Voice, swallowing, and quality of life after management of laryngeal cancer with different treatment modalities

Medhat M.H. Mansour[a], Mahmoud F. Abdel-Aziz[a], Magdy E. Saafan[a], Haytham R.M. Al-Afandi[a], Mohammed Darweesh[b]

[a]Department of ENT, Faculty of Medicine, [b]Unit of Phoniatrics, ENT Department, Tanta University, Tanta, Egypt

Correspondence to Mohamed Darweesh, E.N.T. Department, Faculty of Medicine, Tanta University, Tanta, Egypt
Tel: 01223947970;
E-mail: mohameddarwish@hotmail.com

Received 08 April 2015
Accepted 10 April 2015

The Egyptian Journal of Otolaryngology
2016, 32:37–44

Background
Laryngeal cancer is the most common malignant tumor of the upper aerodigestive tract. Surgical treatment of advanced laryngeal cancer often requires a total laryngectomy (TL), resulting in a permanent tracheostomy and potential difficulties with a patient's speech and communication.

Objectives
The aim of this study was to assess post-treatment voice changes, swallowing, and quality of life (QoL) of patients with carcinoma of the larynx treated with different treatment modalities.

Patients and methods
A total of 100 patients with laryngeal cancer treated with different treatment modalities were included in the present study. The primary treatment modality included TL (n = 46), partial laryngectomy (PL) (n = 7), transoral cordectomy (n = 9), radiotherapy (Rx) (n = 29), or combined treatment during the last 10 years with radiation after TL (TL and Rx, n = 9). Patients were subjected to full history taking, complete ENT examination, and assessment of: global QoL, voice, and acoustic parameters using the computerized speech lab at the outpatient clinic of Tanta University Hospitals (TUH). Evaluation of swallowing was carried out using a modified Arabic version of the QoL questionnaire called the Sydney Swallow Questionnaire. Patients having problems with swallowing were further evaluated using fiberoptic endoscopic evaluation of swallowing, at the outpatient clinic of TUH. Respiratory function of the larynx was evaluated by applying a modification of St George's Respiratory Questionnaire.

Results
Results of voice analysis showed that the best voice was evident in patients who had undergone cordectomy, followed by those who had received radiotherapy. There was no significant difference in voice characteristics between patients using voice prosthesis, esophageal voice, or electrolarynx after TL and those using these aids after PL. Worst voice as well as swallowing was seen in patients who had undergone combined TL and postoperative radiotherapy. The best results of swallowing were seen in patients who had undergone cordectomy. Patients who had undergone TL or radiotherapy alone showed similar swallowing results, but better than those who had undergone PL, especially those who had undergone supracricoid laryngectomy. Assessment of respiratory function showed best results in patients who had undergone cordectomy, followed by those who had undergone TL and radiotherapy. Poorest results were seen in patients with combined surgery and Rx, and those who had been treated with PL.

Conclusion
Our study revealed that the best significant performance results were seen in patients who had undergone transoral cordectomy, followed by patients who had received radiotherapy only. This was followed by patients who had undergone TL and PL, with no significant difference between the two groups. The worst results were seen in patients who had undergone combined surgery and radiotherapy as the primary treatment modality.

Keywords:
fiberoptic endoscopic evaluation of swallowing, partial laryngectomy, radiotherapy, St George's Respiratory Questionnaire, supracricoid laryngectomy, Sydney Swallow Questionnaire, Tanta University Hospitals, total laryngectomy, transoral cordectomy

Egypt J Otolaryngol 32:37–44

1012-5574

Introduction

The main functions of the larynx are phonation, respiration, and protection of the upper airway during swallowing. Many reasons contribute to the development of laryngeal cancer, such as heavy smoking, alcoholism, and gastroesophageal reflux disease [1]. The aim of management of cancer larynx is to preserve these functions as much as possible to improve the quality of life (QoL) of patients with laryngeal cancer after its management [2].

Conservation laryngeal surgery refers to techniques that preserve the sphincteric, respiratory, and phonatory functions of the larynx. The techniques vary from simple excisions of small laryngeal cancers to technically difficult resections of the supraglottic region and hypopharynx and reconstruction of the remaining laryngeal structures. It also includes partial reconstructive surgery, radiation therapy alone, induction chemotherapy, or concurrent chemoradiotherapy. Chemoradiation organ preservation strategies have demonstrated that some larynges can be saved without compromising overall survival [3]. All of these conservative laryngeal techniques are based on the knowledge of the exact extent of the tumor and its pathophysiologic course in terms of local tumor spread and metastatic pathways [4].

