ORIGINAL ARTICLE

Assessment of Vocal Quality Following Treatment of Advanced Pharyngo-laryngeal Carcinoma With a Protocol of Organ Preservation

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KEYWORDS
Head and neck cancer;
Voice analysis;
Functional outcomes

Abstract

Introduction and objectives: Advanced laryngeal and pharyngeal cancer, as well as methods to treat them, have a direct impact on voice function, speech communication and deglutition. Such alterations in function can influence employability and general quality of life.

Patients and methods: To characterise the vocal status of the patients treated with an organ-preservation protocol, we report the voice outcomes of 17 patients who were alive and disease free at the time of the survey, with a minimum follow-up of 6 months, after a combination of radiotherapy and chemotherapy to treat advanced cancer. Objective voice assessment by means of spectrographic analysis, the GRBAS perceptual analysis system and the Voice Handicap Index was the methodology followed, which we suggest could be used in future large-scale investigations.

Results: Normal or slightly dysphonic voices were observed in five patients (29.4%) and moderate/severe in 12 (70.6%). Spectrographically, the 17 samples were classified as normal in four cases (23.4%), Grade I in three cases (17.6%), Grade II in three (17.6%), Grade III in four (23.5%) and Grade IV in two (11.7%). The Voice Handicap Index questionnaire, which was completed by the patients themselves, gave normal results in all the patients except for four (23.5%).

Conclusions: The voice acoustic analysis of this series shows that the damage related to the organ-preservation protocol displays a relatively wide range of voice function outcomes. To characterise the vocal status of these patients reliably, we propose using homogeneous instruments (spectrography, GRBAS scale, maximum phonation time and Voice Handicap Index) in future meta-analyses.

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PALABRAS CLAVE
Cáncer de cabeza y cuello; Análisis de voz; Resultados funcionales

Valoración de la calidad vocal tras el tratamiento del carcinoma faringolaringeo avanzado en un protocolo de preservación de órgano

Resumen
Introducción y objetivos: Los carcinomas avanzados de faringe y laringe y los distintos métodos que se emplean para su tratamiento tienen un impacto directo en la función vocal, la comunicación oral y la deglución, alteraciones que pueden influir en la capacidad laboral y en la calidad de vida general.

Pacientes y métodos: Con el fin de conocer la salud vocal de los pacientes tratados mediante un protocolo de preservación de órgano presentamos los resultados vocales de 17 pacientes tras ser tratados mediante una combinación de radioterapia y quimioterapia, y que han sido seguidos un mínimo de 6 meses, encontrándose vivos sin evidencia de enfermedad en el momento del estudio. Se realiza una valoración objetiva de la voz mediante espectrografía, análisis perceptual por el sistema GRABS y el Voice Handicap Index como metodología aconsejada, que puede ser empleada en el futuro en estudios más extensos.

Resultados: Se observaron voces normales o levemente disfónicas en 5 pacientes (29,4%), y moderadas/severas en 12 (70,6%). Espectrográficamente, las 17 muestras se clasificaron como normales en 4 casos (23,4%), Grado I en 3 casos (17,6%), Grado II en 3 (17,6%), Grado III en 4 (23,5%) y Grado IV en 2 (11,7%). Las puntuaciones en el cuestionario Voice Handicap Index se encontraron dentro de los rangos normales en todos los casos, excepto en 4 (23,5%).

Conclusiones: El análisis acústico de la voz de los pacientes de esta serie demuestra que el daño que se produce tras un tratamiento de preservación de órgano causa un amplio rango de resultados vocales. No obstante, la sensación de incapacidad de estos pacientes es mínima. En este estudio se propone el uso de instrumentos homogéneos (espectrografía, GRABS, Tiempo Máximo de Fonación y Voice Handicap Index) para ser usados en futuros metaanálisis.

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Introduction

Function preservation is a crucial aspect in assessing the therapies used in head and neck cancer, where it is noted that organ preservation does not imply preservation of functions. The study of functional outcomes has become a very important aspect in assessing alternative therapeutic options with similar oncological results.

