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Correlation of voice and quality of life with adjuvant radiotherapy in patients with larynx cancer

Larenks kanserli hastalarda adjuvant radyoterapinin ses ve yaşam kalitesi ile ilişkisi

Medine Kara[1], Hülya Ertekin[2], Başak Şahin[2], Sibel Cevizci[3], Fevzi Sefa Dereköy[1]

[1] Department of Otolaryngology, Çanakkale Onsekiz Mart University, Çanakkale, Turkey
[2] Department of Psychiatry, Çanakkale Onsekiz Mart University, Çanakkale, Turkey
[3] Department of Public Health, Çanakkale Onsekiz Mart University, Çanakkale, Turkey

ABSTRACT

Introduction: To evaluate the effect of surgery type and adjuvant radiotherapy (RT) on voice quality and quality of life in patients with larynx cancer.
Methods: 38 patients with larynx cancer (37 males, 1 female; mean age 63.6 ± 9.63 years) were included in this study. The parameters including tumor localization, TNM staging, and type of surgery performed, adjuvant/primary RT intake and recurrence were recorded. All participants filled voice handicap index (VHI-10) and University of Washington Quality of Life Questionnaire version-IV (UWQOL-4). Voice analysis was performed by Xion Endo Strop-DX system. Questionnaire scores and voice parameters were compared between groups.
Results: There was a statistically significant low mean values of VHI detected within the group of stripping/cordectomy compared to groups of partial or total laryngectomy. In the group without RT, the mean values of SPLmin, MPT, pain, appearance, swallowing and chewing subgroups of UWQOL scale were higher than the group treated with RT. There was a negative correlation identified between VHI and QOL parameters.
Conclusion: In advanced stage larynx cancer, increased surgical manipulation and adjuvant RT requirements decrease QOL. As a result early diagnosis of disease and treatment is very important. As subjective voice quality increases QOL scores rise, indicating the importance of referring patients for voice therapy and psychotherapy after treatment.
Keywords: Laryngeal Neoplasms; Radiotherapy, Adjuvant; Quality of Life; University of Washington Quality of Life Questionnaire version-IV; Voice quality; VHI-10

ÖZET

Giriş: Bu çalışmanın amacı larenks kanserli hastalarda ameliyat tipi ve adjuvant radyoterapinin (RT) hastaların ses ve yaşam kalitesi üzerindeki etkisini araştırmaktır.
Yöntem: Larenks kanseri nedeni ile ameliyat edilen 38 hasta (37 erkek, 1 kadın; ort. yaş 63,6 ± 9,63 yıl) bu çalışmaya dahil edildi. Tanı esnasındaki tümör lokalizasyonu, TNM evrelemesi, uygulanan ameliyat tipi, adjuvant/primer RT alımı, nüks varlığı ve postoperatif takip süresi kaydedildi. Tüm katılımcıların öznel ses handikap indeksi (VHI-10) ve Washington Üniversitesi Yaşam Kalitesi Anketi versiyon-IV (UWQOL-4) ile ses ve yaşam kalitesi skorları hesaplandı. Ses analizi Xion Endo Strop-DX sistemi ile gerçekleştirildi. Anket skorları ve ses parametreleri gruplar arasında karşılaştırıldı.
Bulgular: VHI ortalamaları stripping/kordektomi grubunda, parsiyel veya total larenjektomi gruplarına göre istatistiksel olarak daha düşüktü. ortalama SPLmin, MFZ ve UWQOL'ın ağrı, görünüş, yutma ve çiğneme puan ortalamaları RT almayan grupta RT alan gruptan daha yüksek idi. VHI ve yaşam kalitesi parametreleri arasında bir negatif yönlü bir korelasyon saptandı.
Sonuç: İleri evre larenks kanserlerinde artan cerrahi manüpülasyonlar ve adjuvant RT ihtiyacı hastaların ağrı, ses, konuşma, yutma, çiğneme fonksiyonlarını etkileyerek yaşam kalitesini düşürmektedir. Bu nedenle hastalığın erken tanınıp tedavisinin planlanması oldukça önemlidir. Öznel ses kalitesi arttıkça yaşam kalitesi skorlarının da artmış olması hastaların tedavi sonrası ses terapisine ve psikoterapiye yönlendirilmelerinin önemini bir kez daha göstermektedir.
Anahtar kelimeler: Larenks Kanseri; Adjuvan Radyoterapi; Yaşam Kalitesi; Washington Üniversitesi Yaşam Kalitesi Anketi, Ses Kalitesi, Ses Handikap İndeksi-10.