There is an inherent difficulty in comparing the voices obtained after different therapeutic modalities. Voice can be measured objectively in a number of ways. Some of the more commonly used measures are acoustic parameters (fundamental frequency, jitter, shimmer, and signal-to-noise ratio), aerodynamic studies (subglottic pressure and maximum airflow), general phonatory studies such as maximal phonation time, and videostroboscopic analysis [5].

As swallowing impairment is a common occurrence in head and neck cancer patients, there is a need for a mechanism by which patients can be screened and evaluated to detect and document swallowing problems, and those with impairment can be further evaluated using instrumental methods. To overcome these problems, a new patient-reported swallow function-specific evaluation tool, the Sydney Swallow Questionnaire (SSQ), has been recently validated for use in head and neck cancer patients [6,7].

Assessment of respiratory function of the larynx includes mainly various methods for assessment of the laryngeal lumen. Indirect laryngeal examination followed by direct laryngoscope and bronchoscopy is essential; high-resolution computed tomography of the larynx and trachea may be useful. Recently, three-dimensional computed tomography and virtual endoscopy have been used to evaluate the extent or severity of a laryngeal stenosis [8].

QoL is increasingly a major point of interest in head and neck oncology, especially with the development of organ preservation strategies for advanced laryngeal cancer. There is a perception that a total laryngectomy (TL) has a devastating effect on patients and their family members because of the presence of a definitive stoma and the loss of the larynx. Nevertheless, when QoL is assessed with questionnaires that go beyond speech and stoma, the results seem to indicate that functional impairment from TL does not diminish overall QoL. Although there is evidence that with time patients learn to cope with the disease and treatment sequelae, only a few studies have addressed long-term QoL after laryngectomy [9].

Patients and methods

Patients

A total of 100 patients with laryngeal cancer treated with different treatment modalities were included in the present study. The primary treatment modality included TL ($n = 46$), partial laryngectomy (PL) ($n = 7$), transoral cordectomy (TC) ($n = 9$), radiotherapy (Rx) ($n = 29$), or combined treatment during the last 10 years with radiation after TL (TL and Rx, $n = 9$). Patients were selected during their regular follow-up visits from the outpatient clinic starting from January 2012. Eighty-six patients had received their primary treatment modality at Tanta University Hospitals (TUH), nine patients at Tanta Cancer Institute, and five patients at Kasr Eleiny Hospitals. The duration of the study was 6 months. Adequate provisions to maintain privacy of participants and confidentiality of data were taken.

Inclusion criteria

(1) Previous history of laryngeal cancer treated primarily with TL or radiotherapy or both.
(2) Previous history of laryngeal cancer managed primarily with conservation laryngeal surgery.

Exclusion criteria

(1) Recurrent laryngeal cancer.
(2) Residual laryngeal cancer.
(3) Chronic illness such as advanced liver disease, uncontrolled diabetes mellitus, tuberculosis, and chronic renal failure.
(4) History of nonepithelial cancer.
(5) Noncompletion of the study.
(6) Undergoing treatment longer than 10 years from the study.

Data collection and clinical research measures

After discussing the details of this study with each patient and getting their consent to participate in the study, the patients were subjected to the following:

(1) Full history taking, including the detailed history of laryngeal cancer and its management modality, as well as review of patients' records.
(2) Complete ENT examination.
(3) Assessment of the QoL of the patients after receiving the treatment for laryngeal cancer was achieved through

questionnaires, applying the Karnofsky Performance Status Scale definitions rating (%) criteria (Table 1), and evaluating each laryngeal function separately after laryngeal cancer management as follows.

Assessment of voice

Voice was assessed first by applying the four-point scale (good, 4; reasonable, 3; moderate, 2; and bad, 1) questionnaire designed by the Netherlands Cancer Institute [10] addressing intelligibility, loudness, pitch, fluency, telephone intelligibility, and intelligibility in noise. This was validated objectively through measurement of acoustic parameters including fundamental frequency, maximal phonation time, jitter, shimmer, and harmonic-to-noise ratio.

The assessments of voice and acoustic parameters were evaluated using the computerized speech lab (CSL) (CSL model 4150; Kay Pentax, Lincoln Park, NJ) in the outpatient clinic of TUH (Figs. 1 and 2).

Assessment of swallowing

Swallowing was assessed subjectively with a modified Arabic version of the QoL questionnaire called SSQ. The SSQ is a tool specifically designed for evaluation of swallowing difficulties in neuromyogenic, oropharyngeal, or dysphagia patients [6,7]. The SSQ consists of 17 well-structured questions for the assessment and quantification of patient-reported difficulties in swallowing function.

