Voice Outcomes after Radiotherapy for Laryngeal Cancer

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Abstract

Objective The study was aimed to assess changes in voice outcomes after radiotherapy in laryngeal cancer patients.

Materials and Methods The study included 60 laryngeal cancer patients treated with definitive radiotherapy or chemoradiotherapy between 2005 and 2012. The primary endpoint of this study was to assess abnormalities of the patients' voices after the treatment. The Thai version of the Voice Handicap Index (VHI) and xerostomia questionnaire were conducted by telephone. Videostroboscopic examination was done to objectively assess voice outcomes.

Results The median age of patients was 63 years. Most patients had glottic cancer (84.1%) and T1–2 disease (84.1%). The median time from treatment to the study was 46 months. In terms of the total VHI score, most patients were in the normal and slight handicap groups (22% and 71.4%, respectively). Only 4.8% and 1.6% of the patients were in moderate and severe handicap group, respectively. Twenty-eight patients had significant xerostomia. Videostroboscopy examination was done in 23 patients and most common findings were telangiectasia (95.7%), abnormal mucosal wave (47.8%), and abnormal glottic closure configuration (34.8%). Regarding total VHI score, lower radiation dose, conventional radiation dose per fraction, longer period after treatment, and significant xerostomia status were significantly correlated with worse voice outcomes. There were no statistically significant correlations between the videostroboscopic findings and VHI scores.

Conclusion Voice outcomes in most of laryngeal cancer patients treated with radiotherapy had a normal or mild handicap at more than 1 year of follow-up. Only 4.8% and 1.6% of the patients had moderate and severe voice outcome handicap, respectively.

Keywords
- voice outcome
- radiotherapy
- laryngeal cancer
- voice handicap index
- videostroboscopy

Introduction

In early stage (stages I and II) laryngeal cancers, there are two main options of treatment—definitive radiotherapy (RT) and the laryngeal sparing surgery. No significant differences in local control[1-10] and overall survival[2,6-8,10-13] have been reported between RT and laryngeal sparing surgery. A recent systematic review and meta-analysis showed better

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treatment results after transoral surgery than RT in terms of laryngeal preservation for selected T1 glottic cancer patients[1,3,7-9,12] and survival.[1,3,9] Regarding postoperative voice quality, the results of the studies examining this have been inconsistent. However, in most studies, RT resulted in better voice outcomes compared with transoral surgery in both subjective and objective aspects.[2,3,6,14-16]

In locally advanced laryngeal cancers, the VA study showed no significant difference in overall survival was found between induction chemotherapy followed by RT and total laryngectomy. At a median follow-up time of 33 months, 64% of the patients in the chemotherapy plus RT group still had their larynx.[17] In the RTOG 91–11 trial, there were no statistically significant differences in overall survival between induction chemotherapy followed by RT, concurrent chemoradiotherapy, and RT alone. However, the concurrent chemoradiotherapy arm achieved the highest level of locoregional control and larynx preservation. The 10-year larynx preservation rate was 81.7% in the concurrent chemoradiotherapy arm.[18]

RT and chemoradiotherapy tend to result in better post-treatment vocal quality than surgery in laryngeal cancer. However, RT still causes damage to normal tissue within the radiation field and deterioration of vocal quality after the RT often occurs. This study aimed to assess changes in voice outcomes after RT to enable a better understanding of the mechanism of radiation damage which could help develop voice therapy strategies.

There are two main methods of vocal outcome assessment—subjective assessment and objective assessment. In this study, the Voice Handicap Index (VHI) was chosen for the subjective category and videostroboscopy was chosen for direct detection of vibration patterns of the vocal folds, supraglottic activity, and abnormal lesions of the laryngeal structures.