Although the main purpose of cancer treatment is the complete eradication of the disease, the preservation of an effective voice is another significant consideration when selecting treatment for advanced head and neck cancer.

Head and neck cancer patients experience a series of respiratory, phonation, and deglutition problems, as well as other physical limitations which radically alter how they live their daily lives. Examples of this are how participative the patients may be in a social dining situation, their ability to be responsible for their own personal hygiene, their speech communication, and their employability. The WHO stated that all these aspects may be summed up under the term “functional”. Functional assessment following head and neck cancer has become a key component in the most recent clinical trials, insofar as the severity of functional alterations are linked with survival as an independent predictive factor. Comparisons should therefore be established between foreseeable functional outcomes of equivalent therapies, aimed at offering patients a more detailed prognosis of their effects when advising on which treatment to select.

Another major concept here is that of “quality of life in its relationship to health” which represents the patient’s subjective and psychological notion of their state of health. This notion is multidimensional, encompassing emotional, physical, social, and behavioural aspects of wellbeing, as well as functional capacity from the patient’s point of view. Despite the great interest and consequently large number of publications addressing this issue, it is difficult to extract global conclusions for clinical application. This is partly due to trial limitations (low number of cases, imprecise details on tumour location and tumour treatment) or a lack of criteria definition to value a function, as well as the heterogeneity of instruments used for their assessment.

This study focuses on the assessment of the voice function remaining after treatment for advanced head and neck cancer with protocols of organ preservation.

Since voice is a multidimensional phenomenon, it must be assessed through a battery of tools used to measure the different important parameters that define its quality. Firstly voice quality is measured objectively, as is the auditory perception of the examiner and this is followed by the patient’s subjective sensation of the quality of their life related to their voice. In this study, bias was added for functional capacity from the point of view of the disability associated with voice alteration.

Patients and Methods

The study included 17 patients with advanced laryngeal and pharyngeal cancer, treated according to the organ preservation protocol reached between the Radiation Oncology, Medical Oncology and Otolaryngology Departments of the
University Hospital Central de Asturias. Four of the patients were women and 13 men. Ages ranged between 43 and 67, with a mean age of 56.7. Voice function assessment was made 6 months after treatment termination.

All lesions were classified according to criteria from the American Joint Committee on Cancer, the data from which is contained in Table 1.

100% of patients were treated for primary tumours and in accordance with the organ preservation protocol approved in our hospital, which consisted of single-cycle induction chemotherapy, following the protocol described by Urba et al. 100 mg/m² cisplatin administered daily, and 1000 mg/m²/day 5-fluorouracil administered continuously for 24 h over 5 days. Final response was assessed 3 weeks after chemotherapy termination using a CT scan and a medical examination. Response was defined as 50% or more reduction of highest tumour dimension, in accordance with RECIST. Patients who responded were treated with concurrent chemoradiation (75 mg/m² cisplatin on days 1, 21 and 43, standard radiotherapy using a linear accelerator unit with 6 MV photons, with a 2 Gy fractionation in 35 fractions for a total dose of 70 Gy). Patients who did not respond were treated with surgery, followed by radiotherapy if appropriate.

A temporary tracheostomy was required in two patients who presented with dyspnoea and cervical emptying in five patients (Table 1).

Objective voice assessment and a study on the quality perceived both by the examiners and patients 6 months after treatment termination were performed:

- The Kay Elemetrics CSL 4400 was used for acoustic speech analysis. Sampling frequency was 44,100 Hz and a high frequency resolution microphone was used. The microphone was placed 25 cm distance from the patient’s mouth whilst vowel phonation/intensity and comfortable tones were expressed in a sound-proofed chamber. A narrow-band spectogram was made (45 Hz). Spectrograms were grouped into four types, according to Yanagihara criteria: Grade I, when the harmonic components mix with the noise components, mainly in the area vowel formant area; Grade II, when the noise components predominate over the harmonics of the second formant; there are slight high frequency noise components above 3 kHz; Grade III, when it is observed that the second formant is completely replaced by noise; the high frequency noise component intensifies its energy and expands its range, and Grade IV, when the first formant loses its periodic components and noise components are observed, and in high frequencies the noise is even more highly intensified. Subharmonics are also recorded in the spectrum.