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Correspondence / Yazışma : Department of Otorhinolaryngology, Canakkale Onsekiz Mart University Faculty of Medicine, Canakkale, Turkey.

E-mail: medinekara@gmail.com

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INTRODUCTION

Quality of life (QOL) assesses the effects of disease and treatment on the patient's functional, psychological and social health. As new treatment methods have not significantly affected survival after head and neck squamous cell carcinomas, assessing the QOL of patients with head-neck cancers has become an important parameter.[1] Head and neck squamous cell carcinomas which are identified 540,000 new cases on the world annually and comprise 5-10% of all cancers, are an important reason of morbidity and mortality.[2] Treatment of head-neck cancers may negatively affect cosmetic appearance due to the region's anatomical characteristics and may cause problems with speaking, swallowing and respiration to varying degrees.[3]

Just as measuring QOL is considerable to assess the effects of head and neck cancer treatment, more effective treatment strategies may be developed based on these parameters.[1,3–5] Many QOL questionnaires have been developed specific to this region for head-neck cancer patients, however each questionnaire has advantages and disadvantages.[6–9] The University of Washington Quality of Life Questionnaire (UWQOL) is one of the surveys specific to the head-neck region commonly used globally.[3,9] Prepared in English and validity and reliability of the questionnaire for Turkish-speaking patients has been proven.10 In this study we investigated the effect of type of surgery and adjuvant radiotherapy (RT) on the voice and QOL in patients with larynx cancer by used UWQOL-4 and the Turkish versions of Voice Handicap Index-10 VHI-10).

METHODS

This study was conducted with ethics committee approve (number: 2014-08, date: 30.04.2014). In this study 38 patients were included with the diagnosis and treatment of larynx cancer who agreed to participate out of 103 patients came for regular check-ups between 2009 and 2015. As control group 38 healthy individuals (38-84 years) with no history of voice problems, previous laryngeal surgery or respiratory tract problems were participated. Patient files were retrospectively scanned to record age at diagnosis, sex, tumor localization, indirect laryngoscopy, direct laryngoscopy and computed tomography results accompanying stage according to AJCC-2012 (American Joint Committee on Cancer) staging system and TNM classification, surgery performed, adjuvant/primary RT intake, postoperative recurrence and time since treatment. Patients were divided into those with alone surgery as group-1, those with both surgery and adjuvant RT as group-2.

Acoustic voice analysis

Voice recording was conducted in a quiet room. The voice samples were obtained as follows: the subjects were requested to phonate "a" three times lasting, in the standing position after a deep breath. Voice samples were analyzed with the Xion Endo Strop-DX program and maximum phonation time (MPT), minimum and maximum fundamental frequency (F0max and F0min), Jitter%, minimum and maximum sound pressure level (SPLmax, SPLmin) and dysphonia severity index (DSI) values were automatically calculated using the computer program.

Voice evaluation form

The Turkish version of the Voice Handicap Index 10 (VHI-10) was used to asses perceptual voice analysis.11 Scoring according to answers given by patients (never 0; rarely 1; sometimes 2; mostly 3; always 4) ranged from a total of 0 for no handicap to 47 points for highest handicap.

Quality of Life Scale

At the last postoperative check-up of patients, after explaining the aim and targets of the study, patients were informed about the treatment and signed informed consent forms. UWQOL-4 was filled by patients with clinician. The survey included 12 questions with answers given points from 0 to 100. Apart from the 12 survey questions, these patients were also asked three general questions. These questions compared current QOL related to health to that before cancer (general question 1), definition of QOL related to health in the last seven days (general question 2) and assessment of general QOL in the last seven days (general questions 3).