Materials and Methods

This was an observational study of nonmetastatic laryngeal cancer patients treated with definitive radiotherapy or chemoradiotherapy at Siriraj Hospital (Bangkok, Thailand) between January 2005 and October 2012. The study was approved by the institutional review board of the Faculty of Medicine, Siriraj Hospital. The study excluded patients who had residual/recurrent disease after treatment or surgery of the vocal cords or larynx. The primary endpoint of this study was to assess abnormalities of the voices of laryngeal cancer patients treated with definitive RT or concurrent chemoradiotherapy. The secondary endpoints were to examine any correlations between patients, tumors, and treatment factors with the VHI and between the VHI and the videostroboscopic findings.

Treatment Details

Treatment options were discussed in the tumor board which included an otolaryngologist, a radiation oncologist, and a medical oncologist before making the decision to suggest RT or concurrent chemoradiotherapy for each patient.

The radiation techniques used in this study were conventional two-dimensional radiotherapy (2D-RT) and three-dimensional conformal radiotherapy (3D-CRT). Conventional radiotherapy

Table 1 Patient and tumor characteristics

Patient and tumor characteristics	Number of patients	Percentage
Gender		
Male	60	95.2%
Female	3	4.8%
Age		
≤60 years	32	50.8%
>60 years	31	49.2%
Presenting symptoms		
Hoarseness	56	88.9%
Dysphagia	3	4.8%
Sore throat	3	4.8%
Neck mass	1	1.6%
Site		
Glottis	53	84.1%
Supraglottis	10	15.9%
T stage		
T1–2	53	84.1%
T3–4	10	15.9%
N stage		
N0	48	76.2%
N1–3	15	23.8%
Treatment		
RT alone	46	73.0%
Concurrent chemoradiotherapy	17	27.0%
Total RT dose (mean 66.7 Gy, min 56 Gy, max 71.6 Gy)		
≤66 Gy	43	68.3%
>66 Gy	20	31.7%
RT dose per fraction		
1.8–2.0 Gy per fraction (conventional fractionation)	55	87.3%
>2 Gy per fraction (hypofractionation)	8	12.7%
RT field size		
≤49 cm^2	22	34.9%
>49 cm^2	41	65.1%
RT technique		
Conventional (2D-RT)	59	93.7%
3D conformal RT (3D-CRT)	4	6.3%
Time from the last treatment (median 46 months, range 12–101 months)		
≤46 months	33	53.4%
>46 months	30	47.6%

(*Continued*)

Table 1 (*Continued*)

Patient and tumor characteristics	Number of patients	Percentage
ECOG		
0–2	59	93.7%
3–4	4	6.3%
Occupation		
Elite voice performer	0	0.0%
Professional voice user	9	14.3%
Nonvocal professional	15	23.8%
Nonvocal nonprofessional	17	27.0%
Out of work	22	34.9%
Smoking status		
Current smoker	5	7.9%
Former smoker	49	77.8%
Never smoker	9	14.3%
Xerostomia status		
Nonsignificance	35	55.6%
Significance	28	44.4%

Abbreviations: ECOG, Eastern Cooperative Oncology Group; 2D-RT, two-dimensional radiotherapy; 3D-CRT, three-dimensional conformal radiotherapy; RT, radiotherapy.

was used in most of the patients (93.7%). In patients with early-stage glottic cancer, opposed lateral fields targeting the larynx were applied and the radiation prescribed dose was prescribed to the midplane of the neck. Most of the early-stage glottic cancer patients were treated with a cobalt-60 machine. In locally advanced glottic and supraglottic cancer, the primary tumor and regional cervical nodes were included in the treatment field. The common prescribed RT dose was 63 to 65.25 Gy in 28 to 29 fractions in early-stage glottic cancer patients and 66 to 70 Gy in 33 to 35 fractions for locally advanced glottic and supraglottic cancer patients.

Voice Assessment

One investigator (JB) interviewed the patients by telephone and after the interview the patients were asked if they would agree to a videostroboscopic examination.