Patients having problems with swallowing were further evaluated with fiberoptic endoscopic evaluation of swallowing (FEES) in the outpatient clinic of TUH (water and ice chips colored with FDA-approved green food dyes McKormic CoR).

Assessment of respiratory function of the larynx

Respiratory function of the larynx was evaluated by applying a modification of the St George Respiratory Questionnaire (SGRQ) [11,12], which included questions about the activities that usually make the patient feel breathless. For each item, the patient is asked to answer either true or false, as it applies to him or her.

Table 1 The Karnofsky Performance Status Scale [13]

Able to carry on normal activity and to work; no special care needed	100	Normal, no complaints; no evidence of disease
	90	Able to carry on normal activity; minor signs or symptoms of disease
	80	Normal activity with effort; some signs or symptoms of disease
	70	Cares for self; unable to carry on normal activity or perform active work
Unable to work; able to live at home and care for most personal needs; varying amount of assistance needed	60	Requires occasional assistance, but is able to care for most of his or her personal needs
	50	Requires considerable assistance and frequent medical care
	40	Disabled; requires special care and assistance
Unable to care for self; requires equivalent of institutional or hospital care; disease may be progressing rapidly	30	Severely disabled; hospital admission is indicated, although death not imminent
	20	Very sick; hospital admission necessary; active supportive treatment necessary
	10	Moribund; fatal processes progressing rapidly
	0	Dead

Figure 1

Computerized speech lab (CSL, KayPentax Model 4150).

Figure 2

Computerized speech lab (CSL) attached to PC unit.

Statistical analysis

For the description of the whole random sample and the five study groups, the mean value and SD were determined as descriptive measures. The differences between the study groups concerning the QoL were identified by the analysis of variance and covariance. Correlations were made to find associations between the dimensions and the moderators of the QoL, using univariate and multivariate analysis.

Results

A total of 100 consecutive patients fulfilled the criteria of this study until completion. Patients were allocated into five groups according to the primary treatment modality: TL, PL, TC, radiotherapy (Rx), and combined surgery and radiotherapy (S and R). The epidemiologic characters of these patients are shown in Table 2. A total of 46 patients had been treated with TL as the primary treatment, 29 patients had received only 70 Gy of radiotherapy, nine patients had been treated with TC, seven patients had been treated with PL, and nine patients had received 60 Gy radiation after TL.

The global QoL was first assessed by applying the Karnofsky Performance Status Scale criteria. Table 3 depicts the results of the Karnofsky Performance Status Scale. As shown in the table, the least score seen in our sample was 50%. The best significant performance results were seen in patients who had undergone TC, followed by patients who had undergone radiotherapy only. This was followed by patients who had undergone TL and PL, with no significant difference between the two groups. The worst results were seen in patients who had undergone combined surgery and radiotherapy as the primary treatment modality. We considered patients with scores of 80% or more to be good performers. Univariate as well as a multivariate analysis was performed to study the effect of age at presentation, sex, T-stage, N-stage at presentation, and site of the primary tumor on post-treatment global performance. The results are shown in Table 4. Age less than 65 years at presentation, patients with Tis, T1, and T2a, N0, and glottic cancers were associated with a better post-treatment global QoL.

Table 5 shows the results of the four-point scale (good, reasonable, moderate, and bad) questionnaire designed by the Netherlands Cancer Institute for subjective evaluation of voice. Table 6 shows the results of objective voice analysis of the groups. Again the best voice was evident in patients had undergone cordectomy, followed by those who had undergone radiotherapy. Results of voice analysis showed a slight difference but not a significant difference in voice characteristics between patients using voice prosthesis, esophageal voice, or electrolarynx after TL and those using these aids after PL. Worst voice was seen in patients who had undergone combined surgery and postoperative radiotherapy.

Table 7 depicts the results of the SSQ, showing the mean values for the five groups. The worst swallowing results were seen in patients who had undergone combined TL and radiotherapy. The best results were seen in patients who had undergone cordectomy.

