CHAPTER

THE EFFICACY OF VOICE THERAPY IN PATIENTS AFTER TREATMENT FOR EARLY GLOTTIC CARCINOMA

CHRISTINE D. L. VAN GOGH
IRMA M. VERDONCK-DE LEEUW
BRIGITTE A. BOON-KAMMA
RICO N. P. M. RINKEL
M. DIANA DE BRUIN
JOHANNES A. LANGENDIJK
DIRK J. KUIK
HANS F. MAHIEU

ABSTRACT

Background After treatment for early glottic carcinoma, a considerable number of patients end up with voice problems that interfere with daily life activities. The objective of this randomized and controlled study was to assess the efficacy of voice therapy in these patients.

Methods Of 177 patients, 6–120 months after treatment for early glottic carcinoma, 70 patients (40%) suffered from voice impairment based on a 5-item screening questionnaire. Approximately 60% of those 70 patients were not interested in participating in the current study. Twenty-three patients who were willing to participate were assigned randomly either to a voice therapy group (n=12 patients) or to a control group (n=11 patients). Multidimensional voice analyses (the self-reported Voice Handicap Index [VHI], acoustic and perceptual voice quality analysis, videolaryngostroboscopy, and the Voice Range Profile) were conducted twice: before and after voice therapy or with 3 months in between for the control group.

Results Statistical analyses of the difference in scores (postmeasurement minus premeasurement) showed significant voice improvement after voice therapy on the total VHI score, percent jitter, and noise-to-harmonics ratio in the voice signal and on the perceptual rating of vocal fry.

Conclusions Voice therapy proved to be effective in patients who had voice problems after treatment for early glottic carcinoma. Improvement not only was noticed by the patients (VHI) but also was confirmed by objective voice parameters.
INTRODUCTION

Radiotherapy and endoscopic laser surgery are the main treatment modalities for patients with early-stage, glottic laryngeal carcinoma. Both treatment modalities provide good cure rates\(^1\)–\(^16\). Several reports on functional results have described a wide range of incidence of abnormal voice quality in 14–92% of patients after radiotherapy\(^15\)–\(^29\) and in 17–70% of patients after laser surgery\(^15\),\(^21\)–\(^33\). Furthermore, studies on the influence of a deteriorated voice on quality of life revealed that 27–58% of patients with voice problems experienced difficulties in communication that led to a disrupted social life\(^18\),\(^34\)–\(^42\). Evidently, considerable numbers of patients who are treated for early glottic carcinoma have to deal with voice problems in daily life. It is not clear whether these voice problems respond to voice therapy. Outcome studies on the efficacy of voice therapy are scarce. Fex and Henriksson\(^43\) applied voice therapy to reduce voice damage caused by radiotherapy for laryngeal carcinoma. In their study, 15 patients received voice treatment during radiation therapy. Unfortunately, the definition of normal voice quality in that study remained unclear, and a control group was not included; therefore, it is impossible to conclude that the voice results were a consequence of voice therapy. Zwirner et al\(^44\) reported a positive acoustic effect of voice therapy in patients after laser surgery for T1–T3 laryngeal carcinomas. In that prospective study, 13 patients with substantial deterioration of voice function after laser surgery were subjected to an intensive voice rehabilitation program. After rehabilitation, the standard deviation of fundamental frequency and the noise-to-harmonics ratio (NHR) improved significantly, but it did not return to “normal” values, which were obtained from an age-matched and gender-matched control group. Sittel et al\(^45\) could not demonstrate this beneficial effect of voice therapy after laser surgery for patients with T1–T2 laryngeal carcinomas. On the contrary, those authors found that patients who did not receive voice therapy had considerably better voices than patients who did receive voice therapy. The patients after voice therapy showed a high percentage of ventricular fold phonation. According to the authors, this may have been because of a lack of information and knowledge of the speech therapists, who may have assumed that phonation on a glottic level was impossible after laser surgery.

