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Vocal dysfunction following thyroid surgery: a multidimensional subjective and objective study

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Abstract

Background and objective Following thyroid surgery, vocal changes are a common complication and well-known morbidity that may be linked to neuronal and non-neuronal voice breakdown. Nevertheless, their effects on different voice characteristics are not fully understood, and their bases are still poorly characterized. In order to determine the diagnostic indicators that address the nature of such post-thyroidectomy voice alternations, this study was designed to provide a multidimensional assessment of vocal function after thyroid surgery.

Methods This research was a 1-year prospective cohort study conducted on 100 adult patients aged 40.19 (± 12.82) years who were recruited from the outpatient clinic of Phoniatric Unit, Assiut University Hospital, and scheduled to undergo thyroid surgery during the period from November 2020 to November 2021. All subjects underwent vocal assessment preoperatively and 15 days, 1 month, and 2 months postoperatively by filled in subjective evaluation of voice complaints via voice handicap index (VHI-30), auditory perceptual assessment (APA) of the voice, and videolaryngoscopy in addition to acoustic analysis using computerized speech lab (CSL). Statistical analysis was performed to compare multi-parameter voice assessment tools across different assessment time points.

Results The voice changes were significantly decreased from 51.0% after 15 days postoperatively to 33.0% after 2 months of follow-up. Among these cases, 35.0% cases developed vocal fold paralysis and complained of a breathy voice (27% developed unilateral vocal fold paralysis, and 8% developed bilateral focal fold lesions), and the remaining 16.0% cases had no paralytic manifestations. Also, only one case developed gross lesion "bilateral vocal fold nodules." The subjective evaluation of voice outcome after thyroidectomy showed significant improvement in VHI subscales and total score from 15 days postoperatively to 2 months of follow-up ($P < 0.001$). All of the acoustic parameters except HNR showed a significant difference across the different assessment settings ($P < 0.001$).

Conclusion Thyroidectomy can result in significant vocal alterations, even in cases where the laryngeal nerve is unharmed. These changes should be taken into consideration in patient having thyroid surgery, especially a total thyroidectomy because of malignant lesions. More efforts are needed in order to determine the extent and pathophysiological reasons for the vocal alterations following thyroid surgery in order to reduce the morbidity associated with one of the most popular surgical procedures performed globally.

Keywords Thyroid surgery, Vocal dysfunctions, Voice handicap index, Videolaryngoscopy, Acoustic analysis

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Background

After thyroid surgery, voice alterations are a typical symptom that may or may not be caused by laryngeal nerve injury [1]. However, very few published studies highlighted the effects of thyroidectomy and other associated parameters, such as patient age, sex, operation type, surgeon experience, laryngeal nerve injury, and orotracheal intubation on postoperative patients' voices.

The incidence of problems following thyroid surgery is variable and diverse. Hypocalcemia and airway problems are the most frequent postoperative side effects after thyroidectomy. These are potentially fatal and significantly lower quality of life. Postoperative hematoma, paralysis of the vocal folds, laryngeal oedema, and tracheomalacia can all cause airway difficulties [2]. Recurrent laryngeal nerve palsy (RLNP) is a rare yet severe post thyroidectomy side effect [3]. When a recurrent laryngeal nerve (RLN) is damaged, the only vocal fold abductor muscle (posterior cricoarytenoid) is paralyzed. This can result in symptoms ranging from hoarseness to stridor and acute airway obstruction [3, 4].

Changes in voice can have other causes besides laryngeal nerve damage. Other potential reasons include damage to the cricothyroid and prethyroid strap muscles as well as impaired laryngotracheal mobility brought on by wound contracture following soft tissue surgery. A careful surgical approach may avoid these issues, although it is still unclear if voice changes can happen following thyroidectomy without laryngeal nerve damage. Among the several reasons of post-thyroidectomy dysphonia are surgical cervical muscle stretching and stabilization, endotracheal intubation, manipulation, laryngeal nerve injuries, and cricothyroid muscle injuries. Even in the absence of laryngeal nerve injury, functional dysphonia can occur [5]. Maeda et al. assessed 110 patients' voices following total thyroidectomies without causing nerve damage. They discovered that patients who underwent more extensive surgical manipulation had higher levels of jitter, shimmer, and harmonic to noise ratio, as well as decreased maximum phonation time and fundamental frequency [6]; Pedro Netto et al. assessed 100 patients following a partial or whole thyroidectomy and discovered functional dysphonia in 29.7% of those who did not have paralysis [7]. The determination of potential voice changes in individuals undergoing thyroidectomies without laryngeal nerve injury may be assisted by objective instrument voice evaluation "computerized acoustic analysis" [8].