Subjective Voice Assessment

The Thai version of VHI questionnaire was conducted by telephone. The Thai VHI questionnaire is a reliable tool for assessing the severity of voice abnormalities with high internal conformity and high consistency (index of consistency > 0.5, Cronbach's $\alpha = 0.96$, and $r = 0.843$). The VHI questionnaire consists of 30 questions divided into three topics—physical, functional, and emotional. Each topic has 10 questions. For each question, a score from 0 to 4 was given (a larger number indicates a greater perceived degree of handicap). In each part, the maximum available score is 40 points and the total score is then classified as slight handicap (below 20 points), moderate handicap (21–30 points), and severe handicap (more than 30 points). In the overall total score, the maximum available score is 120 points and classified as slight (less than 30 points), moderate (31–60 points), severe (61–90 points), and serious (91–120 points) handicap.

Since xerostomia can also cause vocal changes, questions concerning xerostomia were included, excerpted from the Late Effect in Normal Tissues: Subjective, Objective, Management And Analytic scales (LENT-SOMA) questionnaire. Four questions from the subjective assessment part of the LENT-SOMA questionnaire were used in the interview and the patients were divided into nonsignificant and significant xerostomia groups.

Objective Voice Assessment

The videostroboscopy was performed and recorded by an otolaryngologist (CC). The findings of interest were arytenoid movement, supraglottic hyperfunction, glottis appearance, and vibratory portion.

Statistical Analysis

Descriptive statistics were used to report patient factors and VHI scores. For group data, the mean or median were used as appropriate. The Mann–Whitney U test was used for the analysis of the relations of the datum factors and VHI scores between the two groups. The Kruskal–Wallis test was used for factors that had more than two levels. We originally planned to analyze factors correlated with VHI scores using multiple linear regression, however, when we finished the data collection, all the significant factors were found to be nonuniformly distributed and multiple linear regression seemed to be unreliable. SPSS version 18 was used for all statistical analyses.

Results

The medical records of 403 nonmetastatic laryngeal cancer patients treated with definitive radiotherapy or chemoradiotherapy were reviewed. Three hundred and forty patient records were excluded because the patient had surgery ($n = 201$), had a history of tracheostomy ($n = 55$), had recurrent disease ($n = 26$), was deceased ($n = 24$), had a wrong diagnosis ($n = 3$), had an incomplete medical history ($n = 1$), was unable to be contacted ($n = 28$), or refused to participate in this study ($n = 2$). Finally, 63 patients were enrolled in the study.

Patient Characteristics

The study included 60 men (95.2%) and 3 women (4.8%) with a median age of 63 years (range 29–89 years). None of the patients were singers or orators. The highest employment category of patients was retired ($n = 22$, 34.9%). The most prevalent site was glottic cancer ($n = 53$, 84.1%). The T stage was mostly early stage ($n = 53$, 84.1%). Most patients were treated with RT alone ($n = 46$, 73%). The mean radiation dose was 66.7 Gy (range 56–71.6 Gy). The radiotherapy was mostly done using conventional fractionation (1.8–2.0 Gy per fraction) ($n = 55$, 87.3%). The 2D-RT technique was used in almost all patients ($n = 59$, 93.7%). The median time from treatment to the study was 46 months (range 12–101 months). The details of patient and tumor characteristics are shown in ►**Table 1**. Twenty-eight patients (44.4%) had significant xerostomia.

Table 2 The details of the Voice Handicap Index (VHI) scores

VHI scores	Physical domain Total score 0–40	Functional domain Total score 0–40	Emotional domain Total score 0–40	Total score 0–120
Mean (standard deviation)	2.87 (4.9)	5.6 (6.7)	1.65 (3.54)	10.13 (13.8)
Median	0	4	0	5
Min, max	0, 27	0, 32	0, 18	0, 77

Voice Handicap Index (VHI)

The median overall VHI score was 5 (range 0–77 points). The median scores in each part were 0 (range 0–27 points) in the physical domain, 4 (range 0–32 points) in the functional domain, and 0 (range 0–18 points) in the emotional domain. The details of the VHI scores are shown in ►**Table 2**.