Table 2 Characteristics of the patients according to the primary treatment group (TL, Rx, PL, TC, TL and Rx radiotherapy)

Characteristics	TL (*n* = 46)	Rx (*n* = 29)	PL (*n* = 7)	TC (*n* = 9)	TL and Rx (*n* = 9)
Age (years)					
Median	56	69	62	58	68
Range	42–78	53–74	44–65	48–62	68–72
Sex					
Male	44	28	7	8	9
Female	2	1	0	1	0
Primary site					
Supraglottis	9	2	2	0	8
Glottis	37	27	5	9	1
AJCC stage					
I	0	9	4	8	0
II	0	18	3	1	0
III	38	2	0	0	7
IV	8	0	0	0	2
cT classification					
Tis	0	0	0	3	0
T1	0	6	4	5	0
T2	0	23	3	1	2
T3	41	0	0	0	7
T4	5	0	0	0	0
cN classification					
N0	0	27	4	7	2
N1	25	1	2	2	6
N2A	14	1	1	0	0
N2B	5	0	0	0	1
N2C	2	0	0	0	0
N3	0	0	0	0	0

PL, partial laryngectomy; Rx, radiotherapy; TC, transoral cordectomy; TL, total laryngectomy.

Table 3 Results of the Karnofsky Performance Status Scale [13]

Score (%)	TL (*n* = 46) with prosthesis	Rx (*n* = 29)	PL (*n* = 7)	TC (*n* = 9)	TL and Rx (*n* = 9)
50	2	2	1	0	2
60	3	3	1	0	2
70	7	3	1	1	1
80	12	7	1	1	1
90	14	8	3	3	2
100	8	6	0	4	1

PL, partial laryngectomy; Rx, radiotherapy; TC, transoral cordectomy; TL, total laryngectomy.

Table 4 Univariate and multivariate analysis of prognostic covariates for a better post-treatment global quality of life (the Karnofsky Performance Status Scale [13])

Characteristics	HR, 95% CI, *P* value	HR, 95% CI, *P* value
	Univariate analysis	Multivariate analysis
Age (years)		
Over 65	0.73, 0.37–1.45, 0.03*	10.6, 0.3–1.28, 0.005*
Under 65	1	1
Sex		
Female	1	1
Male	0.73, 0.25–2.1, 0.28	0.7, 0.2–2.0, 0.48
T classification		
Cis	2.1, 0.29–17, 0.001*	2.0, 0.28–19, 0.001*
1	1.8, 0.27–15, 0.04*	1.7, 0.3–17, 0.008*
2	1.6, 0.24–16, 0.009*	1.8, 0.28–18, 0.007*
3	2.2, 0.23–12, 0.05*	2.4, 0.21–14, 0.002*
4	2.4, 0.29–18, 0.002*	2.6, 0.20–19, 0.008*
Nodal involvement		
No	1	1
Yes	2.2, 0.29–19, 0.002*	2.6, 0. 33–20, 0.008*
Primary site		
Glottis	1	1
Supraglottis	1.29, 0.63–2.6, 0.04*	1.4, 0.6–3.2, 0.002*

CI, confidence interval; HR, hazard ratio; *Statistically significant.

Table 5 Subjective evaluation of voice in patients of the study

Characteristics	TL (*n* = 46) with prosthesis	Rx (*n* = 29)	PL (*n* = 7)	TC (*n* = 9	TL and Rx (*n* = 9)
Intelligibility (mean)	2	3	2	4	1
Loudness	2	3	3	3	1
Pitch	2	4	3	4	1
Fluency	1	3	2	4	1
Telephone intelligibility	2	4	2	3	1
Intelligibility in noise	2	3	3	4	1
Total (24)	11	20	15	22	6

PL, partial laryngectomy; Rx, radiotherapy; TC, transoral cordectomy; TL, total laryngectomy.

Patients who had received TL had a better swallowing result compared with those who had undergone PL, especially those who had undergone supracricoid laryngectomy. Patients with dysphagia were further evaluated using the FEES. In patients who had undergone TL, there was pharyngeal residue and neopharyngeal stenosis. Patients who had been treated with Rx alone were affected with dryness of mucosa and neck lymphedema. Aspiration was evident in supracricoid laryngectomy.

Respiratory function was assessed with a modified SGRQ (Table 8). Best results were seen in patients who had undergone cordectomy, followed by those who had undergone TL and radiotherapy. Poorest results were seen in patients who had undergone combined surgery and Rx, and those who had undergone PL.

Table 6 Results of voice analysis using CSL

Parameters	TL (*n* = 46) with prosthesis	Rx (*n* = 29)	PL (*n* = 7)	TC (*n* = 9)	TL and Rx (*n* = 9)
Mean MPT (s)	11.6	13.2	12.5	15.2	9.51
Mean fundamental frequency (FO) (Hz)	180	220	205	225	155
Mean jitter %	1.17	0.64	0.84	0.54	2.97
Mean shimmer %	5.4	3.2	4.6	2.9	8.2
Mean HNR	13	25	18	35	11

CSL, computerized speech lab; MPT, maximal phonation time; PL, partial laryngectomy; Rx, radiotherapy; TC, transoral cordectomy; TL, total laryngectomy.