It may be concluded that convincing evidence for the efficacy of voice therapy in patients with early glottic carcinoma is lacking. The main objective of the current randomized study was to assess the efficacy of voice therapy in patients with voice problems after they received treatment for early glottic carcinoma by using a multidimensional voice-assessment protocol.
MATERIALS AND METHODS

Study Design

During 1 year, all patients who received treatment for early glottic carcinoma (carcinoma in situ [Tis], T1N0M0, and T2N0M0, as defined according to the International Union Against Cancer staging system [46]: T1, tumor limited to the vocal folds with normal mobility; T2, supraglottic and/or subglottic tumor expansion and/or impaired mobility; N0, no regional lymph node metastasis; M0, no distant metastasis) at least 6 months previously with either radiotherapy or endoscopic laser surgery were screened regarding voice impairment during their regular follow-up visit at our outpatient department. The screening instrument consisted of a validated and standardized, 5-item, 10-point, anchored, scaled questionnaire that covered vocal abilities and social situations [38,47].

According to the questionnaire, patients who showed voice impairment (a score ≤ 5 on at least 1 of the 5 items) were asked to participate in a study on the efficacy of voice therapy. Those who were willing to participate were divided, in the order of their presentation (i.e., random), into either a voice-therapy group or a control group.

Radiotherapy

Patients who were treated with radiotherapy received local irradiation with the Varian CLINAC 2300, a linear 6 MV accelerator (Varian Medical Systems Inc., Palo Alto, CA). The total radiation dose was 57.5–60.0 grays (Gy) in patients with T1a and T1b tumors (2.5 Gy per fraction, 5 times per week), whereas patients with T2 tumors generally received an accelerated schedule to a total dose of 70 Gy (2 Gy per fraction, 6 times per week). All patients with T1 tumors were treated with 2 opposing lateral fields, generally with a standard field size of 6 x 6 cm and with 6-MV photons. In patients who had T2 tumors with supraglottic extension beyond the false cords and/or subglottic extension >1 cm, the radiation portals were extended to Levels II to IV on both sides and/or to the paratracheal lymph node areas, respectively.

Endoscopic laser surgery

Patients who underwent endoscopic laser surgery had been selected by means of videolaryngostroboscopic evaluation using the presence of mucosal undulation as an indication for superficial tumor spread only. A Sharplan CO2-laser (with an AcuSpot™ micro-manipulator; Sharplan Laser Industries, Tel Aviv, Israel) in a super-pulse mode was used for a chordectomy Type II [48].

Voice Therapy

Patients in the voice-therapy group were referred to a speech-language pathologist who specialized in voice therapy (voice therapist) in their own neighborhood and were treated
with a maximum of 24 sessions. The sessions lasted for 30 minutes each and were held twice per week. The voice therapists were informed about the patient’s medical history and videolaryngostroboscopic examination findings. The type of voice therapy could be chosen freely according to the patient’s needs. To gather information about the kind of voice therapy used, the voice therapists kept a log.

**Voice Analyses**

All patients’ voices were examined twice: once at baseline (study entry assessment) and once after voice therapy or after 3 months for patients in the control group (study exit assessment). Digital recordings of a standardized text that was read aloud (30 seconds) and a sustained vowel /a/ at comfortable loudness and pitch were performed using the Computerized Speech Lab and Multidimensional Voice Program developed by Kay Elemetrics (Pine Brook, NJ). A mouth-to-microphone distance of approximately 30 cm was held constant throughout all samples.

**Voice Handicap Index**

The Voice Handicap Index (VHI) was chosen as the primary outcome measure. The VHI is a validated questionnaire that measures psychosocial handicapping effects of voice disorders\(^{49}\) and was translated and validated in Dutch\(^{50}\). The questionnaire consists of 30 statements on voice-related aspects in daily life (5-point rating scale). The total score for the 30 questions ranges from 0 to 120. A higher score indicates a higher level of voice handicap (Appendix 2).

**Communicative suitability**

The concept of communicative suitability developed by Franken et al\(^{51}\) for stuttering patients was adapted by van der Torn et al\(^{34}\) for patients after treatment for early glottic carcinoma. A panel of 10 untrained volunteers judged the voice samples on communicative suitability in 3 different, demanding speaking situations on a 10-point, anchored scale that ranged from extremely poor (score 1) to excellent (score 10). The three speaking situations ranged from low demanding (talking about everyday events with a friend), medium demanding (asking a passer-by for directions), to highly demanding (giving a lecture) (Appendix 1). The raters assessed communicative suitability of text samples that were read aloud in a computerized-rating protocol. Voice samples from all patients (the voice-therapy group and the control group; study entry and exit assessments) were presented in random order for both study groups and for study entry or exit assessments. To test reliability, 10 randomly chosen voice samples were rated twice. The raters were blinded to the clinical data.

