychological and emotional condition that characterized patients who undergo VAT, as well as the reduced postoperative pain, could be at least in part responsible of the better voice and swallowing outcome of the video-assisted procedures.

Conclusions

VAT seems to have significant advantages compared with CT in terms of postoperative voice and swallowing changes in absence of laryngeal nerves injury, at least at a short-term follow-up. Regardless the reason for these advantages, VAT has been confirmed to be a valid and validated procedure for the surgical treatment of small thyroid nodules. If further study confirms its significant advantages over CT in terms of reduction and prevention of postthyroidectomy voice and swallowing impairment, it could soon become the preferred option for thyroid surgery, at least in a small, but significant, percentage of patients.

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