- For aerodynamic assessment we used the maximum phonation time (MPT) for the vowel.

- The GRBAS scale was used for subjective voice assessment by the examiners. This scale assesses five aspects: overall level of dysphonia (G), harsh voice (R), weak voice (A), breathless voice (B) and strained voice (S), in its four levels of normal (0), mild (1), moderate (2) and severe (3).

- Quality of life relating to the vocal function perceived by patients was assessed with the Voice Handicap Index validated for Spanish, self-assessment questionnaire completed by the patient. This comprises 30 questions which explore three areas: functional, physical and emotional. Each question is given a score of between 0 and 4 (from lower to higher disability). The maximum possible score for each item is 40 points, classified into mild incapacity (under 20 points), moderate incapacity (21–30 points) and severe incapacity (over 30 points). The sum of the three scales is a maximum obtainable score of 120 points, and is divided into: mild incapacity (under 30 points), moderate incapacity (31–60 points) and severe incapacity (61–90 points).

**Table 1 Patients included in the Study.**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Gender</th>
<th>Age (years)</th>
<th>Primary Tumour</th>
<th>Stage</th>
<th>QT</th>
<th>RT</th>
<th>Surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>V</td>
<td>64</td>
<td>Larynx</td>
<td>T3N2aM0</td>
<td>3 doses</td>
<td>Concomitant</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>V</td>
<td>53</td>
<td>Supraglottis</td>
<td>T3N2aM0</td>
<td>3 doses</td>
<td>Concomitant</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>V</td>
<td>67</td>
<td>Hipopharynx</td>
<td>T2N2cM0</td>
<td>3 doses</td>
<td>Concomitant</td>
<td>No</td>
</tr>
<tr>
<td>4</td>
<td>V</td>
<td>52</td>
<td>Hipopharynx</td>
<td>T3N1M0</td>
<td>3 doses</td>
<td>Concomitant</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>V</td>
<td>64</td>
<td>Larynx</td>
<td>T3N0M0</td>
<td>3 doses</td>
<td>Concomitant</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>V</td>
<td>52</td>
<td>Hipopharynx</td>
<td>T3N1M0</td>
<td>3 doses</td>
<td>Concomitant</td>
<td>No</td>
</tr>
<tr>
<td>7</td>
<td>V</td>
<td>62</td>
<td>Larynx</td>
<td>T3N2bM0</td>
<td>3 doses</td>
<td>Concomitant</td>
<td>VCFr</td>
</tr>
<tr>
<td>8</td>
<td>V</td>
<td>43</td>
<td>Larynx</td>
<td>T3N0M0</td>
<td>3 doses</td>
<td>Concomitant</td>
<td>No</td>
</tr>
<tr>
<td>9</td>
<td>M</td>
<td>51</td>
<td>Larynx</td>
<td>T3N1M0</td>
<td>3 doses</td>
<td>Concomitant</td>
<td>Tracheotomy</td>
</tr>
<tr>
<td>10</td>
<td>V</td>
<td>60</td>
<td>Hipopharynx</td>
<td>T3N3M0</td>
<td>3 doses</td>
<td>Concomitant</td>
<td>VCFr</td>
</tr>
<tr>
<td>11</td>
<td>V</td>
<td>53</td>
<td>Larynx</td>
<td>T3N0M0</td>
<td>3 doses</td>
<td>Concomitant</td>
<td>No</td>
</tr>
<tr>
<td>12</td>
<td>M</td>
<td>49</td>
<td>Supraglottis</td>
<td>T3N0M0</td>
<td>3 doses</td>
<td>Concomitant</td>
<td>No</td>
</tr>
<tr>
<td>13</td>
<td>M</td>
<td>67</td>
<td>Supraglottis</td>
<td>T3N0M0</td>
<td>3 doses</td>
<td>Concomitant</td>
<td>No</td>
</tr>
<tr>
<td>14</td>
<td>V</td>
<td>60</td>
<td>Hipopharynx</td>
<td>T2N2bM0</td>
<td>3 doses</td>
<td>Concomitant</td>
<td>VCFr</td>
</tr>
<tr>
<td>15</td>
<td>M</td>
<td>57</td>
<td>Supraglottis</td>
<td>T2N3M0</td>
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<td>Concomitant</td>
<td>VCFr</td>
</tr>
<tr>
<td>16</td>
<td>V</td>
<td>59</td>
<td>Larynx</td>
<td>T3N2M0</td>
<td>3 doses</td>
<td>Concomitant</td>
<td>Tracheotomy</td>
</tr>
<tr>
<td>17</td>
<td>V</td>
<td>56</td>
<td>Hipopharynx</td>
<td>T3N2bM0</td>
<td>3 doses</td>
<td>Concomitant</td>
<td>VCFr</td>
</tr>
</tbody>
</table>