According to Prabhat et al. (2018), voice alterations are typically temporary. In most situations, the voice recovery takes less than a month or up to 6 months. Voice changes that are temporary, including voice tiredness, weakening, or dysphonia, are more common and can occur in the majority of cases. The temporary alterations in voice are frequently caused by irritation of one or more nerves, either during the thyroid gland dissection by shifting them out of the way or following thyroid surgery by inflammation or oedema [9].

This study is a multidimensional study aimed to evaluate voice dysfunction using different subjective and objective modalities after thyroid surgery in our community. This will aid in improving preoperative patient counseling and providing appropriate postoperative care for patients following thyroid surgery.

Methods

This research was a 1-year prospective cohort study conducted on 100 adult patients who recruited from the Phoniatric Unit at Assiut University Hospital and scheduled to undergo thyroid surgery during the period from November 2020 to November 2021. All subjects gave an informed consent before being included in the current research.

The patients in this study were adult patients with either benign or maligned thyroid diseases as indication of thyroidectomy, with normal voice, and having controlled thyroid hormone level whatever normal or under antithyroid drugs. Patients with any cardiac, hepatic, renal, and respiratory problem which can interfere with surgery or general anesthesia; those with previous head and neck surgery or those neurological deficits; and patients complaining of any speech, voice, or swallowing disorders due to any cause before surgery were excluded from the study.

All participants were subjected to the following protocol of voice assessment preoperatively and 15 days, 1 month, and 2 months postoperatively.

1. Patient interview: All patients were subjected to history taking about their age, sex, residence, and education. The following were done: tailed analysis of complaint (duration, onset and course) and phonesthetic manifestations related to voice complain which include frequent throat clearing, soreness, tenderness, throat dryness, and difficulty in swallowing sticky throat mucous (globus), in addition to searching for etiological factors such as repeated upper respiratory tract infection, excessive and faulty use of voice, allergic tendencies, and chronic cough
2. Full ENT and vocal tract examination: Examination of the ears, nasal cavity, oral cavity, pharynx, and tonsil to exclude any cases that may cause voice or swallowing disorder
3. Auditory perceptual assessment (APA) of the voice: It is considered as a semi objective assessment of the participant's voice. All participants were subjected to

an APA of voice using a modified GRBAS scale (overall grade of dysphonia, strained, leaky, breathy, and irregular). Each domain was graded on a scale of 0–3, in which 0 is normal voice, 1 is mild, 2 is moderate, and 3 is severe [10]

4. Voice handicap index (VHI)-30: Handicap index in its Arabic version "VHI" which is a patient survey to detect functional, physical, and emotional features of the handicap index caused by voice impairment. Scoring of each question was rated from 0 to 4 (0 = never, 1 = rare, 2 = sometimes, 3 = often, 4 = always). The total score ranges from 0 to 120; the higher the score, the greater degree of handicap is detected [11, 12]
5. Visual augmentation and documentation of the glottis: Video laryngoscopic examination of the larynx using a rigid 90° laryngoscope (Explorant Gyrus, ACMI) and in uncooperative cases, a flexible fiberoptic laryngoscope (KARL STORZ) connected to monitor (STORZ tele pack X LED) and camera (telecam PAL). We examined the general configuration of the larynx and the presence or absence of vocal fold gross lesion and both vocal fold mobility in both direction
6. Acoustic analysis of voice: Acoustic analysis was carried out using computerized speech lab (CSL) model 4300 Kay Elemetrics Corporation, New Jersey (USA), for measurement of the following:

   – Fundamental frequency
   – Perturbation of frequency (jitter)
   – Perturbation of amplitude (shimmer)
   – Harmonic-to-noise ratio (HNR)

Patients were asked to phonate the sustained vowel "*a*" at a comfortable pitch and intensity level. The patient's voice was recorded using a microphone that was placed about 10 cm from their mouth. The signals were then sent to a computer database, where a computer software calculated and analyzed the data. The CSL was calibrated according to the instructions in the instruction booklet before testing.