In terms of the total VHI score, most patients were in the normal and slight handicap groups (22% and 71.4%, respectively). Only 4.8% and 1.6% of the patients were in moderate and severe handicap group, respectively. When examining the VHI scores in each part, 62 patients (98.4%) in the functional domain, 60 patients (95.2%) in the physical domain, and 63 patients (100%) in the emotional domain were in the normal or mild handicap groups. The details of the VHI score groupings are shown in ►**Table 3**.

The analysis of the mean VHI scores in each domain found that the functional domain had the highest mean score (worst function). The emotional domain had the lowest mean score (best function). However, the largest proportion of patients who had moderate to severe handicap was found in the physical domain ($n = 3$, 5.8%). The question which received the highest score was question 2.4 "Does your voice feel hissy or dry" in the physical part. The second highest score was question 2.2 "Does your voice vary during the day" in the physical part. The question receiving the lowest score was question 3.6 "Do feel impaired because of your voice problem."

We analyzed the correlations between patients, tumors, treatment factors and VHI. In the functional domain, lower total radiation dose, longer period after treatment, and significant xerostomia status were found to be significantly correlated with worse voice outcomes. In the physical domain, younger age, lower total radiation dose, conventional radiation dose per fraction, and longer period after treatment were found to be significantly correlated with worse voice outcomes. In the emotional domain, longer period after treatment and significant xerostomia status were statistically significantly correlated with worse voice outcomes. Regarding the total VHI scores, lower total radiation dose, conventional radiation dose per fraction, longer period after treatment, and significant xerostomia status were found to be significantly correlated with worse voice outcomes. The details of the correlations between patient, tumors, and treatment factors and VHI scores are shown in ►**Table 4**.

Videostroboscopic Findings

Twenty-three patients agreed to participate in the videostroboscopy. However, due to technical limitations, the phase symmetry could be evaluated in only 19 patients and the nonvibrating status could be evaluated in only 22 patients.

Table 3 The details of the Voice Handicap Index (VHI) scores groupings

VHI scores	Number of patients	Percentage
Functional domain		
Normal (0 points)	33	52.4%
Mild (≤20 points)	29	46.0%
Moderate (21–30 points)	1	1.6%
Severe (>30 points)	0	0.0%
Physical domain		
Normal (0 points)	17	27.0%
Mild (≤20 points)	43	68.2%
Moderate (21–30 points)	2	3.2%
Severe (>30 points)	1	1.6%
Emotional domain		
Normal (0 points)	42	66.7%
Mild (≤20 points)	21	33.3%
Moderate (21–30 points)	0	0.0%
Severe (>30 points)	0	0.0%
Total score		
Normal (0 points)	14	22.2%
Slight (≤30 points)	45	71.4%
Moderate (31–60 points)	3	4.8%
Severe (61–90 points)	1	1.6%
Serious (91–120 points)	0	0.0%

The studies of all patients showed an abnormal glottis appearance. Telangiectasia was the most common abnormality found in 22 patients (95.7%). The second and third most common abnormalities were an abnormal mucosal wave (47.8%) and an abnormal glottis closure configuration (34.8%). The details of the videostroboscopy findings are shown in ►**Table 5**.

There were no statistically significant correlations between the videostroboscopic findings and VHI scores.

For the five patients who had moderate to severe VHI, the most abnormal VHI scores were found in the physical domain while the emotional domain scores were never worse than mild or slight handicap. The analysis found that four of the five patients whose VHI went beyond mild or slight handicap had T1 glottic cancer and the other patient had T1 supraglottic cancer. However, most (four patients) were treated with a large radiation field (larger than 7 cm × 7 cm.). Four of the five patients had significant xerostomia. Only two

Table 4 The details of correlations between patients, tumors, and treatment factors and Voice Handicap Index (VHI) scores