M: woman; QT: chemotherapy; RT: radiotherapy; MeV: megarad/centigrade; V: man; VCFr: emergency functional cervical emptying. In chemotherapy 75 mg/m² cisplatin is administered on days 1, 21, and 43 of radiotherapy. In radiotherapy 70 Gy are administered with a photon accelerator of 6 MeV.
**Table 2** Outcomes of the Objective and Subjective Voice Assessment.

<table>
<thead>
<tr>
<th>Sample</th>
<th>TMF (seg)</th>
<th>Spectrogram</th>
<th>G</th>
<th>R</th>
<th>A</th>
<th>B</th>
<th>S</th>
<th>Disability Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>27</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>I (5%)</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>No disability</td>
</tr>
<tr>
<td>3</td>
<td>15</td>
<td>III with sub</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>I (7%)</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>No disability</td>
</tr>
<tr>
<td>5</td>
<td>22</td>
<td>III with sub</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>I (7%)</td>
</tr>
<tr>
<td>6</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>No disability</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>III with sub</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>Ila (18%)</td>
</tr>
<tr>
<td>8</td>
<td>6</td>
<td>IV</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>Ila (23%)</td>
</tr>
<tr>
<td>9</td>
<td>6</td>
<td>IV</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>Ila (23%)</td>
</tr>
<tr>
<td>10</td>
<td>6</td>
<td>II</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>Ila (23%)</td>
</tr>
<tr>
<td>11</td>
<td>14</td>
<td>III with sub</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>I (11%)</td>
</tr>
<tr>
<td>12</td>
<td>8</td>
<td>II with sub</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>Ila (12%)</td>
</tr>
<tr>
<td>13</td>
<td>5</td>
<td>I</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>Ila (23%)</td>
</tr>
<tr>
<td>14</td>
<td>6</td>
<td>II with sub</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>Ila (23%)</td>
</tr>
<tr>
<td>15</td>
<td>6</td>
<td>I</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>Ila (23%)</td>
</tr>
<tr>
<td>16</td>
<td>9</td>
<td>I</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>Ila (12%)</td>
</tr>
<tr>
<td>17</td>
<td>27</td>
<td>II</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>I (7%)</td>
</tr>
</tbody>
</table>

Sub: subharmonics; TMF: maximum phonation time for vowel.

- Assignation of disability level: the disability level classification responds to the unified technical criteria, fixed by the limits described in Appendix I, published in Royal Decree 1971/1999, of December 23. The level of disability is expressed in percentages.

**Results**

The results of the objective voice assessment are summarised in Table 2, together with the TMF values.

Table 2 also shows the results from the GRBAS assessment. Normal or light voices are observed in five patients (29.4%), and moderate or severe dysphonias in the other cases.