Table 7 The results of the SSQ

Parameter	TL (*n* = 46) with prosthesis	Rx (*n* = 29)	PL (*n* = 7)	TC (*n* = 9)	TL and Rx (*n* = 9)
Question 1	25	50	50	0	75
Question 2	25	50	75	0	50
Question 3	25	50	75	0	75
Question 4	50	25	25	0	50
Question 5	50	75	50	25	75
Question 6	25	50	50	25	75
Question 7	25	25	50	0	50
Question 8	0	50	25	0	50
Question 9	25	25	0	0	25
Question 10	25	50	75	0	50
Question 11	0	50	75	25	25
Question 12	25	50	25	0	75
Question 13	0	0	0	0	25
Question 14	25	50	25	0	50
Question 15	25	50	25	0	25
Question 16	25	50	50	0	75
Question 17	25	50	50	0	75
Total	400	750	725	75	925

MPT, maximal phonation time; PL, partial laryngectomy; Rx, radiotherapy; SSQ, Sydney Swallow Questionnaire; TC, transoral cordectomy; TL, total laryngectomy.

Discussion

The larynx is the most common site for cancer in the upper aerodigestive tract, of which squamous cell carcinoma is the predominant type (95%) [14]. The attempts to preserve the laryngeal functions have generated diverse strategies for the optimal treatment of patients affected with cancer larynx.

Data from consecutive 100 patients treated for laryngeal cancer were collected and statistically analyzed. Ninety-five patients were male, and only five were female. Laryngeal cancer is known to be more common in the male population, with a reported male-to-female ratio of 5 to 1 in the UK [15] and 7 to 1 in the USA [16]. A population-based study for head and neck cancer incidence in Elgharbeya province in 2010 showed a male-to-female ratio of 10 to 1 for incidence of laryngeal cancer [17].

Table 8 Results of modified SGRQ

Parameter	TL (*n* = 46) with prosthesis	Rx (*n* = 29)	PL (*n* = 7)	TC (*n* = 9)	TL and Rx (*n* = 9)
Sitting or lying still	0	0	0	0	0
Getting washed or dressed	0	0	0	0	1
Walking around the house	0	0	0	0	1
Walking outside on level ground	0	0	1	0	1
Walking up a flight of stairs	1	1	1	0	1
Walking up a hill	1	1	1	1	1
Playing sports or games	1	1	1	1	1
Total	3	3	4	2	6

PL, partial laryngectomy; Rx, radiotherapy; SGRQ, St George's respiratory questionnaire; SSQ, Sydney Swallow Questionnaire; TC, transoral cordectomy; TL, total laryngectomy.

Patients were allocated into five groups according to the primary treatment modality: TL, PL, TC, radiotherapy (R), and combined surgery and radiotherapy (S and R). TL either alone or followed by radiotherapy was the primary treatment modality in 55 patients. This reflects that most laryngeal cancer patients still present in a late stage.

The Karnofsky Performance Status Scale was applied to assess the global QoL in our patients. The validity of this scale has been assured and it can be considered as a standard tool for QoL measurements in head and neck cancer patients [18]. Patients with scores less than 50% are not seen in outpatient clinics; this explains why scores in our series start from 50%.

Voice was evaluated in our series first by applying the four-point scale (good, reasonable, moderate, and bad) questionnaire designed by the Netherlands Cancer Institute [10], for subjective evaluation of voice. Best voice results were reported in patients treated with radiotherapy and cordectomy, with no significant difference between the two groups. Worst results were seen in patients treated with combined surgery and radiotherapy. Unexpectedly, the difference between voice quality in patients treated with TL and using provox and those treated with PL was not statistically significant, which could be due to the small number of available cases in our study. The tracheoesophageal puncture with valved prosthesis, proposed by Blom and Singer in 1980, offered the possibility to rapidly and easily acquire a fluent alaryngeal speech after TL, overcoming, at least in part, the old voiceless handicap and making TL a more acceptable procedure for the patients and their family [14]. These results were further validated by voice analysis using CSL. We measured speaking fundamental frequency, jitter %, shimmer %, and noise–harmonic ratio.