Factor	*N*	Functional domain		Physical domain		Emotional domain		Total score	
		Median(min, max)	*p*-Value	Median(min, max)	*p*-Value	Median(min, max)	*p*-Value	Median(min, max)	*p*–Value
Age			0.755		0.031		0.496		0.079
≤60 years	32	1 (0–14)		5 (0–24)		0 (0–14)		7 (0–37)	
>60 years	31	0 (0–27)		1 (0–32)		0 (0–18)		2 (0–77)	
Presenting symptom			0.906		0.615		0.724		0.773
Hoarseness	56	0 (0–27)		4 (0–32)		0 (0–18)		5 (0–77)	
No hoarseness	7	1 (0–9)		2 (1–24)		0 (0–4)		2 (2–30)	
Laryngeal site			0.422		0.746		0.277		0.495
Glottis	53	0 (0–27)		4 (0–32)		0 (0–18)		5 (0–77)	
Supraglottis	10	1 (0–9)		2 (0–24)		0 (0–4)		2 (0–30)	
T staging			0.19		0.27		0.805		0.252
T1–2	53	0 (0–27)		3 (0–32)		0 (0–18)		4 (0–77)	
T3–4	10	2.5 (0–14)		6 (0–14)		0 (0–4)		8.5 (0–29)	
N staging			0.328		0.478		0.817		0.922
N0	48	1 (0–27)		4 (0–32)		0 (0–18)		5 (0–77)	
N1–3	15	0 (0–11)		6 (0–24)		0 (0–10)		8 (0–30)	
Treatment			0.834		0.123		0.993		0.255
RT alone	46	0 (0–27)		2.5 (0–32)		0 (0–18)		4 (0–77)	
CCRT	17	1 (0–11)		6 (0–24)		0 (0–10)		9 (0–30)	
Total RT dose			0.021		0.009		0.068		0.002
≤ 66 Gy	43	1 (0–27)		5 (0–32)		0 (0–18)		8 (0–77)	
> 66 Gy	20	0 (0–11)		1 (0–24)		0 (0–4)		1 (0–30)	
RT dose per fraction			0.123		0.016		0.133		0.027
1.8–2.0 Gy/F	55	1 (0–27)		4 (0–32)		0 (0–18)		5 (0–77)	
>2 Gy/F	8	0 (0–5)		0 (0–5)		0 (0–1)		1 (0–7)	
RT field size			0.618		0.110		0.149		0.309
≤49 cm^2	22	0 (0–7)		3 (0–13)		0 (0–5)		4.5 (0–22)	
>49 cm^2	41	0 (0–27)		4 (0–32)		0 (0–18)		8 (0–77)	

(*Continued*)

Table 4 (*Continued*)

Factor	*N*	Functional domain		Physical domain		Emotional domain		Total score	
		Median (min, max)	*p*-Value	Median (min, max)	*p*-Value	Median (min, max)	*p*-Value	Median (min, max)	*p*–Value
RT technique			0.946		0.673		0.755		0.577
2D-RT	59	0 (0–27)		4 (0–32)		0 (0–18)		5 (0–77)	
3D-CRT	4	1.5 (0–6)		3 (0–11)		0 (0–3)		4.5 (0–20)	
Time after completed RT			0.008		0.019		0.004		0.005
≤46 months	33	0 (0–17)		2 (0–21)		0 (0–10)		2 (0–48)	
>46 months	30	2 (0–27)		6 (0–32)		0.5 (0–18)		10.5 (0–77)	
Occupation			0.849		0.308		0.710		0.576
Elite vocal performance	0								
Professional voice user	9	0 (0–10)		5 (0–18)		0 (0–9)		5 (0–37)	
Nonvocal professional	15	0 (0–14)		5 (0–24)		0 (0–10)		5 (0–30)	
Nonvocal nonprofessional	17	2 (0–17)		4 (0–21)		0 (0–14)		8 (0–48)	
Out of work	22	0 (0–27)		1 (0–32)		0 (0–18)		2 (0–77)	
Smoking status			0.809		0.606		0.669		0.794
Current smoker	5	0 (0–7)		4 (0–13)		0 (0–2)		4 (0–22)	
Former smoker	49	0 (0–27)		4 (0–32)		0 (0–18)		5 (0–77)	
Never smoker	9	1 (0–14)		1 (0–11)		0 (0–3)		4 (0–26)	
Xerostomia status			0.002		0.068		0.042		0.013
Nonsignificant	35	0 (0–14)		2 (0–19)		0 (0–14)		3 (0–35)	
Significant	28	4 (0–27)		6 (0–32)		0 (0–18)		9 (0–77)	

Abbreviations: CCRT, concurrent chemoradiation; 2D-RT, two-dimensional radiotherapy; 3D-CRT, three-dimensional conformal radiotherapy; RT, radiotherapy.

