Long-term voice and swallowing modifications after supracricoid laryngectomy: objective, subjective, and self-assessment data

Antonio Schindlera, Elena Faverob, Silvia Nudob, Roberto Alberac, Oskar Schindlerb, Andrea Luigi Cavalotc

*Department of Clinical Sciences, University of Milan, Italy
bDepartment of Audiology and Phoniatrics, University of Turin, Italy
cDepartment of Otorhinolaryngology, University of Turin, Italy

Received 8 December 2005

Abstract

Purpose: The supracricoid laryngectomies (SCLs) are conservative surgical techniques for the treatment of selected laryngeal carcinomas. The advantage of SCL is that a permanent tracheostoma is not required, thus, maintaining the principal laryngeal functions. The aim of the study is to report objective, subjective, and self-assessment long-term results of voice and swallowing in a large group of patients who underwent SCL at least 2 years before this study was undertaken.

Methods: Twenty male subjects who underwent SCL with a mean age of 71 years (range, 51–82) were involved in a retrospective study on swallowing and vocal function. Videendoscopic ratings were taken of neoglottic vibration patterns and bolus transit. The maximum phonation time and the syllable diadochokinesis were measured. Spectrograms were recorded. Voices were perceptually rated using the Grade, Instability, Roughness, Breathiness, Asthenicity, Strain (GIRBAS) scale. All of the subjects completed a self-assessment questionnaire for both voice and swallowing.

Results: Videendoscopic ratings showed moderate to severe impairment of neoglottal vibration, whereas bolus transit appeared only mildly impaired. The mean values of the GIRBAS scale were 2.4, 2.6, 2.4, 0.8, 0.5, and 0.8. The mean maximum phonation time was 7.5 seconds, whereas the mean value of the Yanagihara scale was 3.7 for voice spectrograms. Mean syllable diadochokinesis appeared as 3.3 syllables per second. Voice and swallowing quality of life questionnaires revealed satisfied patients.

Conclusions: Swallowing after SCL was satisfactory; on the contrary, endoscopic, aerodynamic, perceptual, and acoustic data showed a highly dysphonic voice after SCL. However, self-assessment results revealed relatively satisfied speakers on the emotional, physical, and functional levels.

© 2006 Elsevier Inc. All rights reserved.

1. Introduction

Supracricoid laryngectomies (SCL) are conservative surgical techniques for the treatment of selected laryngeal carcinomas, classified as T1–T4; 2 reconstruction techniques, cricohyoidoepiglottopexy (CHEP) and cricohyoidopexy (CHP), are used depending on whether the epiglottis is preserved or not [1-4]. Several investigators have demonstrated the SCL to be an oncologically sound alternative to total laryngectomy (TL), the standard technique for advanced-stage laryngeal carcinoma, with similar local control and survival rates [5-11]; finally, the SCL has also been shown to be an acceptable salvage surgical technique [12].

Firstly developed and adopted in Europe, SCL have gained an increasing acceptance in North America and around the world [13-15]. The advantage of SCL over TL is that a permanent tracheostoma is not required because the main laryngeal functions (respiration, phonation, and swallowing) are preserved, when at least 1 functioning cricoarytenoid joint is maintained, facilitating neoglottal
competency. Volitional sphincteric approximation of the mobile arytenoid cartilage and base of tongue, in the case of CHP, or epiglottis, in the case if CHEP, provides the mucosal source of vibration for voice production [16]. Compensatory mechanisms with reorganization of the stepwise sequence of neuromuscular events, lasting several months, are necessary to restore swallowing [17].

Satisfactory functional results of both voice and swallowing after SCL have been reported by different authors [18-26]; however, significant alterations have appeared inevitable. Different authors have used different methods to assess voice and swallowing, and the definition of guidelines to evaluate the functional results of SCL has been suggested [27]. However, no previous study has been presented with self-assessment data for both voice and swallowing reported in addition to subjective and objective data. The aim of the study is to report objective, subjective, and self-assessment long-term results of voice and swallowing in a large group of subjects who underwent SCL with either CHEP or CHP at least 2 years before the study was undertaken.

