Stroboscopy to report voice treatment outcomes in patients with HNC

Kendrea L. Focht, C.Sc.D., CCC-SLP\textsuperscript{1,2,3,4}
Bonnie Martin-Harris, Ph.D., CCC-SLP, BRS-S\textsuperscript{1,2,3,4}
Heather Bonilha, Ph.D., CCC-SLP\textsuperscript{1,2,3}

\textsuperscript{1}Otolaryngology-Head & Neck Surgery
\textsuperscript{2}Evelyn Trammell Institute for Voice & Swallowing
\textsuperscript{3}Health and Rehabilitation Science
\textsuperscript{4}Ralph Johnson VA Medical Center

We have no disclosures.
Introduction

- ~13,000 men and women will be diagnosed with laryngeal cancer in the US in 2012 (NCI, 2011)
  - ~60% will start in the glottis
- Voice and swallowing preservation is primary functional goal
- Laryngeal stroboscopy considered “gold standard” for observing vocal fold motion
Background—How Stroboscopy Works

- Synchronized, flashing light passed through a flexible or rigid endoscope
- Creates an apparent slow motion view of vocal fold vibration
- Derived from many successive cycles

Background-Why Use Stroboscopy?

- Commonly used in differential diagnosis of voice disorders
  - Improves accuracy of diagnosis
  - Structural versus functional causes
- Aids in targeted treatment
- Stroboscopy can alter diagnosis or treatment plan

(Faure & Muller, 1992; Remacle, 1996; Rosen, 2005; Sataloff, Spiegel, Hawkshaw, 1991; von Leden, 1961; Weir & Bassett, 1987)
Purpose

- Evaluate use of laryngeal stroboscopy as a treatment outcome measure of vocal fold function after laryngeal cancer treatments
  - Systematic review of literature
- Compare existing evidence to determine which therapeutic technique is related to the best outcome(s)
  - Meta-analysis of outcomes
Methods-Search Strategy

- 2 computerized journal databases
  - PubMed and Cochrane (through Feb 2011)

- Search terms (+ treatment)
  - Laryngostroboscopy
  - Stroboscopy
  - Strobovideolaryngoscopy
  - Strobolaryngoscopy
  - Videostroboscopy
  - Videolaryngostroboscopy
Methods-Inclusion Criteria

- One reviewer (KLF)
- English language
- Original article
- Human study
- Laryngeal cancer
- Stroboscopy findings reported both pre- and post-treatment
- Duplicated results deleted
Methods-Assessment of Evidence

- Stroboscopy parameters
  - Features of laryngeal structure or function
- Parameter scale
- Number of raters
- Rater reliability
- Methodological quality and strength of evidence
  - 2 raters (KLF and HSB)
Methods-Assessment of Evidence

- Oxford Centre for Evidence-based Medicine (CEBM, 2009)

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ia</td>
<td>Well-designed meta-analysis of &gt;1 randomized controlled trial</td>
</tr>
<tr>
<td>Ib</td>
<td>Well-designed randomized controlled study</td>
</tr>
<tr>
<td>IIa</td>
<td>Well-designed controlled study without randomization</td>
</tr>
<tr>
<td>IIb</td>
<td>Well-designed quasi-experimental study</td>
</tr>
<tr>
<td>III</td>
<td>Well-designed non-experimental studies, i.e., correlation studies</td>
</tr>
<tr>
<td>IV</td>
<td>Clinical (case) series, expert committee report, consensus conference, clinical experience of respected authorities</td>
</tr>
</tbody>
</table>
Methods-Data Synthesis

- Unable to perform meta-analysis
- Descriptive in nature
  - Heterogeneity of eligible articles
    - Stroboscopy parameters
    - Study design
    - Methodology
Results-Eligible Articles

- 520 articles reviewed
  - 509 excluded
  - 11 articles met inclusion criteria
    - 7 reported parameters prior to and after cancer treatment
    - 3 reported parameters prior to and after voice surgery post-cancer treatment
    - 1 reported parameters prior to and after behavioral voice treatment
PubMed and Cochrane Search Results
(520 citations)

Titles and Abstract Screened for Non-English Language
(137 citations excluded)

Titles and Abstract Screened for Non-Human
(10 citations excluded)

Titles Screened for Repeats
(6 citations excluded)

Titles and Abstract Screened for Reviews
(23 citations excluded)

Titles and Abstract Screened for Irrelevant Study Population
(287 citations excluded)

Full Text Screened for Stroboscopy Used as Outcome Measure
(46 citations excluded)

Eligible Articles (11 citations)
PubMed = 11
Cochrane = 0
Results-Demographics

- N = 480 (90% Male)
  - Range of n: 10 – 101 subjects
- 8 studies reported age
  - Mean age: 51.8 years
  - Age range: 15 – 78 years
- Race/ethnicity not reported
- Disparities do exist!!
- All studies reported tumor stage
  - Tis – T3
Results-Diagnosis and Treatment