Spectrographically, the 17 samples are classified according to the Yanagihara criteria as normal in four cases, Grade I in four (23.5%), Grade II in three (17.6%), Grade III in four (23.5%) and Grade IV in two (11.7%). Six of the cases also showed subharmonics on the spectrum (35.2%).

Scores from the Voice Handicap Index version 30 and version 10, which were completed by the patients themselves, are shown in Table 3: four cases (23.5%) have pathological scores, of which three are severe, and one mild.

Regarding disability levels (Table 3), eight of the patients present no disability or mild disability below 7%. The other patients were classified as Grade IIa, with a disability percentage between 12% and 23%.

**Discussion**

This study presents a short but sufficiently illustrative series of the speech results obtained following treatment with an organ preservation protocol in advanced pharyngeal cancer patients. Said results were analysed with widely distributed and accessible tools, such as the spectrograph, the GRBAS system, the Voice Handicap Index validated for Spanish use, and the TMF. The cases we provided may be added to future meta-analysis since few studies exist regarding objective assessment of phonatory function following organ preservation treatment. A disability level assessment is also included, in keeping with official figures, which may be of interest for establishing a prognostic of functional capacity related to voice, to be expected after organ preservation treatment.

Quality of life after cancer treatment is an important aspect. In the case of pharyngeal tumours, it is closely linked with phonatory and deglutitory functions, since their alterations profoundly affect the patients’ social life. They are no longer able to carry out basic daily activities, such as oral communication or participation in family meals.

Previous studies on this subject using small series of patients for objective voice assessment aimed at introducing methodology which could be used in future large-scale investigations. They showed voice assessment results encompass a wide functional range and suggested there was a need for large patient series to be used to reliably determine voice status.

As was to be expected, preservation of the larynx explains why maximum phonation time does not fall under 5 s, as sufficient glottic closure is maintained. This parameter may be significantly altered following resection with CO2 laser of a stage T1 cancer of the vocal cords.

Dysphonia is the alteration of one of the three voice acoustic characteristics: intensity, tone and pitch. The latter is the most frequently altered in voice function disorders, which is why the term dysphonia is accepted as a synonym for change in voice pitch.

The study of dysphonia from a physical viewpoint may be multifactorial since no single parameter may be used to define all of its aspects.

Spectrographic analysis of patients’ voices in the sample series shows that deterioration after organ preservation treatment is wide in range of severity: from a normal voice function to significant alteration. Spectrograms with greater impact correspond to those patients with tumours which
primary affected the larynx. However, a lower number of patients gave pathological scores on the Voice Handicap Index. This shows that dysphonia as a physiopathological laryngeal product is to be considered and so too are the effects this could entail on the patients’ quality of life. The patient’s perception of dysphonia is complex and subjective, based on many factors. These include both the sound of the voice, and the physical sensation, the level at which the voice covers communicative needs, patient expectations, cultural prejudices, and the patient’s ability to overcome a disability.19

Regarding disability grades found in the series, eight patients had none, or it was under 12%, whilst the others scored a maximum of Grade IIa and 23% disability for oral communication (moderate limitation), which is interpreted as a general disability level of 14%. It should be noted that the laryngectomised person who has not been rehabilitated presents a Grade IIIb and 59% disability, through to a IIb and 35% in cases in which successful rehabilitation has taken place through erigmophonia or tracheoesophageal puncture.

This study proposes a multidimensional method of evaluating the outcomes of the phonatory function using accessible and widely distributed tools, which help to understand the potential of different therapies used in advanced head and neck cancers.

Conclusions

- The impact of the phonatory function after organ preservation treatment in advanced laryngeal and pharyngeal cancer has a wide range of severity, from normal to dysphonia Grade IV.
- The score results from the Voice Handicap Index shows less perception of severity than the objective trials.
- Maximum phonation time scores are no less than 5 s for larynx organ preservation.
- The disability grade found in the series does not alter from Grade IIa or 23%.

Conflict of Interests

The authors have no conflict of interests to declare.

References