2. Materials and method

2.1. Patients

A total of 20 male patients with histologically verified invasive squamous cell carcinoma of the larynx, T1–T3, treated during 1989 to 2001, were involved in a retrospective study on swallowing and vocal function. Table 1 describes the study population. Mean age was 71 years (range, 51–82 years). Three subjects underwent additional radiotherapy. All the subjects had swallowing rehabilitation in the early postoperative phase.

Table 1

<table>
<thead>
<tr>
<th>Patients no.</th>
<th>Years since surgery</th>
<th>No. of arytenoids retained</th>
<th>Reconstruction type</th>
<th>Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
<td>2</td>
<td>CHEP</td>
<td>T1N0M0</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>2</td>
<td>CHEP</td>
<td>T1N0M0</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>2</td>
<td>CHEP</td>
<td>T1N0M0</td>
</tr>
<tr>
<td>4</td>
<td>11</td>
<td>2</td>
<td>CHEP</td>
<td>T1N0M0</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>2</td>
<td>CHEP</td>
<td>T1N0M0</td>
</tr>
<tr>
<td>6</td>
<td>15</td>
<td>2</td>
<td>CHEP</td>
<td>T1N0M0</td>
</tr>
<tr>
<td>7</td>
<td>10</td>
<td>2</td>
<td>CHEP</td>
<td>T1N0M0</td>
</tr>
<tr>
<td>8</td>
<td>12</td>
<td>2</td>
<td>CHEP</td>
<td>T1N0M0</td>
</tr>
<tr>
<td>9</td>
<td>8</td>
<td>2</td>
<td>CHEP</td>
<td>T1N0M0</td>
</tr>
<tr>
<td>10</td>
<td>5</td>
<td>2</td>
<td>CHEP&lt;sup&gt;a&lt;/sup&gt;</td>
<td>T3N0M0</td>
</tr>
<tr>
<td>11</td>
<td>4</td>
<td>1</td>
<td>CHP</td>
<td>T2N0M0</td>
</tr>
<tr>
<td>12</td>
<td>7</td>
<td>2</td>
<td>CHEP</td>
<td>T2N0M0</td>
</tr>
<tr>
<td>13</td>
<td>13</td>
<td>1</td>
<td>CHP</td>
<td>T1N0M0</td>
</tr>
<tr>
<td>14</td>
<td>3</td>
<td>1</td>
<td>CHP</td>
<td>T2N0M0</td>
</tr>
<tr>
<td>15</td>
<td>15</td>
<td>2</td>
<td>CHEP</td>
<td>T3N0M0</td>
</tr>
<tr>
<td>16</td>
<td>11</td>
<td>2</td>
<td>CHEP&lt;sup&gt;a&lt;/sup&gt;</td>
<td>T2N0M0</td>
</tr>
<tr>
<td>17</td>
<td>5</td>
<td>2</td>
<td>CHEP</td>
<td>T2N0M0</td>
</tr>
<tr>
<td>18</td>
<td>13</td>
<td>2</td>
<td>CHEP</td>
<td>T2N0M0</td>
</tr>
<tr>
<td>19</td>
<td>6</td>
<td>1</td>
<td>CHEP&lt;sup&gt;a&lt;/sup&gt;</td>
<td>T3N0M0</td>
</tr>
<tr>
<td>20</td>
<td>7</td>
<td>1</td>
<td>CHEP</td>
<td>T2N0M0</td>
</tr>
</tbody>
</table>

<sup>a</sup> Patients who underwent additional radiotherapy.

2.2. Physical examination

Each subject underwent a videolaryngoscopy, with a flexible endoscope. The Mediastroboscope by Atmos (ATMOS Medizin Technik GmbH and Co KG, Leutkirch, Germany) was used, and the images obtained were stored. Endoscopic examinations were conducted using a Storz FNL-10RP2 fiberscope (STORZ Endoskop Productions GmbH, Tuttingen, Germany). A 5-point rating scale was used in the assessment of the voice to analyze the following variables: (1) vibratory characteristics of the neoglottis, (2) degree of arytenoid motion, and (3) anterior-posterior valving of the arytenoids/epiglottal/base-of-tongue complex during various phonation efforts. At the extremes of the scale, a score of 1 represented poor performance and a score of 5 represented excellent ability.