The speaking fundamental frequency — that is, the average speaking pitch — for men is around 128 Hz (cycles per second), for women it is about 225 Hz, and for children under the age of 10 years it can average 260 Hz. Jitter % is also known as pitch perturbation and refers to the minute involuntary variations in the frequency of adjacent vibratory cycles of the vocal folds. In essence, it is a measure of frequency variability in comparison with the client's fundamental frequency. Pathological voices often exhibit a higher percentage of jitter. Shimmer % is a measure of the percentage irregularity in the amplitude of the vocal note. It is often referred to as amplitude perturbation. Shimmer, therefore, measures the variability in the intensity of adjacent vibratory cycles of the vocal folds. As with jitter, pathological voices will typically exhibit a higher percentage of shimmer. The vocal note produced by the vibrations of the vocal folds is complex and made up of periodic (regular and repetitive) and aperiodic (irregular and nonrepetitive) sound waves. The aperiodic waves are random noise introduced into the vocal signal owing to irregular or asymmetric adduction (closing) of the vocal folds. Noise impairs the clarity of the vocal note and too much noise is perceived as hoarseness. Laryngeal pathology may lead to poor adduction of the vocal folds and, therefore, increases the amount of random noise in the vocal note. The greater the proportion of noise, the greater the perceived hoarseness, and the lower the harmonic to noise ratio (HNR) — that is, a low HNR indicates a high level of hoarseness, and a high HNR indicates a low level of hoarseness. Normal jitter % is below 1.040%, whereas normal shimmer % is below 3.810%. A healthy voice phonating/a/or/i/should have an HNR of 20 and an HNR of 40 for the phonation of the vowel/u/. Consequently, an HNR below 20 is considered to be a measure of noticeable hoarseness [10].

In our study, global health status scores did not differ between patients who had undergone laryngectomy with a tracheoesophageal puncture and patients treated with radiotherapy only. Stewart *et al.* [14], reporting on physical voice handicap scores, did not show a significant difference between those who had undergone tracheoesophageal puncture and those who had undergone radiotherapy.

Swallowing function in the present work was evaluated with a swallow-specific questionnaire, the SSQ, as it appears to be shorter, consisting of 17 well-structured questions, validated, and more precise questionnaire designed for directly evaluating swallowing function [6,7].

The severity of swallowing impairment in laryngeal cancer patients is directly related to the site and T-stage of the cancer, the age of the patient, and the use of surgical reconstruction. It will be important to use SSQ in the future for prospective studies to gain a clearer picture of its potential role in such patient population, as other questionnaires have many limitations as proved by Dwivedi *et al.* [6,7].

The results of the SSQ in this study clarified that the highest scores and poor swallowing function were seen in patients who had undergone combined laryngectomy with radiation due to the high incidence of aspiration in these patients, whereas the best results were seen in patients who had been treated with TC followed by patients treated with TL. The results of this study demonstrate that TL has a good global long-term QoL and better swallowing function when compared with patients treated with radiotherapy; similar results were reported by Vilaseca *et al.* [9].

However, Müller *et al.* [19] stated that the QoL of patients treated with TL with or without postoperative radiotherapy is worse compared with patients with a saved intact larynx. It is assumed that laryngectomees have a higher tumor stage compared with patients with a saved larynx (grades I and II). Hammerlid *et al.* [20] also found that patients with a larger tumor are more impeded in their QoL compared with patients with a smaller tumor.

The worst results were always seen in patients treated with TL, followed by postoperative radiotherapy, and the poorest QoL was seen in patients who were treated with TL after failure of radiotherapy due to recurrence of the tumor. Similar results were reported by Holsinger *et al.* [21]. Thus, this indicates that patients with advanced laryngeal cancer who choose radiotherapy alone as a treatment to save their larynx should be advised very carefully about the hazards of failure of radiotherapy that will necessitate TL with a high risk of very poor QoL.

FEES, as described by Langmore *et al.* in 1988 [22], provides direct endoscopic observation of the pharyngeal phase of swallowing. The pharyngeal phase is often the most relevant in determining swallowing safety as significant pharyngeal disturbances can result in disabling dysphagia, malnutrition, and aspiration. FEES can assess abnormal bolus transport before and immediately after swallowing [23].

In our study, FEES revealed a high rate of aspiration in patients treated with conservation laryngeal surgery. Moreover, it revealed a high rate of retention of food (pharyngeal residue) in patients who had been treated with radiotherapy either alone or following TL. In contrast, most patients treated with TL alone had good swallowing function with FEES; similar results were reported by Aviv *et al.* [24].