Statistical analysis

SPSS (statistical package for the social sciences; SPSS Inc., Chicago, IL, USA) version 22 was used for all statistics. When applicable, percentages (number of instances) and frequency distributions (percentages) were used to statistically describe the data along with medians (range) because the data were not normally distributed. For comparing quantitative data in the same group overtime, Friedman test was used. Cochran *Q* test was used to compare the difference in distribution of frequencies in the same group overtime. *P*-value is always 2 tailed set significant at 0.05 level.

Results

Demographic and clinical characteristics of the studied patients

The demographic and clinical data of the studied participants was summarized in Table 1. The mean age of the studied participants at time of surgery was 40.19 years; 84% were females, and 16% were males. The most performed procedure was partial thyroidectomy in 65% of our sample, and the remaining patients underwent total thyroidectomy. The majority of patients (72.0%) had benign thyroid disease, and the remaining patients had maligned disorders.

Preoperative voice profile

Preoperatively, all participants had normal auditory perceptual assessment findings (overall grade of dysphonia and its characters), normal videolaryngoscopic finding (vocal fold gross lesions and vocal fold mobility in both directions), and normal scoring of voice handicap index.

Comparing the voice assessment tools across different assessment settings

1. Auditory perceptual assessment

On comparing the overall grade of dysphonia of the study group preoperatively to different assessment sittings postoperatively, a statistically significant difference

Table 1 Demographic and clinical characteristics of the studied patients

Variables	*N* = 100	
Age (years)		
• Mean ± SD	40.19 ± 12.82	
Sex, *n* (%)		
• Male	16	(16.0)
• Female	84	(84.0)
Pathology, *n* (%)		
• Malignant	28	(28.0)
• Benign	72	(72.0)
▪ Goiter	60	(83.3)
▪ Graves	12	(16.7)
Types of surgery, *n* (%)		
• Total thyroidectomy	35	(35.0)
• Partial thyroidectomy	65	(65.0)
▪ Right lobe	40	(61.5)
▪ Left lobe	25	(38.5)

Data are presented as mean ± SD or number (percentage)

was observed regarding the overall grade of dysphonia as 51% developed dysphonia (42% grade 1, 5% grade 2, 4% grade 3) after 15 days and 1 month. After 2 months, 33% was still suffering from dysphonia (25% grade 1, 5% grade 2 and 3% grade 3) as there was improvement in 18 cases ($P < 0.001$).

On comparing the character of dysphonia of the study group preoperatively to different assessment sittings postoperatively, another statistically significant difference was observed regarding the breathy character of dysphonia as 35% developed breathy character (26% grade 1, 5% grade 2, 4% grade 3) after 15 days and 1 month. But after 2 months, only 33% was suffering from breathy voice (25% grade 1, 5% grade 2, 3% grade 3) as there was improvement in only two cases ($P < 0.001$) (Table 2).

2. Voice handicap index findings

On comparing the voice handicap index findings preoperatively to different assessment sittings postoperatively, a statistically significant difference was observed in comparison to preoperative score as there was an increase in the mean of total score of VHI from 0 to 9.17 after 15 days and 1 month. After 2 months, the mean was 6.18 as there was improvement in some cases ($P < 0.001$).

Regarding the emotional subscale, there was a statistically significant difference as there was an increase in the mean subscale score from 0 preoperative to 2.76 postoperatively in after 15 days and after 1 month assessment settings. After 2 months, the mean was 1.74 as there was improvement of some cases ($P < 0.001$).

Table 2 Results of the voice assessment tools across different assessment settings