**Perceptual voice-quality assessment**

The same voice samples (text read aloud) that were used to assess communicative suit-
ability were used to assess voice quality. Two trained raters, both voice therapists experienced with patients who had laryngeal carcinoma but not familiar with the study patients, assessed voice quality perceptually in a computerized rating protocol. Voice samples from all patients (the voice-therapy group and the control group; study entry and exit assessments) were presented in random order for both study groups and for study entry or exit assessment. To test reliability, 10 randomly chosen voice samples were rated twice. The raters were blinded to the clinical data. An adapted and limited version of the Vocal Profile Analysis Protocol by Laver et al was used. The following 10 items were judged on a 4-point-scale based on a consensus reached by the 2 raters: breathiness, roughness, tension/strain, unsteadiness, asthenia, aphonia, falsetto, vocal fry, diplophonia, and tremor.

_Acoustic voice analyses_

Acoustic analyses of voice quality were performed by using samples of a sustained vowel /a/. Acoustic signal typing according to Behrman et al. revealed that all recordings were suitable for further acoustic analyses. Average fundamental frequency (F0), the percentage jitter, the percentage shimmer, and the NHR were determined. The percentage of jitter represents the relative period-to-period variability. The percentage of shimmer represents the relative variability of the peak-to-peak amplitude. The NHR is an average ratio of energy of the inharmonic components in the range 1500 – 4500 Hz to energy of the harmonic components in the analyzed signal.

_Videolaryngostroboscopy_

Vocal fold anatomy and movement were assessed by means of videolaryngostroboscopy (stroboscopy). Digital recordings were obtained by using a Stroboscopy 2000 ACLS digital system (developed by Alphatron Medical and Microwave Systems BV, Rotterdam, The Netherlands). Each individual was asked to produce the sustained vowels /u/ and /i/ and two vowel glides (from high to low frequency, and vice versa). Two raters, both experienced laryngologists, participated in a randomized, blinded rating protocol. The 16-item rating form was adapted from Hirano and Bless and consisted of scales relating to overall laryngeal anatomy, vocal fold movement, mucosal wave pattern, irregularity, periodicity and glottic closure. Judgments were performed by the two raters reaching consensus. To test the reliability of the raters, 10 randomly chosen samples were rated twice.

_Voice Range Profile_

The Voice Range Profile (VRP) or phonetogram was obtained using the automatic VRP, which was developed by Kay Elemetrics, to assess the pitch and intensity ranges of the speakers’ voices. The speakers were asked to produce a sustained /a/ as loud and soft as possible at selected frequencies and to produce several vowel glides. Two parameters were determined for each patient: the pitch range in semitones (highest frequency minus
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lowest frequency) and the intensity range in decibels (loudest level minus softest level).

Statistic Analyses

Interrater reliability of the communicative suitability test was determined by calculating the intraclass correlation coefficients (ICC) between the 10 raters. Intrarater reliability of each rater of the communicative suitability test was determined by calculating the ICC between the first and second (repeated) ratings. Test-retest reliability of perceptual and stroboscopic ratings was determined by calculating weighted values between the first and second (repeated) ratings. Because of the small number of patients who underwent endoscopic laser surgery compared with the number of patients who were treated with radiotherapy, statistic analyses were performed for both treatment groups together. Independent Mann–Whitney U tests (perceptual and stroboscopic evaluation) and independent Student t tests (VHI, communicative suitability, acoustical analyses, VRP) were used to compare the study entry data between the two different study groups. The efficacy of voice therapy was assessed by independent Student t tests on the mean difference scores, which were defined as the study exit assessment score/value minus the study entry assessment score/value.

RESULTS

Study Group Composition

In total, 177 patients (162 men and 15 women; mean age, 66 yrs; age range, 39 – 80 yrs), including 126 patients who received radiotherapy and 51 patients who underwent endoscopic laser surgery, completed the screening questionnaire. Of these 177 patients, 70 patients (40%; 67 men and 3 women) suffered from voice impairment based on their answers in the questionnaire, including 55 patients who were treated with radiotherapy and 15 patients who underwent endoscopic laser surgery. Thus, 44% percent of the patients who received radiotherapy and 29% of the patients who underwent endoscopic laser surgery had overall voice impairment. This difference between the 2 treatment modalities was not significant (p = 0.079).

Forty-one of 70 patients (58%) who had voice complaints did not wish to participate in the study. Twenty-nine patients (41%) were willing to participate and were included in the study after they provided written informed consent. There were no significant differences concerning the questionnaire scores between patients who were willing or unwilling to participate in the study.