On evaluating the respiratory function, there were no significant differences between patients managed with TL or radiotherapy. However, some patients treated with TL complained of chronic cough and thick mucus secretions that obstruct the tracheostoma or the voice prosthesis.

Ackerstaff *et al.* [25] stated that patients treated with TL reported significantly greater problems with breathing and sleeping. TL precludes nasal air conditioning. As a consequence, inhaled air can cause irritation of the bronchial mucosa, coughing, excessive daily sputum production, and crusting, requiring frequent forced expectoration and frequent stoma cleaning. These respiratory problems correlate with several aspects of daily living, including sleeping.

We also noticed that some patients treated with TL suffered from stenosis of tracheostoma on the long run, which interferes with their breathing and impairs coughing thick mucus discharge, and so it is better to perform TL with large tracheostoma to avoid stomal stenosis that may necessitate stomaplasty on the long run.

Conclusion

(1) Most of our patients with laryngeal cancer still present in a late stage. An extra work is needed to highlight the magnitude of the problem of cancer larynx at public, media, teaching, and training levels.
(2) The male-to-female ratio for cancer of the larynx in our region is higher than that in Europe and USA.
(3) The Karnofsky Performance Status Scale is a valid tool for evaluating global QoL in patients treated for laryngeal cancer.
(4) The earlier the patient is discovered as having laryngeal cancer, the better the post-treatment QoL.
(5) CSL can be used to measure voice parameters even in patients rehabilitated with Provox voice prosthesis.
(6) The SSQ is a valid tool for assessment of the physiological function of swallowing. It is short and better understood by the patients.
(7) SGRQ is an easy and short tool to assess respiratory function in patients treated for laryngeal cancer.

Table A1 Layout of the component questions of the Sydney Swallow Questionnaire

SN	Question
Question 1	How much difficulty do you have swallowing at present?
Question 2	How much difficulty do you have swallowing THIN liquids? (e.g. tea, soft drink, beer, or coffee)
Question 3	How much difficulty do you have swallowing THICK liquids? (e.g. milkshakes, soups, or custard)
Question 4	How much difficulty do you have swallowing SOFT foods? (e.g. mornays, scrambled egg, or mashed potato)
Question 5	How much difficulty do you have swallowing HARD foods? (e.g. steak, raw fruit, or raw vegetables)
Question 6	How much difficulty do you have swallowing DRY foods? (e.g. bread, biscuits, or nuts)
Question 7	Do you have any difficulty swallowing your saliva?
Question 8	Do you ever have difficulty starting a swallow?
Question 9	Do you ever have a feeling of food getting stuck in the throat when you swallow?
Question 10	Do you ever cough or choke when swallowing solid foods? (e.g. bread, meat, or fruit)
Question 11	Do you ever cough or choke when swallowing liquids? (e.g. coffee, tea, or beer)
Question 12[a]	How long does it take you to eat an average meal?[a]
Question 13	When you swallow does food or liquid ever go up behind your nose or come out of your nose?
Question 14	Do you ever need to swallow more than once for food to go down?
Question 15	Do you ever cough up or spit out food or liquids DURING a meal?
Question 16	How do you rate the severity of your swallowing problem today?
Question 17	How much does your swallowing problem interfere with your enjoyment or quality of life?

[a]All questions except Question 12 are answered on a visual analogue scale under each response.

Recommendations

We recommend further studies on a larger number of patients to obtain valid conclusion about the best treatment modality for each stage of laryngeal cancer.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Appendix

Table A1.

References

1 Pou MA. Tracheoesophageal voice restoration with total laryngectomy. Otolaryngol Clin N Am 2004; 37:531–545.

2 Luna-Ortiz K, Nunz-Valencia ER, Tamez-Velarde M, Granados-Garcia M. Quality of life and functional evaluation after supracricoid partial laryngectomy with cricohyoidoepiglottopexy in Mexican patients. J Laryngol Otol 2004; 118:284–288.

3 Boscolo-Rizzo P, Maronato F, Marchiori C, Gava A, Da Mosto MC. Long-term quality of life after total laryngectomy and postoperative radiotherapy versus concurrent chemoradiotherapy for laryngeal preservation. Laryngoscope 2008; 118:300–306.

4 Thawely SE, Genden EM. Conservation laryngeal surgery. In: Gerald M, editor. *English otolaryngology*. Philadelphia: Lippincott Williams & Wilkins; 1998; 1–40.

5 Kreiman J, Gerratt BR, Kempster GB, Erman A, Berke GS. Perceptual evaluation of voice quality: review, tutorial, and a framework for future research. J Speech Hear Res 1993; 36:21–40.