- Treated for glottic or supraglottic cancer
  - 7 articles specifically reported squamous cell cancer
- Surgery
  - Partial laryngectomy (n = 1)
  - Corpectomy (longitudinal) (n = 2)
  - Outcomes in corpectomy + additional intervention (n = 3)
  - Surgery + adjuvant cryotherapy (n = 1)
  - Corpectomy + medialization laryngoplasty with bipedicled strap muscle transposition (n = 1)
  - Corpectomy + autologous fat augmentation (n = 1)
Results-Diagnosis and Treatment

- Chemotherapy and/or radiation
  - Radiotherapy (RT) (n = 3)
  - Concomitant chemotherapy and radiotherapy (CRT) or radiotherapy alone (n = 1)
  - Surgery + radiotherapy + modified arytenoid adduction (n = 1)
- Behavioral voice treatment (n = 2)
Results - Radiotherapy Treatment

- Tsunoda et al. (1997)
  - Prospective cohort of 10 patients
  - 6 months post-RT, all patients showed presence of mucosal wave on stroboscopy
Results - Radiotherapy Treatment

- Verdonck-de Leeuw et al. (1999)
  - Cross-sectional and longitudinal design
  - Glottic edema remained the same after RT
  - Supraglottic edema, vascular injection, and supraglottic involvement reduced from pre-RT measures
  - Vocal cord edge, mucosal wave, nonvibrating portion, and vocal cord closure all improved after RT
Results - Radio- or Chemoradiotherapy

- Iloabachie et al. (2007)
  - Retrospective review of 14 patients
  - 9/14 (64%) patients had return of vocal fold mobility
Results-Cordectomy Treatment

- Knott et al. (2006)
  - Retrospective review on 20 patients
  - Did repeated stroboscopy on each patient
  *However, no information regarding specific stroboscopy parameters was provided*
Results-Cordectomy Treatment

- Peretti et al. (2003)
  - Prospective cohort of 101 patients
  - 69 patients were followed 1-year post
  - 89% (16/18) patients who underwent type I and II cordectomies showed glottic closure
  - 75% (12/16) patients who underwent extended cordectomies had anterior commissure web
Results - Fat Injection Treatment

- Guven et al. (2006)
  - Prospective cohort of 10 patients
  - Improvement in glottic closure
  - No change in mucosal wave
* No further specifics provided*
Results-Cordectomy Treatment

- Keilmann et al. (2011)
  - Prospective cohort of 16 patients
  - Morphological changes, glottic closure & mucosal wave pattern (Ott score)
    - Slight improvement in mean value of Ott score but not statistically significant
  - 8/16 (50%) patients had cord-to-cord phonation
Results - Laryngoplasty Treatment

- Su et al. (2005)
  - Prospective cohort of 13 patients
  - Mucosal wave patterns
    - Improved wave pattern of the unaffected vocal fold
  - Mucosal wave amplitude
    - Remained small/absent
  - Glottal closure
    - Markedly enhanced in 12/13 (92%) patients
Results-Modified Arytenoid Adduction

- Shi et al. (2011)
  - Retrospective review of 42 patients
  - Significant post-operative improvement in glottal closure and vertical gap
  - Stable medialization of paralyzed vocal fold
Results-VPL Treatment

- Dursun and Ozgursoy (2005)
  - Prospective cohort of 15 patients
  - Neoglottic closure
    - 12/15 (80%) patients had complete closure by 3 months post-surgery
van Gogh et al. (2006)

Prospective cohort of 23 patients

After voice therapy, no significant changes seen on stroboscopic parameters reported

EXCEPT, vocal fold edge became more irregular ($Z = -2.67; P = 0.008$)

Left vocal fold edge changed only ($Z = -2.12; P = 0.034$)
### Results - Methodology and Levels of Evidence