Voice assessment tools	Preoperative		After 15 days		After 1 month		After 2 months		*P* value
Auditory perceptual assessment (APA)									**< 0.001**
• Normal	100	(100.0)	49	(49.0)	49	(49.0)	67	(67.0)	
• Overall grade of dysphonia	0	(0.0)	51	(51.0)	51	(51.0)	33	(33.0)	
■ Grade 1	0	(0.0)	42	(42.0)	42	(42.0)	25	(25.0)	
■ Grade 2	0	(0.0)	5	(5.0)	5	(5.0)	5	(5.0)	
■ Grade 3	0	(0.0)	4	(4.0)	4	(4.0)	3	(3.0)	
Character									**< 0.001**
• Normal	100	(100.0)	65	(65.0)	65	(65.0)	67	(67.0)	
• Breathy	0	(0.0)	35	(35.0)	35	(35.0)	33	(33.0)	
■ Grade 1	0	(0.0)	26	(26.0)	26	(26.0)	25	(25.0)	
■ Grade 2	0	(0.0)	5	(5.0)	5	(5.0)	5	(5.0)	
■ Grade 3	0	(0.0)	4	(4.0)	4	(4.0)	3	(3.0)	
Video-laryngoscopy									**< 0.001**
• Normal	100	(100.0)	65	(65.0)	65	(65.0)	67	(67.0)	
• VF paralysis	0	(0.0)	35	(35.0)	35	(35.0)	33	(33.0)	
■ Unilateral	0	(0.0)	27	(27.0)	27	(27.0)	26	(26.0)	
■ Bilateral	0	(0.0)	8	(8.0)	8	(8.0)	7	(7.0)	
Gross VF pathology									1
• No	100	(100.0)	99	(99.0)	99	(99.0)	99	(99.0)	
• Yes	0	(0.0)	1	(1.0)	1	(1.0)	1	(1.0)	
VHI									
• Emotional	0.0 ± 0.0		2.76 ± 3.35		2.76 ± 3.35		1.74 ± 2.97		**< 0.001**
• Physical	0.0 ± 0.0		2.78 ± 3.48		2.78 ± 3.48		1.99 ± 3.49		**< 0.001**
• Social	0.0 ± 0.0		3.61 ± 4.53		3.61 ± 4.53		2.45 ± 4.06		**< 0.001**
• Total	0.0 ± 0.0		9.17 ± 10.17		9.17 ± 10.17		6.18 ± 9.74		**< 0.001**
CSL									
• Pitch (FO)	228.47 ± 33.11		202.05 ± 46.24		204.88 ± 46.11		206.26 ± 45.27		**< 0.001**
• Jitter	3.93 ± 1.44		3.95 ± 1.43		4.06 ± 1.44		4.05 ± 1.44		**< 0.001**
• Shimmer	4.47 ± 1.26		4.52 ± 1.26		4.66 ± 1.29		4.62 ± 1.27		**< 0.001**
• HRN ratio	5.55 ± 2.21		5.59 ± 2.10		5.61 ± 2.07		5.52 ± 2.10		0.580

Data are presented as mean ± SD or number (percentage). Significant P value was considered when it is < 0.05. Cochran Q test was used to compare the difference in distribution of frequencies in the same group overtime

APA Auditory perceptual assessment, *VHI* Voice handicap index, *CSL* Computerized speech lab, *HRN* Harmonic/noise ratio

Regarding the physical subscale, there was a statistically significant difference as there was an increase in the mean subscale score from 0 preoperative to 2.78 postoperatively in after 15 days and after 1 month assessment settings. After 2 months, the mean was 1.99 as there was improvement of some cases ($P < 0.001$).

Regarding the social subscale, there was a statistically significant difference as there was an increase in the mean subscale score from 0 preoperative to 3.61 postoperatively in after 15 days and after 1 month assessment settings. After 2 months, the mean was 2.45 as there was improvement of some cases ($P < 0.001$).

On comparing the affection of the three subscales, we noticed that the social domain was the most affected one followed by the physical one, and the least affected was the emotional domain (Table 2).

3. Videolaryngoscopy findings

On comparing the videolaryngoscopic findings of the study group preoperatively to different assessment sittings postoperatively regarding vocal fold paralysis and laryngeal pathology, a statistically significant difference was observed as 35% of patients developed vocal fold immobility (27% unilateral, 8% bilateral) after 15 days and 1 month. After 2 months, only 33% was still suffering from vocal fold paralysis (26% unilateral lesion, 7% bilateral lesion) as there was improvement in only two cases ($P < 0.001$).

On comparing the videolaryngoscopic findings of the study group preoperatively to different assessment sittings postoperatively regarding vocal fold gross lesion, no statically significant difference was observed as only one case developed vocal fold gross lesion (bilateral vocal fold nodules) which appeared at first assessment sitting (15 days) and still present in the other two postoperative settings (1 month and 2 months). This is mostly unrelated to the operative procedure, and the lesion appeared as this female patient was a voice abuser (Table 2) (Fig. 1).

4. Acoustic analysis findings

On comparing the findings of the acoustic analysis of the study group preoperatively to different assessment sittings postoperatively, a statistically significant difference was observed regarding F0 (fundamental frequency) as there was a significant decrease in mean FO values postoperatively after 15 days, 1 month, and 2 months in comparison with the preoperative values ($P < 0.001$).