Statistical analysis

Data related to study and control groups were analyzed using SPSS 19.0 for Windows (SPSS Inc., Chicago, IL, USA). Descriptive data are given as mean, standard deviation, minimum, maximum, frequency and percentage values. Normal distribution of variables was investigated with the Kolmogorov-Smirnov test. Univariate analysis for dependent and independent variables was completed with the chi-square test. Two-way comparison of groups used the Mann Whitney U test for variables without normal distribution. For comparison of means of more than two numbers groups, the Kruskal Wallis variance analysis was used for those without normal distribution. The Bonferroni correction was applied to identify which group caused the difference in two-way comparisons. The relationship between continuous variables in the case group was investigated with Spearman's correlation test. The level of statistical significance was accepted as $p<0.05$.

RESULTS

A total of 38 patients with larynx cancer accepted participation in the study with 37 male (97.4%) and 1 female (2.6%). The control group was 34 males (97.8%) and 4 females (2.2%). The mean age of the study group was 63.6 ± 9.63 (44-85) years, while this was 61.6 ± 13.4 (38-84) in the control group.

Twelve of the cases (31.6%) had supraglottic, 16 (42.1%) had glottic and 10 (26.4%) had subglottic localized tumors. Twelve cases (31.6%) were T1, 17 cases (44.8%) were T2, 4 cases (10.5%) were T3 and 5 cases (13.1%) were T4. Thirty patients (78.9%) were N0, 3 patients (7.9%) were N1, and 5 patients (13.2%) were N2. As no patients with distant metastasis or coincident cancer in other organs were included in the study, all cases were M0.

Stripping and/or cordectomy was performed in 17 cases (44.7%), supraglottic laryngectomy was performed 6 cases (15.8%), frontolateral/frontoanterior hemilaryngectomy was performed 10 cases (26.3%) and total laryngectomy was performed 5 cases (13.2%).

Surgery+adjuvant RCT was performed 17 patients (44.7 %), while 21 patients (55.3 %) had alone surgery. During postoperative routine check-ups, recurrence was detected in 9 cases (23.7%), and neck lymph's node metastasis was detected in 2 cases (5.3%). The mean duration after surgery was 34.5 ± 27.2 (10-132) months.

Assessment of acoustic and aerodynamic voice parameters in patient and control group are presented in the Table 1. The mean SPLmin of the group-1was statistically higher than group-2 and the control group (p=0.007; p=0.001, respectively). The mean jitter% and DSI of group-1 were statistically higher than control group (p<0.001; p=0.001, respectively). The mean MPT of group-2 was statistically lower than group-1 and the control group (p=0.036; p=0.002, respectively). The mean F0max of group-2 was lower than the others group (p>0.05), but there was statistically significant difference between group-2 and the control group (p=0.001). There was no statistically significant difference between surgery types and acoustic voice analysis parameters (Table 2).

Table 1. Assessment of acoustic and aerodynamic voice parameters in patient and control group

	Group 1 (n=21)	Group 2 (n=17)	Control Group (n=38)	p
MPT	10.5 ± 7.1	7.0 ± 3.6	12.0 ± 6.3	***0.006****
F0max	246.6 ± 111.1	204.8 ± 133.4	247.2 ± 69.6	***0.011****
F0min	189.4 ± 97.9	147.7 ± 63.1	156.1 ± 57.6	0.228
SPLmax	84.9 ± 6.7	83.4 ± 8.1	87.7 ± 8.4	0.277
SPLmin	79.2 ± 8.5	70.9 ± 8.5	67.4 ± 13.4	***0.001****
Jitter	1.7 ± 1.2	1.8 ± 1.4	0.8 ± 0.5	***<0.001****
DSI	7.4 ± 2.4	6.0 ± 2.4	4.8 ± 2.7	***0.004****

SD: standard deviation, MPT: maximum phonation time, F0: fundamental frequency, SPL: sound pressure level, DSI: dysphonia severity index.* Statistically significant differences; significance level p < 0.05