Swallowing skills were assessed using standard fiberoptic endoscopic evaluation of swallowing (FEES) techniques [28]. Each participant was assessed with room temperature yogurt and dyed water; a 5-ml bolus was given to each patient 3 times for each consistency. Premature spillage of the food bolus, retention of the bolus, laryngeal penetration, and ability to cough or clear aspirated substances were assessed. A 5-point rating system similar to the one used for assessment of voice function was used for the swallowing parameters, as suggested by Zacharek et al [16].

2.3. Aerodynamic measures

The patients were asked to produce an /a/ as long as possible; the voice signal was recorded and directly stored in the host computer. The Computerized Speech Lab (version 5.05) with a 4300 external module of Kay Elemetrics Corporation (Lincoln Park, NJ), was used. The maximum phonation time was determined by measuring the sustained /a/ in 3 productions on the basis of the oscillogram signal. The longest possible phonation time was used for further processing. Each subject was then asked to utter the syllable /pa/ and the trisyllable /pataka/ as fast as possible on a single breath; syllable and trisyllable diadochokinesis was rated in number of syllable uttered and in syllables per second. Finally, each subject was asked to read a 300-word and 578-syllable passage; the time needed to read the passage as well as the number of syllables per second in reading were calculated.

2.4. Perceptual and acoustic voice analysis

The Computerized Speech Lab program (version 5.05) and the Multi Dimensional Voice Program (version 1.34) with a 4300 external module of Kay Elemetrics Corporation were used to perform objective voice evaluation. All voices were recorded with a microphone positioned approximately 15 cm from the mouth and slightly below the chin to reduce airflow effects. A spectrography of the sustained vowels /a,i/ at FFT-1024 points ranging between 0 and 8 kHz was performed; the sample frequency was 20000 Hz. Yanagihara’s classification of hoarseness was used [29].
extension of harmonic distribution was calculated throughout the spectrogram. Voices without harmonic structure were not included in this calculation.

The GIRBAS scale was used for the perceptual voice analysis [30,31]; 2 experienced phoniatricians rated each patient on conversational speech and sustained vowels.

2.5. Self-assessment

Each subject completed the Voice Handicap Index (VHI). The VHI is a validated instrument designed to assess patients’ self-perceived emotional, physical, and functional effects relative to their voice dysfunction [32]. The VHI is an ordinal scale, which is scored from 0 (never) to 4 (always) for a minimum of 0 and a maximum of 120. The higher the score, the more severe the patient’s perception of disability is due to a voice problem. For self-assessment of swallowing, the MD Anderson Dysphagia Inventory (MDADI) was used [33]. The MDADI is a validated dysphagia-specific quality-of-life questionnaire for patients with head and neck cancer; similar to the VHI, it assesses emotional, physical, and functional consequences of a deglutition impairment. Each item is scored on an ordinal scale of 1 (strongly agree) to 5 (strongly disagree). All the statements regarding each aspect of dysphagia are summed, and a mean score is then calculated. The mean scores are multiplied by 20 to obtain a score, with a range of 0 (extremely low functioning) to 100 (high functioning). Results are given as arithmetic mean, standard deviation, and range of the variable. The study was carried out according to the Declaration of Helsinki.

3. Results

3.1. Physical examination

Videoendoscopic laryngeal function analysis results are reported in Tables 2 and 3. Mean value of neoglottis vibratory characteristics was 2.5 (range, 1–5), whereas the degree of arytenoid motion was 3.05 (range, 1–5) and for anterior-posterior squeezing of the arytenoids/epiglottal/base-of-tongue 3.0 (range, 1–5). A slight difference was found in the FEES between liquid and pureed food; as for pureed food, the mean value of premature spillage of the food bolus was 1.1 (range, 1–2), whereas the degree of retention of the bolus was 2.7 (range, 1–5), the laryngeal penetration 1.8 (range, 1–5), and the ability to cough or clear aspirated substances was 1.3 (range, 1–3). With liquids, mean value of premature spillage was 1.5 (range, 1–3), the degree of retention of the bolus was 2.1 (range, 1–4), the laryngeal penetration was 2.1 (range, 1–5), and the ability to cough or clear aspirated substances was 1.2 (range, 1–3).