None of the patients who were included in the study had received previous voice therapy, and none suffered from neurologic diseases that could influence speech or voice.
The 29 patients who were included were assigned randomly to either the voice-therapy group (n = 16 patients) or the control group (n = 13 patients). During the course of the study, 6 of 29 patients dropped out of the study, four patients dropped out because of a biopsy that was suspicious for recurrent tumor, 1 patient developed myocardial infarction, and 1 patient withdrew from the study because of lack of motivation.

Of the remaining 23 patients, 12 patients formed the voice-therapy group, including 9 patients who received radiotherapy and 3 patients who underwent laser surgery. The other 11 patients formed the control group, which included 8 patients who received radiotherapy and 3 patients who underwent laser surgery. Patients in the control group did not receive voice therapy during the study period.

The average posttreatment time was 31 months (range, 6 – 81 mos) for the voice-therapy group and 42 months (range, 6 –120 mos) for the control group; this difference was not significant (Student t = 0.73; p = 0.47). Both the voice-therapy group and control group consisted of only men with a mean age of 67 years (age range, 55– 80 yrs) for the voice-therapy group and 58 years (age range, 40 – 80 yrs) for the control group; this age difference proved to be statistically different (Student t = -2.13; p = 0.048). There was no difference in tumor stage between the 2 treatment groups (chi-square statistic, 6.33; p = 0.097).

**Voice Therapy**

The patients in the voice-therapy group attended 4 –24 sessions of voice therapy (mean, 16 sessions). The main part of the therapeutic sessions consisted of voice and breathing exercises and vocal hygiene. Specific voice exercises took up > 50% of the treatment time.

![Figure 1](image.png)

**Figure 1.** Differences in Voice Handicap Index scores are illustrated per patient for both study groups (difference postmeasurement -premeasurement score).
Self-Ratings of Vocal Performance

The mean VHI scores for patients in both the voice-therapy group and the control group are presented in Table 1. At the start of the study, there was no significant difference in the total VHI score between the control group and the voice-therapy group (Student t = 1.66; p = 0.11). The mean improvement in VHI was significantly better (Student t = 2.51; p = 0.024) in the voice-therapy group (15.25 points) than the mean VHI improvement in the control group (2.64 points). The VHI difference scores per patient in the 2 study groups are illustrated in Figure 1.

Table 1. Mean Scores/Values with Standard Deviations on the Voice Handicap Index, Acoustic Analyses, and Voice-Range Profile Parameters for Both Study Groups

<table>
<thead>
<tr>
<th></th>
<th>Control group</th>
<th>Voice therapy group</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Study entry assessment</td>
<td>Study exit assessment</td>
</tr>
<tr>
<td>Voice Handicap index</td>
<td>Study entry assessment</td>
<td>Study exit assessment</td>
</tr>
<tr>
<td>Total VHI score</td>
<td>29.45 (13.34)</td>
<td>26.82 (15.04)</td>
</tr>
<tr>
<td>Acoustic analyses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fundamental frequency</td>
<td>131 (27)</td>
<td>127 (19)</td>
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<tr>
<td>NHR</td>
<td>0.18 (0.042)</td>
<td>0.18 (0.057)</td>
</tr>
<tr>
<td>Jitter</td>
<td>1.39 (0.59)</td>
<td>1.70 (1.15)</td>
</tr>
<tr>
<td>Shimmer</td>
<td>8.56 (5.82)</td>
<td>7.48 (2.09)</td>
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<tr>
<td>Voice Range Profile</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intensity range</td>
<td>28.4 (6.6)</td>
<td>30.4 (6.3)</td>
</tr>
<tr>
<td>Pitch range</td>
<td>20.7 (6.1)</td>
<td>21.9 (4.8)</td>
</tr>
</tbody>
</table>

Communicative Suitability

Interrater reliability was high: The ICC was 0.85, 0.84, and 0.90, respectively, for the low-demanding, medium-demanding, and highly demanding speaking situations. Intrarater reliability appeared to be equally high with ICCs ranging from 0.70 to 0.93. Given this high reliability, the means of the ratings of all judges were calculated and were used for further analyses.