Table 2. Assessment of acoustic and aerodynamic voice parameters according performed surgery types in patient

	Stripping/ Cordectomy	Supraglottic laryngectomy	Hemilaryngectomy (frontolateral/ frontoanterior)	Total laryngectomy	p
MPT	12.1 ± 7.8	8.9 ± 4.3	6.0 ± 3.2	9.4 ± 5.5	0.387
F0max	220.5 ± 72.0	177.6 ± 30.3	303.5 ± 186.6	250.4 ± 175.9	0.862
F0min	175.5 ± 51.5	154.21 ± 35.1	188.4 ± 131.5	243.5 ± 185.6	0.587
SPLmax	87.7 ± 7.2	80.4 ± 3.3	82.0 ± 8.3	87.5 ± 9.7	0.128
SPLmin	80.4 ± 7.5	72.6 ± 6.2	74.1 ± 9.5	84.6 ± 13.7	0.049
Jitter	1.1 ± 0.6	1.6 ± 1.4	2.7 ± 1.5	2.1 ± 1.3	0.158
DSI	7.1 ± 2.6	7.8 ± 1.8	7.2 ± 1.80	7.2 ± 1.6	0.078

SD: standard deviation, MPT: maximum phonation time, F0: fundamental frequency, SPL: sound pressure level, DSI: dysphonia severity index.* Statistically significant differences; significance level p < 0.05

The mean VHI in the patients with larynx cancer was significantly higher than in the control group (p<0.001). According to preoperative tumor localization and treatment type, there was no significant difference between the patients in terms of VHI points of the groups (p>0.05); however in all groups the VHI values were higher than the control group. According to treatment type, there was no significant difference between VHI points (p>0.05), however all groups had higher VHI values than the control group. When mean VHI was compared according to operation type, there was a statistically significant low mean VHI group of stripping/cordectomy compared to groups of partial or total laryngectomy (p=0.016; p=0.004, respectively) (Table 3).

Table 3. Assessment of VHI mean according to preoperative tumor localization, treatment type and operation type in patients

	VHI total point	p
Patient group	13.6 ± 12.4	**<0.001***
Control group	0.3 ± 0.7	
Preoperative tumor localization		
Glottic	9.8 ± 9.2	0.317
Supraglottic	14.2 ± 10.8	
Subglottic	18.8 ± 17.3	
Treatment type		
Alone surgery	10.5 ± 10.9	***<0.001****
Surgery+adjuvant radiochemotherapy	17.2 ± 13.5	
Control	0.3 ± 0.7	
Operation type		
Stripping/cordectomy	6.5 ± 6.1	***<0.001****
Supraglottic laryngectomy	10.6 ± 10.9	
Hemilaryngectomy	17.8 ± 12.1	
Total laryngectomy	25.8 ± 16.3	

SD: standard deviation, VHI: Voice Handicap Index**.** p: Statistically significant differences; significance level p < 0.05

Quality of Life analysis

When QOL is assessed according to age group of patients (the cut-off value is 65 year), there was no statistical difference identified between the groups (p>0.05). In the group without RT the mean points for pain, appearance, swallowing and chewing subcategories of the QOL scale were statistically higher than in the group-2, while there was no statistical difference between the groups for other categories (p=0.034, p=0.012, p=0.002, p=0.022, respectively) (Table-4).

Table 4. Assessment of Quality of Life analysis according to whether or not treated radiotherapy