3.2. Aerodynamic measures

Maximum phonation time was 7.5 ± 4.4 seconds (range, 2–18 seconds). The mean numbers of syllables uttered per breath were 23.3 ± 11.9 (range, 4–40 syllables per breath) for the syllable /pa/ and 13.5 ± 7.6 (range, 2–28 syllables per breath) for the trisyllable /pataka/. The mean syllable diadochokinetics appeared as 3.3 ± 1.3 syllables per seconds for the syllable /pa/ and 1.3 ± 0.9 syllables per second for the trisyllable /pataka/. The mean time needed for reading the 578-syllable passage was 157.6 ± 41.4 seconds (range, 96–230 seconds), with a mean speed of 3.3 ± 0.9 syllables per second. A high degree of variability was measured throughout the aerodynamic measures.

3.3. Perceptual and acoustic voice analysis

The mean values of the GIRBAS scale were 2.4 (range, 1–3), 2.6 (range, 1–3), 2.4 (range, 0–3), 0.8 (range, 0–3), 0.5 (range, 0–3), and 0.8 (range, 0–3). With the exception of 2 subjects, the perceptual values were rather high.

The mean value of the Yanagihara scale was 3.7 ± 0.4 (range, 3–4). No harmonic structure was visible in 7 subjects. In the remaining 13 subjects, the mean value in the extension of harmonic distribution throughout the spectrogram was 961 ± 477 Hz (range, 500–2000 Hz). The acoustic signal
could therefore generally be considered as poor, even though a certain amount of variability was visible.

3.4. Self-assessment

Mean values of the VHI were 29.9 ± 22.8 (range, 3–79) for the total score, 7.6 ± 8.9 (range, 2–32) for the emotional subscale, 9.7 ± 6.9 (range, 3–21) for the physical subscale, and 12.2 ± 9.4 (range, 4–33) for the functional subscale. Extreme variability was found in the VHI total scores and subscales. In the MDADI, the mean values were 80 ± 31.4 (range, 20–100) for the global score, 83.4 ± 9.6 (range, 54–100) for the emotional scale, 84.4 ± 20.1 (range, 32–100) for the physical scale, and 77.5 ± 11.2 (range, 52–88) for the functional scale.

4. Discussion

The voice and swallowing characteristics in a group of 20 male subjects who underwent SCL at least 2 years before the study were assessed using endoscopic, aerodynamic, perceptual, acoustic, and self-assessment ratings. A high degree of variability was found throughout the data, suggesting that voice and swallowing functions after SCL vary from good to poor. The reasons for the variability in the results are not known, even though anatomical variations among subjects (number of arytenoids removed, reconstruction type) can be expected to play a significant role. Voice as well as swallowing after SCL have been analyzed in a series of articles [8-10,15-27]; in only 2 of these, however, endoscopic, aerodynamic, perceptual, acoustic, and self-assessment ratings were used, but the number of subjects studied was rather small (n = 10) [16,25]. In no previous study were self-perceived vocal and swallowing abilities reported. Self-assessment instruments are a key point in long-term functional result analysis because they represent the perceived quality of life (QOL), that is, the patient perspective once the surgical procedures are concluded and its consequences stabilized. Although objective measures analyze functional status, self-assessment tools give insight in the disability and the handicap the patient experiences. In the present study of voice and swallowing disorder, patient-based assessment tools have been used.