Regarding jitter and shimmer, there was statistically significant difference was observed as there was a significant increase in mean values of jitter and shimmer postoperatively after 15 days, 1 month, and 2 months in comparison with the preoperative values ($P < 0.001$).

On comparing the findings of CSL (computerized speech lab) of the study group preoperatively to different assessment sittings postoperatively regarding harmonic/noise ratio, there was an increase in mean HRN values postoperatively after 15 days and 1 month but not after 2 months in comparison with preoperative values although not reaching the statistically significant point ($P > 0.001$) (Table 2).

Clinical profile of patients with vocal fold immobility

The demographic and clinical data of patients with vocal fold immobility were presented in Table 3. Their age is ranging from 20 to 73; 30 (85.7%) of patients were females, and 5 (14.3%) were males. The most performed procedure was total thyroidectomy in 30 patients (85.7%); the remaining underwent partial thyroidectomy. The majority of patients (71.4%) had maligned thyroid disease, and the remaining had a benign lesions.

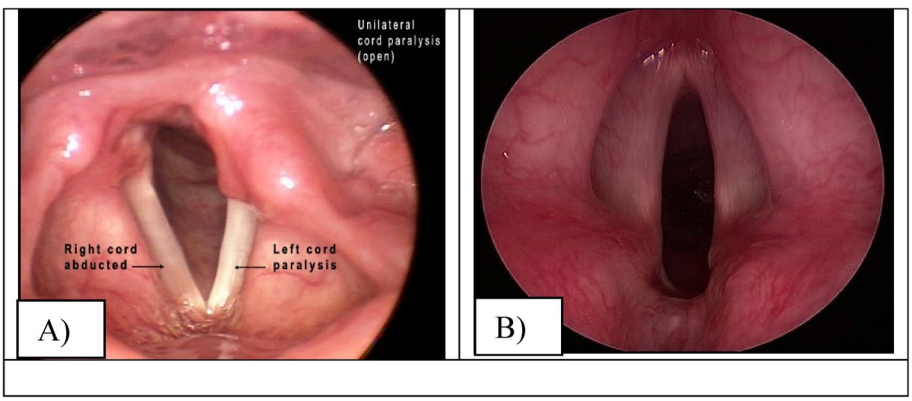

Fig. 1 Vocal fold paralysis. **A** Unilateral. **B** Bilateral

Table 3 Clinical profile of patients with focal fold immobility ($n=35$)

Variables	$N=35$	
Age (years)		
• Range	20–73	
Sex, *n* (%)		
• Male	5	(14.3)
• Female	30	(85.7)
Pathology, *n* (%)		
• Malignant	25	(71.4)
• Benign	10	(28.6)
Types of surgery, *n* (%)		
• Total thyroidectomy	30	(85.7)
• Partial thyroidectomy	5	(14.3)
Follow-up assessment up to 1 year		
• Recovered	5	(14.3)
• Unrecovered	20	(57.1)
• Missed	10	(28.6)

Data are presented as range or number (percentage)

Discussion

Dysphonia, or altered voice function, is a common complaint among patients who have had thyroid surgeries. RLN injury, which can result in vocal fold paralysis, is one of the most frequent causes of dysphonia; however, there are other potential causes as well. Furthermore, inadequate glottic closure resulting from vocal fold paralysis can induce dysphonic symptoms as weakness, dyspnea, and diminished vocal loudness and range [13].

The present study is a prospective cohort study aimed to assessing voice dysfunctions following thyroid surgery and to identify dynamic changes during the follow-up period in order to provide diagnostic indicators that address the nature of postoperative voice problems in adult patients who admitted to Assiut University Hospital in the period from the first of November 2020 up to the end of November 2021.

Both the patient and the physician are concerned about voice quality preservation after thyroid surgery. One of the main concerns during this operation is the preservation of the external branch of the superior laryngeal nerve and the recurrent laryngeal nerve. The results of damaging these nerves during surgery are extensively documented [14]; however, voice alterations after thyroid surgery are more common than expected if they are exclusively caused by neurological injury [15]. In the present study, we observed that the vocal changes were significantly decreased from 51.0% after 15 days postoperatively to 33.0% after 2 months. Among these cases, 35.0% cases developed vocal fold paralysis and complain of breathy voice (27% developed unilateral vocal fold paralysis, and 8% developed bilateral focal fold lesions), and the remaining 16.0% cases have non-paralytic changes of voice. Also, only one case developed gross lesion "bilateral vocal fold nodules." Therefore, following thyroidectomy, patients reported a decline in voice quality even in the absence of vocal fold paresis. Numerous factors, including endotracheal intubation, manipulation, surgical cervical muscle stretching and stabilization, laryngeal nerve injuries, and cricothyroid muscle strains, might result in post-thyroidectomy dysphonia. Furthermore, functional dysphonia can happen even in the absence of laryngeal nerve damage [5].