	Group-1 (n=21) n (%)	Group-2 (n=17) n (%)	p		Group-1 n=21) n (%)	Group-2 (n=17) n (%)	p
Pain				**Speech**			
0	0 (0.0)	2 (100.0)		0	0 (0.0)	1 (100.0)	
25	0 (0.0)	1 (100.0)		30	3 (50.0)	3 (50.0)	0.064
50	1 (50.0)	1 (50.0)	***0.034***	60	0 (0.0)	1 (100.0)	
75	2 (40.0)	3 (60.0)		70	4 (36.4)	7 (63.6)	
100	18 (64.3)	10 (35.7)		100	14 (73.7)	5 (26.3)	
Appearance				**Shoulder**			
0	0 (0.0)	1 (100.0)		0	0 (0.0)	0 (0.0)	
25	0 (0.0)	2 (100.0)		70	4 (50.0)	4 (50.0)	0.147
50	1 (50.0)	1 (50.0)	***0.012***	100	17 (56.7)	13 (43.3)	
75	3 (33.3)	6 (66.7)		**Taste**			
100	17 (70.8)	7 (29.2)		0	0 (0.0)	0 (0.0)	
Activity				70	2 (40.0)	3 (60.0)	0.396
0	1 (100.0)	0 (0.0)		100	19 (57.6)	14 (42.4)	
25	0 (0.0)	1 (100.0)	0.570	**Saliva**			
50	3 (60.0)	2 (40.0)		0	1 (100.0)	0 (0.0)	
75	5 (71.4)	2 (28.6)		30	0 (0.0)	3 (100.0)	0.348
100	12 (50.0)	12 (50.0)		60	1 (100.0)	0 (0.0)	
Recreation				70	1 (33.3)	2 (66.7)	
0	1 (100.0)	0 (0.0)		100	18 (60.0)	12 (40.0)	
25	1 (33.3)	2 (66.7)		**Mood**			
50	0 (0.0)	2 (100.0)	0.493	0	0 (0.0)	1 (100.0)	
75	4 (57.1)	3 (42.9)		25	1 (50.0)	1 (50.0)	0.329
100	15 (60.0)	10 (40.0)		50	1 (25.0)	3 (75.0)	
Swallowing				75	4 (100.0)	0 (0.0)	
0	0 (0.0)	1 (100.0)		100	15 (55.6)	12 (44.4)	
30	0 (0.0)	0 (0.0)	***0.002***	**Anxiety**			
70	2 (16.7)	10 (83.3)		0	1 (100.0)	0 (0.0)	
100	19 (76.0)	6 (24.0)		30	1 (25.0)	3 (75.0)	
Chewing				60	0 (0.0)	1 (100.0)	0.912
0	0 (0.0)	0 (0.0)		70	9 (75.0)	3 (25.0)	
50	1 (14.3)	6 (85.7)	***0.022***	100	10 (50.0)	10 (50.0)	
100	20 (64.5)	17 (44.7)					
General question 1				**General question 2**			
0	0 (0.0)	1 (100.0)		0	0 (0.0)	0 (0.0)	
25	3 (37.5)	5 (62.5)		20	0 (0.0)	1 (100.0)	
50	6 (54.5)	5 (45.5)	0.137	40	1 (20.0)	4 (80.0)	0.620
75	7 (70.0)	3 (30.0)		60	11 (68.8)	5 (31.2)	
100	5 (62.5)	3 (37.5)		80	6 (75.0)	2 (25.0)	
				100	3 (37.5)	5 (62.5)	
General question 3							
0	0 (0.0)	0 (0.0)					
20	0 (0.0)	0 (0.0)					
40	0 (0.0)	6 (100.0)	0.305				
60	13 (72.2)	5 (27.8)					
80	4 (66.7)	2 (33.3)					
100	4 (50.0)	4 (50.0)					

n: number, %: percentage line, RCT: radiochemotherapy, p: Statistically significant differences (chı-square test)

According to median VHI when QOL is assessed, the scores for the parameters of activity, recreation, speech, and QOL in the last seven days and in general, were found to be statistically higher in the group with low VHI (p=0.006, p=0.012, p<0.001, p=0.002, p<0.001, respectively) (Table 5).

There was a negative power correlation between VHI and the QOL parameters of activity, recreation, chewing and speech (p=0.001, r=-0.504; p<0.001; r=-0.551; p=0.001; r=-0.509; p=0.001; r=-0.714; respectively). There was a negative moderate correlation between VHI and the QOL parameters of mood, general question 1, 2 and 3 (p=0.006; r=-0.439, p=0.018; r=-0.381; p<0.001, r=-0.555; p<0.001; r=-0.708; respectively) (Table 6).