In the early postsurgical phase after SCL, swallowing is always impaired because of inadequate neoglottic closure; early studies on functional outcome after SCL measured swallowing ability simply through nasogastric feeding tube removal time and permanent gastrostomy rate [6,9,10,15,16,21,23,25,28]. Some authors used the performance status scale for head and neck cancer to gain a better insight into the swallowing ability after SCL [10,15]. Only recently has the videofluoroscopic evaluation of swallowing analyzed bolus pharyngeal transit [17,25]. Asymptomatic aspiration was frequently present; while in the CHEP aspiration occurred in patients who did not recuperate from epiglottic dynamics, in the CHP, a complete reorganization of the stepwise sequence of the different neuromuscular events is necessary [17,26]. Fiberoptic endoscopic evaluation of swallowing was only used in 2 articles to assess swallowing after SCL, showing moderate degree of premature spillage, residue, and laryngeal penetration [16,25]. In the present study, long-term swallowing ability was assessed through FEES and a self-assessment tool; although FEES allowed the analysis of bolus transit, the MDADI described physical, functional, and emotional self-perception of swallowing. Both instruments revealed a satisfactory deglutition; FEES results of the present study showed better skills compared with what has been reported by other authors, probably because of the higher number of patients with both arytenoids retained in our population.

Eating is a social event for many humans and, thus, any impairment in the ability to swallow may alter both functional status and psychosocial well-being. The impact of dysphagia on QOL needs therefore to be addressed thoroughly after SCL; besides, the main alternative to SCL, that is, TL, usually does not significantly impair swallowing. The MDADI revealed that patients were on average little disabled in eating, suggesting that, from patients’ perspective, swallowing ability is sufficiently restored 2 years after SCL. However, a significant variability in perceived QOL was found, probably reflecting the variability observed in the FEES results. Values of the emotional, physical, and functional subscales of the MDADI did not highly differ, meaning that individual affective responses to the swallowing disorder, its impact on daily activities, and self-perception of bolus transit play a similar role in QOL after SCL.

Endoscopic examination in our group of subjects showed that arytenoid mobility and anteroposterior squeezing of the arytenoid/epiglottal/base-of-tongue complex were generally good, whereas vibration of the neoglottis was sometimes poor. Zacharek et al [16] reported more uniform values among the 3 endoscopic parameters, probably as a result of different postsurgical anatomical conditions. Videendoscopy results have been seldom used, reflecting the lack of standardized scales for neoglottic vibratory characteristic analysis.

Maximum phonation time appears to be the most widely aerodynamic parameter used; different authors report similar data of a highly reduced maximum phonation time, with values ranging between 8 and 11 seconds. Our results do not differ, confirming that there is a significant loss of air during phonation after SCL because of a loose closure of the neoglottis. The GIRBAS scale is one of the most widely perceptual assessment scales used; unfortunately, data on neoglottal voices are scant. The values reported by Bron et al [10], however, are very close to our calculations, confirming that SCL voice is very breathy and rough.

As for acoustic analysis, Jitter and Shimmer have been widely used [16,19,20,22,25]. We preferred not to perform any perturbation analysis because spectrographic results showed a high percentage of subjects (35%) with nonhar-
monic voice, and therefore, it is not suitable for this kind of analysis, as suggested by Titze [34]. Acoustic signal in our subjects, by the way, was generally poor, confirming that voice is extremely deteriorated after SCL.

Self-assessment data revealed a minimal implication on QOL after SCL, on the emotional, physical, and functional levels; the only study reporting QOL measurements, on the contrary, showed high VHI scores [16]. Quality of life brings many factors into play, including the client’s psychosocial traits and cultural and ethnic backgrounds. Therefore, it is not surprising that different authors report different VHI scores on a small number of subjects studied in different countries. Besides, because the voice is mainly used for every day verbal communication, it is possible that vocal QOL is perceived by the patients as not being very compromised, even if the voice per se is rather poor. It should be noted that when the patients elected to undergo the partial laryngeal surgical procedure vs the TL alternative, they considered that a permanent tracheostoma would probably negatively impact their QOL postoperatively. Reported VHI scores might be influenced by the patient perception of a permanent tracheostoma and the vocal performances after TL.

In conclusion, even though a certain degree of variability was present, swallowing after SCL was satisfactory, whereas endoscopic, aerodynamic, perceptual, and acoustic data clearly showed a highly dysphonic voice after SCL. However, self-assessment results revealed relatively satisfied speakers on the emotional, physical, and functional levels, suggesting that oral communication was not significantly limited. The reported self-assessment data on both levels, suggesting that oral communication was not significantly impaired. The reported self-assessment data on both levels, suggesting that oral communication was not significantly impaired.

References