According to Stojadinovic et al., 1–2 weeks following surgery, 30% of patients had vocal alterations; 3 months later, this rate dropped to 14% [16]; in three different time periods—preoperatively, 2 weeks after surgery, and 3 months later—Soylu et al. assessed the vocal quality of forty-eight thyroidectomy patients ($n=8$ lobectomy; $n=40$ complete thyroidectomy). The authors reported vocal changes in 37.5% of patients in the early postoperative time, and 14.6% of patients continued to have voice abnormalities three months following surgery [17]; Page et al. assessed 395 thyroidectomy patients and found that 49% patients had voice impairment after surgery; of these patients, 46% recovered in less than a month, and 3% remained had abnormal voice a year later [18].

Vocal fold paralysis among our studied cases were diagnosed in 35 cases in the 1st postoperative follow-up and remained the same in the second postoperative follow-up and only reduced to 33% in third postoperative follow-up. After 1 year, 20 patients (20.0%) persisted with vocal fold paralysis, 10 patients are missed from our follow-up, and 5 patients returned to their normal vocal fold mobility. According to Iyomasa et al. (2019), out of 151 patients, 42 patients had vocal complaints in the first postoperative follow-up (27.8%), and this number decreased to 7.2% after 6 months. According to videolaryngoscopies, 144 individuals (95.3%) had normal preoperative examinations. Vocal fold palsies were documented in 34 paralyses at the first postoperative day: 32 recurrent laryngeal nerves and 2 superior laryngeal nerves. Ten patients (6.6%) remained paralyzed in the RLN after 6 months [5].

Voice disturbance in patients following thyroidectomy is common and varies throughout various series of cases reported in the literature [19]. The lack of consensus regarding the impact and effect of these alterations across the many listed research could be attributed to the fact that each study provides a different design, and outcome, using different measurement equipment and postoperative assessment intervals.

Pedro Netto et al. examined 100 patients after partial ($n=42$) or whole ($n=58$) thyroidectomies and discovered vocal disorders in 29.7% of them without paralysis,

indicating non-organic dysphonia. Ten patients received a diagnosis of paralysis; only 5% complained of dysphonia [7].

Our finding about the vocal symptoms was higher than the previous mentioned voice alterations after thyroidectomy with a rate of up to 51.0% (dysphonia due to vocal fold paralysis was diagnosed in 35 patients, and 16 patients suffered from dysphonia without vocal fold paralysis). This finding could be attributed to the fact that our studied cases were enrolled from the Assiut University Hospital which is a tertiary health care educational hospital; thus, the lack of enough experience among the surgeons that participate in the current study could explain the high frequency of nerve injury among our studied cases. In this regard, it is highly advised that any surgeon should not operate until he has enough experience to do such critical surgery. Our study also included 28 malignant cases and 12 graves' disease which had higher incidence of complications as mentioned before. Moreover, short period of follow-up as spontaneous vocal fold healing need a longer period to restore its function.

The voice handicap index (VHI) is a simple reliable, self-administered questionnaire that has been used to identify negative voice outcomes following thyroidectomy [20]. This subjective evaluation showed significant improvement in VHI subscales namely (emotional, physical, and social domains) and total score from 15 days postoperatively to 2 months of follow-up ($P<0.001$). According to Vahabzadeh-Hagh et al. (2019), patients who experienced paralysis or paresis following thyroidectomy scored higher on the postoperative questionnaire, and there was a greater difference between the preoperative and postoperative tests than in patients with normal vocal fold mobility [21]. This fact supports the hypothesis that VHI can serve as a screening tool for post-thyroidectomy vocal alterations when an increase of at least two points in the postoperative questionnaire is reported [21].