Table 5. Assessment of Quality of Life analysis according to median VHI point

Pain	VHI<10 (n=18) n (%)	VHI≥10 (n=20) n (%)	p	Taste	VHI<10 (n=18) n (%)	VHI≥10 (n=20) n (%)	p
0	0 (0.0)	2 (100.0)		0	0 (0.0)	0 (0.0)	
25	0 (0.0)	1 (100.0)		70	2 (40.0)	3 (60.0)	0.552
50	2 (100.0)	0 (0.0)	0.458	100	16 (48.5)	17 (51.5)	
75	3 (60.0)	2 (40.0)		**Saliva**			
100	13 (46.4)	15 (53.6)		0	0 (0.0)	1 (100.0)	
Appearance				30	2 (66.7)	1 (33.3)	0.623
0	0 (0.0)	1 (100.0)		60	0 (0.0)	1 (100.0)	
25	0 (0.0)	2 (100.0)		70	1 (33.3)	2 (66.7)	
50	0 (0.0)	2 (100.0)	0.137	100	10 (50.0)	10 (50.0)	
75	4 (44.4)	5 (55.6)		**Mood**			
100	14 (58.3)	10 (41.7)		0	0 (0.0)	1 (100.0)	
Activity				25	1 (50.0)	1 (50.0)	0.095
0	0 (0.0)	1 (100.0)		50	0 (0.0)	4 (100.0)	
25	0 (0.0)	1 (100.0)	***0.006****	75	2 (50.0)	2 (50.0)	
50	1 (20.0)	4 (80.0)		100	15 (55.6)	12 (44.4)	
75	1 (14.3)	6 (85.7)		**Anxiety**			
100	16 (66.7)	8 (33.3)		0	1 (100.0)	0 (0.0)	
Recreation				30	0 (0.0)	4 (100.0)	
0	0 (0.0)	1 (100.0)		60	0 (0.0)	1 (100.0)	0.273
25	0 (0.0)	3 (100.0)		70	6 (50.0)	6 (50.0)	
50	1 (50.0)	1 (50.0)	***0.012****	100	11 (55.0)	9 (45.0)	
75	1 (14.3)	6 (85.7)		**General question 1**			
100	16 (64.0)	9 (36.0)		0	0 (0.0)	1 (100.0)	
Swallowing				25	1 (12.5)	7 (87.5)	
0	0 (0.0)	1 (100.0)		50	7 (63.6)	4 (36.4)	0.119
30	0 (0.0)	0(0.0)	0.277	75	6 (60.0)	4 (40.0)	
70	5 (41.7)	7 (58.3)		100	4 (50.0)	4 (50.0)	
100	13 (52.0)	12 (48.0)		**General question 2**			
Chewing				0	0 (0.0)	0 (0.0)	
0	0 (0.0)	0 (0.0)		20	0 (0.0)	1 (100.0)	
50	1 (14.3)	6 (85.7)	0.061	40	0 (0.0)	5 (100.0)	***0.002****
100	17 (54.8)	14 (45.2)		60	6 (37.5)	10 (62.5)	
Speech				80	6 (75.0)	2 (25.0)	
0	0 (0.0)	1 (100.0)		100	6 (75.0)	2 (25.0)	
30	0 (0.0)	6 (100.0)	***<0.001***	**General question 3**			
60	0 (0.0)	1 (100.0)		0	0 (0.0)	0 (0.0)	
70	3 (27.3)	8 (72.7)		20	0 (0.0)	0 (0.0)	
100	15 (78.9)	4 (21.1)		40	0 (0.0)	6 (100.0)	***<0.001****
Shoulder				60	7 (38.9)	11 (61.1)	
0	0 (0.0)	0 (0.0)		80	4 (66.7)	2 (33.3)	
70	5 (62.5)	3 (37.5)	0.286	100	7 (87.5)	1 (12.5)	
100	13 (43.3)	17 (56.7)					

n: number, %: percentage line, VHI: voice handicap index, p: Statistically significant differences (chı-square test)

