

Acoustic Characteristics of Voice Before and After Endoscopic Partial Laryngectomy in Early Glottic Cancer

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Summary: Objectives. To evaluate the voice changes after narrow-margin endoscopic partial laryngectomy in subjects with T1N0M0 glottic cancer.

Study Design. Uncontrolled retrospective comparison of preoperative and postoperative mean phonation time; fundamental frequency, jitter, shimmer, and noise-to-harmonic ratio; and voice-related quality of life (V-RQOL) survey scores.

Methods. Seventeen adults diagnosed with T1N0M0 glottic cancer who underwent narrow-margin endoscopic partial laryngectomy were included. All subjects had preoperative and postoperative acoustic evaluation and V-RQOL scores. Subjects were separated into three groups based on age and depth of resection. Group A (mean age, 52 years) consisted of seven subjects who underwent superficial resection (superficial layer of lamina propria) and were younger than 60 years. Group B (mean age, 76 years) consisted of six subjects who were older than 60 years and underwent superficial resection (superficial layer of lamina propria). The four subjects in group C were older than 60 years and underwent deep resection (into the vocal ligament and/or into the thyroarytenoid muscle).

Results. There was a statistically significant improvement in V-RQOL in group A. The acoustic measures did not change after surgery (no $P < 0.05$).

Conclusion. For early-stage cancer, patients younger than 60 years and superficial resection of cancer are predictive for better voice.

Key Words: Laryngeal cancer–Glottis–Early glottic cancer–Endoscopic–Partial laryngectomy–Acoustic–Voice outcomes–Transoral.

INTRODUCTION

Early-stage laryngeal cancer can be treated by single modality therapy such as radiation or surgery. Many authors find similar oncologic control rates approaching 80–90% for both of these modalities.^{1–3} Improvements in optics to magnify and visualize tumor margins in high definition coupled with advancements in our understanding of the relationship between histology and laryngeal function have led to innovative surgical techniques. With such high control rates, secondary outcomes such as vocal quality, quality of life, and cost-effective care have become increasingly more important.

The evolution of endoscopic surgical approaches to early glottic cancer includes contributions from many otolaryngologists. In 1920, Dr Lynch⁴ reported during the Forty-Second Annual Congress of the American Laryngological Association his series of nine cases of intrinsic carcinoma of the larynx, which he approached with suspension and dissection. In 1941, New and Dorton⁵ reported a 90% cure rate with endoscopic diathermy for small glottic cancers. In 1973, Lillie and DeSanto⁶ described microscopic cordectomy for treatment of

glottic cancer. In 1975, Strong⁷ reported a case series of T1 glottic cancer, which was treated by carbon dioxide laser resection. Since then, the role of endoscopic resection in early glottic cancer has continued to evolve beyond an oncologically sound operation to a secondary goal of preserving maximal vocal quality. Delsupehe et al⁸ reported a series of patients surgically treated with narrow-margin laser cordectomy in 1999. Narrow-margin approaches continue to evolve using both cold instrument and laser techniques. A phonosurgical conceptual framework, regardless of technique, is based on the cover/body model of mucosal wave production, which was described by Hirano.⁹ The phonosurgical approach is performed by resecting the minimal amount of deep tissue while preserving the maximal normal-layered microstructure. These techniques have been performed using both cold and laser techniques with excellent rates of oncologic control. Authors have proposed that endoscopic approaches have superior voice quality when compared with radiation. In prior studies, both perceptual tools and acoustic voice evaluation have been shown to correlate poorly with patient perceptions.^{8,10–12} We investigated the voice-related quality of life (V-RQOL) scores and acoustic analysis after the use of cold instrument ultranarrow-margin partial laryngectomy in patients with T1 squamous cell carcinoma of the vocal folds.

MATERIALS AND METHODS

Study design

A retrospective review of patients who were diagnosed with early glottic cancer (T1N0M0) and underwent ultranarrow-margin endoscopic partial laryngectomy was conducted between January 2003 and August 2008 at Massachusetts Eye and Ear Infirmary.

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All work was performed at the Massachusetts Eye and Ear Infirmary.

Presentations: This project was presented at The Voice Foundation's 39th Annual Symposium: Care of the Professional Voice; June 2–6, 2010; Philadelphia, Pennsylvania.

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Only patients with both preoperative and postoperative voice evaluations were included in this study. Patients who had radiation treatment were excluded from this study.