Table 5 The videostroboscopic findings of 23 study patients

Videostroboscopic findings	Normal: *n* (%)	Abnormal: *n* (%)	Total
Arytenoid movement	22 (95.7%)	1 (4.3%)	23
Supraglottic hyperfunction	16 (69.6%)	7 (30.4%)	23
Glottic appearance			
Glottic closure configuration	15 (65.2%)	8 (34.8%)	23
Vocal fold edge	19 (82.6%)	4 (17.4%)	23
Abnormal appearance	0 (0%)	23 (100%)	23
Vibratory portion			
Mucosal wave	12 (52.2%)	11 (47.8%)	23
Amplitude	16 (69.6%)	7 (30.4%)	23
Phase symmetry	12 (63.2%)	7 (36.8%)	19
Nonvibrating	17 (77.3%)	5 (22.7%)	22
Periodicity	21 (91.3%)	2 (8.7%)	23

of these five patients had videostroboscopy, as the other three patients refused to undergo the videostroboscopy. Regarding the videostroboscopic findings of these two patients, the study showed no notably different findings compared with the other patients in the study.

Discussion

Radiotherapy with or without chemotherapy is the standard nonsurgical voice-preserving treatment for laryngeal cancers.[19] However, after radiotherapy, many patients still have some level of voice abnormality. This current study aimed to assess voice abnormalities in laryngeal cancer patients following treatment with radiation alone or concurrent chemoradiation via the VHI (subjective evaluation) and videostroboscopy (objective evaluation).

The study found that following their treatment, the majority of the study patients had normal or mildly handicapped voices in every domain assessed by the VHI, physical (98.4%), functional (95.2%), and emotional (100%). The total scores of the VHI were mostly within the normal to slight[20-23] handicapped range (93.7%). These results are similar to previous studies.[24-29]

The VHI score in the emotional subscale section was the lowest in our study and also in other studies.[20,22,24] This was possibly because most of the patients had normal or mildly abnormal voice outcomes in the physical and functional domain so there was a lower effect on the emotional domain.

Our study showed that in patients older than 60 years the VHI score in the physical domain was significantly lower than the group of patients who were under 60 years old. We hypothesize that this could be because older patients had lower expectations and tended to be more accepting, which was also suggested in a previous study.[22]

Abnormal voice outcomes after radiotherapy for laryngeal cancer could come from the effect of a previous tumor invasion involving the laryngeal structures or from a side effect of the radiotherapy. Hence patients who previously presented with hoarseness may have worse voice outcomes. However, our study found that the patients who had originally presented with hoarseness did not show any significant differences in VHI scores compared with the group without symptom of hoarseness. The reason for this may be that most of the patients with hoarseness had lesions on the glottis (53/56 patients, 94.6%), and in the glottic cancer cases, the T stage was mainly T1 (41/53 patients, 77.4%) or T2 (7/53 patients, 13.2%). Since these patients were in an early T stage, they had probably not suffered any structural defects from the early-stage mass. One study reported a trend toward better voice outcomes in T1a glottic cancer patients treated with small-field RT compared with nonlaryngeal cancer stage II–IV patients treated with wide-field RT[24]. This may indicate that abnormal voice outcomes were likely from the RT rather than previous tumor destruction.