Table 6. The correlation between VHI and the quality of life parameters

		Pain	Appearance	Activity	Recreation	Swallowing	Chewing	Speech	Shoulder
VHI	p	0.705	0.055	***0.001***	***<0.001***	0.124	***0.001***	***<0.001***	0.738
	r	-0.064	-0.314	-0.504	-0.551	-0.254	-0.509	-0.714	0.056
		Taste	**Saliva**	**Mood**	**Anxiety**	**General question 1**	**General question 2**	**General question 3**	
VHI	p	0.443	0.327	***0.006***	0.435	***0.018***	***<0.001***	***<0.001***	
	r	-0.128	-0.163	-0.439	-0.131	-0.381	-0.555	-0.708	

VHI: voice handicap index, p: Spearman's correlation, r: correlation coefficient

DISCUSSION

A variety of studies have researched factors affecting QOL in head-neck cancer patients,[6,12–14] the effect of radiotherapy on QOL,[15–17] and the effect of protecting accessory nerves on shoulder functions.[1,18–21] However, best of our knowledge, there was no study assessed the correlation between voice quality and QOL in patients with larynx cancer. In our study we evaluated QOL in larynx cancer patients according to treatment type, surgery type, administration of RT and voice changes.

The satisfaction of the quality of a person's voice is one of the most important factors affecting social relations. As voice quality is one of the parameters that affects QOL, in this study we aimed to research how satisfaction with a person's voice changes or voice quality affect QOL. In this study we found that quality of voice in the patients with larynx cancer by assessing self-reported VHI and acoustic and aerodynamic voice parameters were disrupted. Additionally a negative correlation was found between VHI and QOL scores.

In our study of larynx cancer patients, the mean MPT values were 10.5 ± 7.05 (group-1) and 7.0 ± 3.6 (group-2). Group 1 and 2 had lower mean MPT values compared to the control group (12.0 ± 6.3). Timmermans et al. reported that the use of MPT is a simple method for aerodynamic evaluation of voice. MPT is shorten in situations where glottic closure is insufficient.[22] In our study, in the group-1, values were obtained close to the control group, while very low values were obtained for the groups with adjuvant RT. The fall of MPT may cause a difficulty on control of voice intensity and tone in patients with RT.

In our study the jitter% in group-1 and group-2 were statistically significantly higher than the control group. Increase in jitter% shows that voice quality is rough or dysphonic.[23] Sanal et al.[24] reported that mean F0 was 137 Hz, jitter% was 16.30, shimmer% was 14.51 and MFT was 5.08 in patients with frontolateral laryngectomy; while these values were mean F0 155 Hz, Jitter% 19.05, Shimmer% 15.45 and MFT 3.3 s in cricohyoidopexy cases and mean F0 147 Hz, Jitter% 15.40, Shimmer% 21.73 and MFT 7.05 s for cordectomy cases. MPT was very low in all partial laryngectomy patients and jitter% and shimmer% values appeared to be much increased. In our study in patients with surgical treatment jitter% was high; however there was no statistical difference between surgical groups.

Sound pressure level (SPL) is a marker of voice intensity and is affected by subglottic pressure, closure duration of vocal cords, glottal resistance, air flow and sound spectrum. As the closure duration of the vocal cords increases, the intensity of the sound produced increases.[25] In our study, the SPLmin of group-1 was statistically significantly higher compared to the group-2 and the control group.

Perceptual assessment of voice quality is very important. The dysphonia severity index (DSI) was found by researching the relationship between "grade" parameter of perceptual assessment according to a variety of acoustic parameters in the GRBAS system.[26] DSI values vary from +5 to -5. DSI comprises a formulation of four variables related to voice (DSI= 0.13xMPT+0.0053xFo (high)-0.26xI (low)-1.18x jitter (%)+12.4) and is considered an objective parameter showing voice quality.[26] Sanal et al.[24] did not find a difference in subjective voice evaluation and DSI scores in groups of partial laryngectomy patients. In our study mean DSI in group-1 was statistically significantly higher than the control group. In patient groups the DSI parameter was above 5 showing that the grade parameter (G) of the perceptual evaluation according to the GRBAS system was disrupted.