Voice evaluations

Voice evaluations were performed in the Voice and Speech Laboratory using Kay Elemetrics *Computerized Speech Lab* system for acoustic testing (KayPENTAX, Pentax Medical Care, Montvale, NJ, USA). Each patient is seated in a sound-treated room (Industrial Acoustics Company booth, Industrial Acoustics Co, Bronx, NY, USA) and wears a headband device, which suspends a Shure Beta 53 microphone (Shure Inc, Niles, IL, USA) a constant distance of 15 cm from the lips. The output of the microphone is fed to a TASCAM preamplifier and digitizer (Tascam, TEAC America Corp, Montebello, CA, USA) and recorded as wave files by a personal computer-based acoustic analysis program, *Voice Evaluation Suite* (Estill Voice International, LLC, Pittsburgh, PA, USA, 2006–2007). The system is calibrated with external sound pressure level (SPL) meter measurement of intensity (dB SPL) daily in accordance with the program's instructions. Recordings are made as each patient performs the following tasks: (1) read a standard passage aloud at a conversational level (a 10-second segment is recorded after the patient has settled into reading the first paragraph of "The Rainbow Passage;" the "Cookie Theft" picture from the Boston Diagnostic Aphasia Examination is available as an alternative task); (2) sustain the vowel /a/ three times holding pitch and loudness as "steady" (constant) as possible for at least 4 seconds; (3) produce the /a/ vowel, and sustain in modal range for as long as comfortably possible, that is, maximum phonation time (MPT); (4) produce an /s/ (hiss) and sustain for as long as comfortably possible and then produce an /z/ (buzz) and sustain for as long as comfortably possible, that is, s/z ratio; (5) produce the /a/ vowel with the softest (excluding whisper) and loudest voice possible, that is, maximum intensity range; (6) produce the /a/ vowel with the highest (including falsetto register) and lowest (excluding pulse register) pitches possible, that is, maximum pitch range; and (7) produce rapid but clearly separated "uh-'uh-'uh (etc)"s over 7 seconds, that is, laryngeal diadochokinesis rate.

The audio recordings of the reading passage and other tasks for each patient are digitized and processed on a personal computer workstation using the *Voice Evaluation Suite* (2006). Detailed descriptions of acoustic analysis procedures are contained in the Help file for *Voice Evaluation Suite*, which is printed out and kept in the laboratory. The 10 seconds of reading passage are analyzed on a cycle to cycle basis to yield measures of average fundamental frequency (F_0) and intensity (dB); the system automatically excludes segments of the recording that do not contain harmonic structure. The three 4-second steady /a/ vowels are analyzed to yield percent frequency perturbation (jitter), percent intensity perturbation (shimmer), and harmonics-to-noise ratio (dB). Maximum and minimum F_0 (pitch) and intensity in dB (loudness) are also determined.

Quality-of-life measure

The V-RQOL survey scores were obtained both before and after surgery.

Operative technique

Patients were taken to the operating room and placed under general endotracheal anesthesia. Wide exposure of the larynx was obtained using suspension gallows and a large-bore laryngoscope. 1:10 000 epinephrine in saline was injected into the superficial lamina propria (SLP) or Reinke's space. Hydrodissection accomplishes several goals: (1) improving preoperative visualization of both the depth and extent of the cancer; (2) assisting with hemostasis by vasoconstricting the microvasculature of the SLP; and (3) increasing the depth of the SLP facilitating less traumatic dissection in this layer. After the injection of epinephrine, cold phonosurgical instruments were used to remove the cancer with ultranarrow margins. After removal of the primary specimen, frozen sections of the margins were obtained circumferentially to ensure complete resection (Figure 1).

The extent of vocal fold tissue removal was classified by depth. Superficial resection was defined as dissection limited to the epithelium and the superficial layer of the lamina propria. Deep resection was defined as depth of dissection violating the vocal ligament. Statistical processing of acoustical parameters and V-RQOL was performed with SPSS software, Version 15.0.

RESULTS

Seventeen patients were included in this study: 16 males and one female. The mean age was 66.4 years (ages range from 27 to 88 years). The age distribution of the groups: group A (mean age = 52 years; range, 27–60 years), group B (mean age = 77 years; range, 70–86 years), and group C (mean age = 72 years;

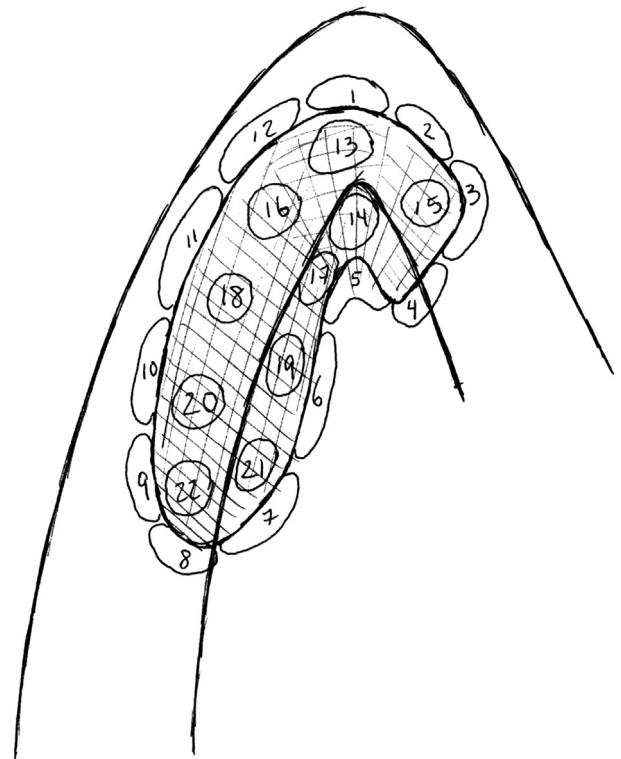


FIGURE 1. Schematic of circumferential, three-dimensional frozen sections obtained in ultranarrow-margin partial laryngectomy.

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