The mean communicative suitability scores for patients in the voice-therapy group and the control group are presented in Table 2. At the start of the study, the suitability scores for all 3 speaking situations showed no significant differences between the 2 study groups (low demanding: Student t = 0.51 [p = 0.61]; medium demanding: Student t = 0.47 [p = 0.65]; and highly demanding: Student t = 0.25 [p = 0.80]). After voice therapy, none of the 3 speaking situations improved significantly compared with patients in the control group (low demanding: Student t = 0.43 [p = 0.67]; medium demanding: Student t = -0.09 [p = 0.93]; and highly demanding: Student t = 0.41 [p = 0.69]).
Table 2. Mean Communicative Suitability Scores with Standard Deviations and Median Perceptual Voice-Quality Scores for Both Study Groups

<table>
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<tr>
<th></th>
<th>Control group</th>
<th>Voice therapy group</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Study entry assessment</td>
<td>Study exit assessment</td>
</tr>
<tr>
<td><strong>Communicative suitability</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Talking with a friend</td>
<td>6.45 (1.15)</td>
<td>6.37 (1.51)</td>
</tr>
<tr>
<td>Asking a passer-by</td>
<td>6.44 (1.11)</td>
<td>6.53 (1.30)</td>
</tr>
<tr>
<td>Giving a lecture</td>
<td>5.85 (1.31)</td>
<td>5.65 (1.53)</td>
</tr>
<tr>
<td><strong>Perceptual voice quality</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breathiness</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Roughness</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Vocal fry</td>
<td>2.00</td>
<td>2.00</td>
</tr>
</tbody>
</table>

**Perceptual Voice Quality**

Of the 10 voice-quality items, 6 items appeared to be noninformative for the study group: unsteadiness, asthenia, aphonors, falsetto, diplophonia, and tremor were absent in all or all but 1 of the voice samples. Reliability of the 4 relevant items proved to be good for breathiness, roughness, and vocal fry with weighted values of 0.83, 0.92, and 0.70, respectively. Reliability of the item tension/strain was low with a weighted value of 0.074. Given these considerations, the ratings on breathiness, roughness, and vocal fry were taken into account for further analyses. The median perceptual voice quality scores are presented in Table 2. At the beginning of the study, there was no significant difference between the 2 study groups regarding roughness (Z = -0.46; p = 0.70) and breathiness (Z = -1.05; p = 0.32); however, vocal fry was present significantly more often (Z = -2.14; p = 0.04) among patients in the voice-therapy group. After voice therapy, vocal fry decreased significantly compared with patients in the control group (Student t = 2.66; p = 0.015) (Figure 2). The items roughness and breathiness did not change significantly after voice therapy (roughness: Student t = 0.0005 [p = 1.00] and breathiness: Student t = -0.91 [p = 0.38]).

**Acoustic Voice Analyses**

Table 1 shows the mean values of the acoustic parameters. At the beginning of the study, there were no significant differences between the 2 study groups regarding F0 (Student t = 0.83; p = 0.42), jitter (Student t = -1.74; p = 0.10), shimmer (Student t = 0.65; p = 0.52), or the NHR (Student t = -1.17; p = 0.26).

After voice therapy, a significant improvement was observed in the NHR (Student t = 2.70; p = 0.013) and in jitter (Student t = 2.76; p = 0.012). Figures 3 and 4 show the difference scores for NHR and jitter.
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Figure 2. Differences in vocal fry scores are illustrated per patient for both study groups.

Figure 3. Differences in noise-to-harmonics ratio scores are illustrated per patient for both study groups.
Although all arytenoids were mobile both at study entry and study exit, there was one patient whose arytenoids showed a minor asymmetry (the left arytenoid started to move slightly earlier than the right arytenoid, but the range of movement was identical) at study entry. At study exit, this finding was identical. Because it was judged that the mobility of the arytenoids itself was normal, and there was no difference in symmetry of the arytenoids between study entry compared with study exit, these two items were not included in the statistical analyses. Test-retest reliability of the remaining 14 items was moderate to good, with weighted κ values ranging from 0.46 to 0.88 for all items except phase symmetry, which had a poorly weighted κ value of 0.098. Therefore, the item phase symmetry was discarded for further analyses.

At the beginning of the study there were no significant differences noted in the laryngostroboscopic findings between the voice-therapy group and the control group (Z ranges between -1.89 and -0.036; p values between 0.079 and 0.98). No significant changes were observed after voice therapy on any of the stroboscopic items, except for the item “regularity of vocal fold edge.” After voice therapy, the vocal fold edge became more irregular (Z = -2.67; p = 0.008). When the left and right vocal folds were observed separately, it became clear that the left vocal fold edge became more irregular (Z = -2.12; p = 0.034), whereas the right vocal fold edge did not change (Z = -0.38; p = 0.71).