In our study, the mean VHI (13.6 ± 12.4) in the patient groups were statistically significantly higher than the control group (0.3 ± 0.7). Patients who underwent stripping/cordectomy were found to have statistically significantly lower mean VHI values compared to those performed partial or total laryngectomy. The mean VHI in group-1 was 10.2 ± 11.1 and group-2 was 17.4 ± 13.5 but there was no statistically significant difference ($p>0.05$). In other words, the groups treated with RT appeared to assess their voices as subjectively worse. This situation shows that in patients with advanced stage laryngeal cancer, voice quality is both objectively and subjectively disrupted.

UWQOL is a short and easily applied scale to evaluate general QOL, symptoms and functions in head-neck cancer patients. In recent years the UWQOL has been used to evaluated QOL of head-neck cancer patients.[14] Karabulut et al.[1] obtained low scores in terms of activity, recreation, appearance and shoulder functions in patients with total/near total laryngectomy compared to patients administrated partial laryngectomy. Additionally they identified a significant correlation between surgery type and speaking and found that a large portion of patients with partial larynx surgery had normal or near-normal speech. Eadie et al.[27] found a weak correlation between perceptual voice quality which was evaluated by listeners and life scores which were evaluated by total laryngectomy patients themselves. Polat et al.[28] reported increase in QOL scores after voice prosthesis applied to total laryngectomy patients. In our study, those who self-reported voice quality assessed as bad had lower QOL scores for activity, recreation, speech, last seven days and general QOL (second and third general question).

Karabulut et al.[1] found that the scores of QOL of patients who underwent aggressive surgery were very low compared to those who underwent partial laryngectomy regarding first general question -comparing before cancer diagnosis and the present moment- and third general question about general QOL in the last seven days. These findings have been found to be important in terms of revealing the psychotrauma caused to patients by surgery. As propounded by Gritz et al.[13] the addition of psychological assist to the treatment of patients with head-neck cancer, our study have supported the psychological assist. Weymuller et al.[12] did not identify a difference in total QOL scores before surgery and after laryngectomy in patients with advanced stage larynx cancer. In all QOL areas, 50% or more of patients reported that they had the same or better function 20 years after surgery. Additionally the majority of patients reported the same or better general QOL scores as one year before cancer diagnosis. Hanna et al.[29] did not find a significant difference in QOL scores depending on whether total laryngectomy patients were given concomitant RCT or not. Karabulut et al.[1] identified lower QOL scores for the parameters of appearance, saliva, swallowing, speech, mood and worry in patients given adjuvant RT after surgery. In our study the patients given adjuvant RT had statistically lower points for the parameters of pain, appearance, swallowing and chewing. Tuomi et al.[30] divided larynx cancer patients treated with RT according to whether they were given voice therapy or not. They reported that in the group given voice therapy, six months after RT Voice Range Profile results had improved while the

group without voice therapy had worsened. Additionally they evaluated S-SECEL of larynx cancer patients after surgery and identified clinical and statistical improvements in environment, attitude and total areas in the group given voice therapy. Similarly in the voice therapy group the social and global areas of EORTC QLQ-C30 also had clinical and statistical significant improvement. On both scales the largest improvement was identified in the first 6 months.

In conclusion, in patients given adjuvant RT and in patients with low voice quality (VHI) assessed low QOL scores were obtained, emphasizing one more time the importance of both early diagnosis and treatment of disease and voice therapy after surgery. Increased surgical manipulation in advanced stage larynx cancers and adjuvant RT requirements affect pain, voice, speech, swallowing and chewing functions of patients, lowering QOL. In larynx cancer patients, after treatment, QOL is becoming more important. As a result early diagnosis and planning of treatment of disease is very important. As subjective voice quality increases, QOL scores increase showing once more the importance of referring patients for voice therapy and psychotherapy after treatment.

Conflict of interest

The authors report no conflict of interest.

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Ethical Standards

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional guidelines on human experimentation (please name) and with the Helsinki Declaration of 1975, as revised in 2008.

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