6 Dwivedi RC, St Rose S, Chisholm EJ, Georgalas C, Bisase B, Amen F, *et al*. Evaluation of swallowing by Sydney Swallow Questionnaire (SSQ) in oral and oropharyngeal cancer patients treated with primary surgery. Dysphagia 2012; 27:491-497.

7 Dwivedi RC, St Rose S, Roe JW, Khan AS, Pepper C, Nutting CM, *et al*. Validation of the Sydney Swallow Questionnaire (SSQ) in a cohort of head and neck cancer patients. Oral Oncol 2010; 46:10–14.

8 Goldenberg D, Esclamado R, Flint P, *et al*. Surgical management of upper airway stenosis. In: Cummings CW, Haughey B, Thomas JR, editors. *Otolaryngology head & neck surgery*. 4th ed. Mosby Inc.; 2005; 2105–2127.

9 Vilaseca I, Chen AY, Backscheider AG. Long-term quality of life after total laryngectomy. Head Neck 2006; 28:313–320.

10 D'Alatri L, Bussu F, Scarano E, Paludetti G, Marchese MR. Objective and subjective assessment of tracheoesophageal prosthesis voice outcome. J Voice 2012; 26:607–613.

11 Jones PW, Quirk FH, Baveystock CM, Littlejohns P. A self-complete measure for chronic airflow limitation — the St George's Respiratory Questionnaire. Am Rev Respir Dis 1992; 145:1321–1327.

12 Meguro M, Barley EA, Spencer S, Jones PW. Development and Validation of an Improved, COPD-Specific Version of the St. George Respiratory Questionnaire. Chest 2007; 132:456–463.

13 Yates JW, Chalmer B, McKegney FP. Evaluation of patients with advanced cancer using the Karnofsky performance status. Cancer 1980; 45:2220–2224.

14 Stewart MG, Chen AY, Stach CB. Outcomes analysis of voice and quality of life in patients with laryngeal cancer. Arch Otolaryngol Head Neck Surg 1998; 124:143–148.

15 Office for National Statistics. Cancer Registration Statistics 2008 England Series MB1 No. 39. 2011.

16 Ridge JA, Glisson BS, Lango MN, *et al*. Head and neck tumors. In: Pazdur R, Wagman LD, Camphausen KA, Hoskins WJ, editors. *Cancer management: a multidisciplinary approach*. 11th ed. Franklin Wong; 2008. p. 199–213.

17 Attar E, Dey S, Hablas A, Seifeldin IA, Ramadan M, Rozek LS, Soliman AS. Head and neck cancer in a developing country: a population-based perspective across 8 years. Oral Oncol 2010; 46:591–596.

18 Adams SG, Britt DM, Godding PR, Khansur TI, Bulcourf BB. Relative contribution of the Karnofsky performance status scale in a multi-measure assessment of quality of life in cancer patients. Psychooncology 1995; 4:239–246.

19 Müller R, Paneff J, Köllner V, Koch R. Quality of life of patients with laryngeal carcinoma: a post-treatment study. Eur Arch Otorhinolaryngol 2001; 258:276–280.

20 Hammerlid E, Mercke C, Sullivan M, Westin T. A prospective quality of life study of patients with laryngeal carcinoma by tumor stage and different radiation therapy schedules. Laryngoscope 1998; 108:747–759.

21 Holsinger FC, Funk E, Roberts DB, Diaz EM Jr. Conservation laryngeal surgery versus total laryngectomy for radiation failure in laryngeal cancer. Head Neck 2006; 28:779–784.

22 Langmore SE, Schatz K, Olsen N. Fiberoptic endoscopic examination of swallowing safety: a new procedure. Dysphagia 1988; 2:216–219.

23 Deutschmann MW, McDonough A, Dort JC, Dort E, Nakoneshny S, Matthews TW. Fiber-optic endoscopic evaluation of swallowing (FEES): predictor of swallowing-related complications in the head and neck cancer population. Head Neck 2013; 35:974–979.

24 Aviv JE, Sataloff RT, Cohen M, Spitzer J, Ma G, Bhayani R, Close LG. Cost-effectiveness of two types of dysphagia care in head and neck cancer: a preliminary report. Ear Nose Throat J 2001; 80:553–556.

25 Ackerstaff AH, Fuller D, Irvin M, Maccracken E, Gaziano J, Stachowiak L. Multicenter study assessing effects of heat and moisture exchanger use on respiratory symptoms and voice quality in laryngectomized individuals. Otolaryngol Head Neck Surg 2003; 129:705–712.