The patients with stage T1–T2 and those with stage T3–4 had no statistically significant differences in VHI scores in our study. However, the T3–4 group had a higher median score than the T1–2 group (median total VHI score = 4 and 9 in T1–2 and T3–4 group, respectively). The higher VHI scores in T3–4 patients could be related to multiple factors; for example, all patients in the T3–4 group received large field radiation (10/10 patients, 100%), 8/10 patients (80%) received concurrent chemoradiotherapy, while only 31/53 patients (58.5%) in the T1–2 group received large field of radiation and 9/53 patients (16.98%) received concurrent chemoradiotherapy. Previous retrospective studies have had varying results when examining correlations between tumor staging and VHI scores.[30-32] Also, the VHI scores of patients with N0 disease and of patients with N1–3 disease were not significantly different, although patients with N0 disease had lower VHI scores compared with patients with N1–3 disease (median total VHI score in patients with N0 disease = 5, in patients with N1–3 disease = 8). This result might be explained by the common use of a large radiation field and concurrent chemotherapy in node positive patients.

Total VHI scores were not statistically different between the patients who received concurrent chemoradiotherapy and the patients who received definitive radiotherapy. However, the median total VHI scores were 5 points different (median total VHI scores: RT alone group = 4, CRT group = 9).

This might have resulted from more damage to normal tissue in the radiation area due to concurrent chemotherapy. These results are similar to a previous study which reported that 1-year mean total VHI scores were higher in the CRT group than the RT group but the difference was not statistically significant.[28]

In contrast to our expectations, patients who received hypofractionated radiotherapy had better total VHI scores. The principle of radiobiology cannot account for this finding. It might be disease and treatment factors that caused the better voice outcomes in the group of patients who received hypofractionated radiotherapy since most patients in this group had a small RT field (<7 × 7 cm^2) (⅞ patients, 87.5%) and the median RT dose was only 63 Gy (63–69.3 Gy, 2.1–2.25 Gy/F). The results concerning dose per fraction from previous studies are conflicting.[32,33]

The group of patients treated with a RT dose higher than 66 Gy unexpectedly had better total VHI scores than the group treated with a total RT dose below 66 Gy. This might be explained by noting that almost all of the cases were treated by conventional radiation technique. The mean RT dose was 66.7 Gy and 90% of the patients were treated with doses between 66 and 70 Gy, mostly 2 Gy per fraction. This very small difference in total dose between the groups might have made it difficult to evaluate small changes.

Although the difference between the voice outcomes from small field (≤7 × 7 cm^2) and large field radiation (>7 × 7 cm^2) was not significantly different, the small field group had a lower median score than the large field group (median total VHI scores: small field = 4.5, large field = 8). A possible reason for this was that these scores not only depended on the larynx function itself, but were also related to the functionality of the salivary glands, the harmonious movements of the tongue and facial muscles and the upper airway which includes the resonance structure, and small field RT should yield the benefit of protecting these structures from receiving radiotherapy. Furthermore, almost all patients who received small RT field (21/22 patients, 95.5%) were T1N0M0.

Our study found that patients with significant xerostomia status had significantly higher VHI score than those without it. This can be explained by noting that when a patient has xerostomia, more effort and phonation threshold pressure are required in pronunciation.[34]

Regarding the videostroboscopy findings, all patients had an abnormal glottis appearance, and 22 out of 23 patients (95.7%) presented with telangiectasia. The second most common abnormalities were abnormal mucosal wave and abnormal glottic closure configuration. No videostroboscopic findings correlates with the VHI, similar to a previous study.[27]

The results of our videostroboscopic findings of supraglottichyperfunction, abnormal mucosal wave, abnormal glottic closure configuration, decreased amplitude, and phase asymmetry of our study were similar to other studies.[24,27,33]

Conclusion

We found that voice outcomes in most patients with laryngeal cancer treated with radiotherapy or concurrent chemoradiotherapy had a normal or mild handicap at more than 1 year of follow-up. Only 4.8% and 1.6% of the patients had moderate and severe voice outcome handicap, respectively. Abnormal morphologic alterations of the vocal folds on videostroboscopic findings were not related to the subjective voice outcomes. Xerostomia seemed to be one of the significant factors that could affect voice outcomes.

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Conflict of Interest
None declared.

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