**Figure 4.** The percentage differences in jitter are illustrated per patient for both study groups.

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**Laryngostroboscopy**

Although all arytenoids were mobile both at study entry and study exit, there was one patient whose arytenoids showed a minor asymmetry (the left arytenoid started to move slightly earlier than the right arytenoid, but the range of movement was identical) at study entry. At study exit, this finding was identical. Because it was judged that the mobility of the arytenoids itself was normal, and there was no difference in symmetry of the arytenoids between study entry compared with study exit, these two items were not included in the statistical analyses. Test-retest reliability of the remaining 14 items was moderate to good, with weighted κ values ranging from 0.46 to 0.88 for all items except phase symmetry, which had a poorly weighted κ value of 0.098. Therefore, the item phase symmetry was discarded for further analyses.

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Voice Range Profile

Table 1 illustrates the mean values of the VRP parameters. At the start of the study, there were no significant differences between both study groups in pitch (Student t = 1.30; p = 0.21) or in intensity range (Student t = 1.25; p = 0.23). Posttreatment, the difference score of pitch and intensity range did not differ significantly between both study groups (pitch: Student t = -1.78, p = 0.092; intensity: Student t = -1.16, p = 0.26).

DISCUSSION

The current study provides evidence of the efficacy of voice therapy in patients with voice problems after treatment of early glottic carcinoma. The voice complaints of the patient, as assessed by the VHI, improved significantly, with an ample score of 15 points, which is comparable to the results from other studies concerning the efficacy of voice therapy. Roy et al.55 reported that results from a randomized, controlled study showed a significant mean improvement of 11.63 points on the VHI after voice therapy in teachers who had voice problems. Rosen et al.56 found that patients who had muscular tension dysphonia improved significantly after voice therapy on the VHI, with a mean improvement of 18 points. More recently, Speyer et al.57 reported a median improvement of 6 points after voice therapy in patients who had a diversity of chronic, benign voice disorders.

In the current study, the primary outcome measure consisted of voice impairment, as assessed by the patients using the VHI. A beneficial effect of voice therapy also was observed in the secondary voice-quality outcome measures (NHR, jitter, and perceptual rating of vocal fry). Other randomized, controlled studies of the efficacy of voice therapy in patients with a diversity of chronic, benign voice disorders produced more or less similar improvements in acoustic and/or perceptual analyses58–63.

Stroboscopic examination in the current study did not show an improvement after voice therapy. The minor but significant increase of irregularity of the left vocal fold edge after voice therapy cannot be explained easily. It is noteworthy that such a change in regularity of the vocal fold edge was not observed for the right vocal fold. It is our educated guess that this difference in regularity of the left vocal fold edge is based on a coincidence. It also may be argued that voice therapy could lead to a temporary overloading of the vocal fold in a fragile laryngeal mucosal condition after radiotherapy or laser surgery. In such a patient, however, a similar finding also would be expected in the right vocal fold.

Nearly 60% of patients, all of whom met the inclusion criteria for the study, were not willing to participate in the study despite their self-reported voice problems. This high percentage may be explained by the time-consuming nature of voice therapy and the fact that many patients accepted their voice problem as a logical consequence of their treat-
ment for a potentially life-threatening disease. Despite the randomization, baseline data from the voice-therapy group seemed slightly worse than data from the control group (but there was no significant difference, with the exception of the perceptual rating on vocal fry).

Although a significant improvement was observed in the VHI scores, the mean total VHI score of 24 points after voice therapy remains above the range of normal voices, which varies from a VHI score < 7 points for a sample of individuals from the general population with good voices, as assessed by an expert, to 12–17 points for a sample of individuals who were chosen randomly from the general population. In other studies regarding voice after treatment for head and neck tumors, VHI scores ranged from 12 points to 45 points. In those studies, patients were not selected with regard to voice problems or site of head and neck tumor. The current study involved patients who were treated for early glottic carcinoma only, and they were selected on the basis of their voice problems. It is our considered opinion that regular assessment of voice quality after treatment for early glottic carcinoma, for example, using the screening questionnaire employed in this study, is helpful to select patients who may benefit from voice therapy.
REFERENCES