Thus, in agreement with the current study, Sõber et al. (2022) found a drop in the physical domain of the VHI and an increase in postoperative voice strain. Subjective voice quality significantly decreased in patients with surgical nerve injury (VHI total score and all subscales). The authors also noted notable variations in the VHI total score and physical domain between patients with temporary and permanent palsy throughout the first week and first month of visits. By the conclusion of the follow-up period, all changes, regardless of the nerve injury, had become statistically insignificant [22].

Detailed appraisal of vocal stability among our studied cases was achieved with frequency-based voice acoustic measures "computerized speech lab." The parameters considered were the amplitude (shimmer, %), fundamental frequency (F0, Hz), glottal noise (i.e., the noise-to-harmonic ratio), and perturbations of the fundamental frequency (jitter, %) [23]. The cycle-to-cycle variability of vocal period and amplitude is indicated by mean percentage vocal jitter and shimmer, respectively [16]. One of the most commonly changed parameters in the current study is a lower-pitched voice, which may be attributable to altered venous drainage and vascular supply following surgery. This drop in vocal pitch could be caused by these vascular alterations as well as the mild congestion caused by the orotracheal intubation [17]. This decline has been shown in earlier research conducted months following surgery [24, 25]. In the early postoperative phase, there were notable jitter and shimmer changes that tend to diminish in the late postoperative period.

Moreover, according to Park et al. (2016), only 18.4% of patients had lower-pitched voices a year following surgery, despite 42.85% of female patients exhibiting a considerable decrease in pitch after surgery, particularly in the first 6 months. At 2 weeks following surgery, the voice changes of patients who underwent total thyroidectomy were much higher than those who underwent lobectomy, but there was no difference at the 3-, 6-, and 12-month follow-up [26]. Additionally, our results are consistent with those of Lang et al.'s systematic review from 2016, which discovered a significant decrease in F0 and an increase in shimmer and NHR in the immediate postoperative period. These changes tended to resolve over the course of the late postoperative period regardless of the vocal movement the patient displayed [19]. Similar to the evaluation points in the current study, the majority of the publications in this review conducted the early assessment 1–2 weeks following surgery and the late assessment 3–6 months following surgery.

However, in the current study, the HRN ratio remain unchanged from preoperative and throughout the follow-up period. Numerous earlier studies report no discernible changes in voice following surgery, which is consistent with our findings [6, 27–30]. For example, Van Lierde [27] reported that following thyroidectomy, individuals' objective and perceptual voice quality matched a Dysphonia Severity Index of 66% and that vocal performance did not change permanently. Furthermore, the vocal quality has no psychosocial handicapping effect; yet, there are greater vocal complaints just after thyroidectomy.

Li et al. [28] stated that after a unilateral thyroid lobectomy that did not result in laryngeal nerve injury, male patients' acoustic measures became slightly abnormal and returned to normal within 1 month, while female patients' indicators improved from before surgery and returned to normal within 3 months. Lombardi et al.

[29] not observed significant differences in acoustic voice analysis (AVA) and maximum phonation time (MPT) characteristics between preoperative and postoperative periods. Furthermore, Santosh et al. [30] declare that after total thyroidectomy, in the absence of apparent laryngeal nerve injury, the functional changes in voice were minor and transient.

Conclusion

Deterioration of voice quality is a common finding post-thyroidectomy. In addition, the patients and caregivers should be informed of the specific subjective discomforts that frequently accompany thyroid surgery. Furthermore, clinicians should advise patients that temporary voice difficulties are common after complete thyroidectomy, even without laryngeal nerve damage.

Abbreviations

APA	Auditory perceptual assessment
CSL	Computerized speech lab
Fo	Fundamental frequency
MPT	Maximam phonation time
RLN	Recurrent laryngeal nerve
RLNI	Recurrent laryngeal nerve injury
VF	Vocal fold
VHI	Voice handicap index

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Not applicable.

Authors' contributions

EA interpreted all data of patients and performed revision of all sections of the research as well as writing and preparing the manuscript for publication. AS collected the data of all patients with or without voice complain after thyroidectomy including history, clinical examination, auditory perceptual assessment, VHI, and videolaryngoscopy. RA analyzed and interpreted the data regarding the auditory perceptual assessment, VHI, and videolaryngoscopy. GA supervised the surgical issues of the patients and revised the writing of the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

Not applicable.

Declarations

Ethics approval and consent to participate

The study protocol was approved by the Institutional Review Board, Faculty of Medicine, Assiut University (approval number: 17101030). Our study met all the criteria established by the Helsinki Declaration. All subjects gave informed consent before being included in the current research.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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