<table>
<thead>
<tr>
<th>First Author</th>
<th>Publication Year</th>
<th>Methodology*</th>
<th>Level of Evidence*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dursun &amp; Ozgursoy (2005)</strong></td>
<td>2005</td>
<td>Prospective longitudinal case series</td>
<td>Level IV</td>
</tr>
<tr>
<td><strong>Guven et al. (2006)</strong></td>
<td>2006</td>
<td>Prospective longitudinal case series</td>
<td>Level IV</td>
</tr>
<tr>
<td><strong>Iloabachie et al. (2007)</strong></td>
<td>2007</td>
<td>Retrospective case series</td>
<td>Level IV</td>
</tr>
<tr>
<td><strong>Keilmann et al. (2011)</strong></td>
<td>2011</td>
<td>Prospective longitudinal case series</td>
<td>Level IV</td>
</tr>
<tr>
<td><strong>Knott et al. (2006)</strong></td>
<td>2006</td>
<td>Retrospective case series</td>
<td>Level IV</td>
</tr>
<tr>
<td><strong>Peretti et al. (2003)</strong></td>
<td>2003</td>
<td>Prospective longitudinal cohort</td>
<td>Level IIa</td>
</tr>
<tr>
<td><strong>Shi et al. (2011)</strong></td>
<td>2011</td>
<td>Retrospective case series</td>
<td>Level IV</td>
</tr>
<tr>
<td><strong>Su et al. (2005)</strong></td>
<td>2005</td>
<td>Prospective longitudinal case series</td>
<td>Level IV</td>
</tr>
<tr>
<td><strong>Tsunoda et al. (1997)</strong></td>
<td>1997</td>
<td>Prospective case series</td>
<td>Level IV</td>
</tr>
<tr>
<td><strong>van Gogh et al. (2005)</strong></td>
<td>2006</td>
<td>Randomized-controlled trial</td>
<td>Level Ib</td>
</tr>
<tr>
<td><strong>Verdonck-de Leeuw et al. (1999)</strong></td>
<td>1999</td>
<td>Prospective longitudinal cohort and cross-sectional</td>
<td>Level IIa</td>
</tr>
</tbody>
</table>
## Results - Parameters

- Neoglottal closure
- Status of neofold during inspiration and phonation
- Mucosal wave pattern
- Vocal cord mobility
- Morphological changes
- Glottal closure
- Level of phonation
- Anterior commissure web
- Vertical vocal fold difference
- Arytenoid movement
- Bowing
- Atrophy
- Mucosal wave amplitude
- Vocal fold edge
- Arytenoid symmetry
- Irregularity
- Periodicity
- Supraglottic edema
- Glottic edema
- Vascular injection
- Supraglottic involvement
- Nonvibrating portion
- Amplitude of vocal fold vibration
- Vocal fold movement
Results-Parameters

- Total of 24 parameters
  - 1 – 8 parameters reported per study
- Commonly reported parameters
  - Glottal closure (63.6%)
  - Mucosal wave (54.5%)
  - True vocal fold vibratory amplitude (27.2%)
Results - Parameters and Scales

- Parameter scales varied
  - Dichotomous items to 6-point rating scales
Results - Parameters and Scales

- Glottal closure (7 articles)
  - Dichotomous scale (n = 2)
  - 3-point rating scale (n = 1)
  - 5-point rating scale (n = 2)
  - Not reported (n = 2)

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No gap</td>
</tr>
<tr>
<td>1</td>
<td>Minimal gap</td>
</tr>
<tr>
<td>2</td>
<td>Small gap</td>
</tr>
<tr>
<td>3</td>
<td>Moderate gap</td>
</tr>
<tr>
<td>4</td>
<td>Complete glottal incompetence</td>
</tr>
</tbody>
</table>

(Su et al., 2005)
Results - Parameters and Scales

- Mucosal wave (6 articles)
  - Dichotomous scale (n = 2)
  - 5-point rating scale (n = 1)
  - 6-point rating scale (n = 1)
  - Not reported (n = 2)
Results-Parameters and Scales

- Amplitude of vibration (3 articles)
  - Dichotomous scale (n = 2)
  - 6-point rating scale (n = 1)
- Vocal fold edge (2 articles)
  - 6-point rating scale (n = 1)
  - Not reported (n = 1)
- Arytenoid movement (2 articles)
  - Not reported (n = 2)
## Results - Raters and Reliability

### Summary of Reported Reliability in Eligible Studies.

<table>
<thead>
<tr>
<th>Article (First Author)</th>
<th>Reported Reliability (yes/no)</th>
<th>Number of Raters</th>
<th>Results of Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dursun &amp; Ozgursoy (2005)</td>
<td>No</td>
<td>Not reported</td>
<td>N/A</td>
</tr>
<tr>
<td>Guven et al. (2006)</td>
<td>No</td>
<td>2</td>
<td>N/A</td>
</tr>
<tr>
<td>Iloabachie et al. (2007)</td>
<td>No</td>
<td>Not reported</td>
<td>N/A</td>
</tr>
<tr>
<td>Keilmann et al. (2011)</td>
<td>No</td>
<td>3</td>
<td>N/A</td>
</tr>
<tr>
<td>Knott et al. (2006)</td>
<td>No</td>
<td>3</td>
<td>N/A</td>
</tr>
<tr>
<td>Peretti et al. (2003)</td>
<td>No</td>
<td>Not reported</td>
<td>N/A</td>
</tr>
<tr>
<td>Shi et al. (2011)</td>
<td>No</td>
<td>3</td>
<td>N/A</td>
</tr>
<tr>
<td>Su et al. (2005)</td>
<td>No</td>
<td>2</td>
<td>N/A</td>
</tr>
<tr>
<td>Tsunoda et al. (1997)</td>
<td>No</td>
<td>Not reported</td>
<td>N/A</td>
</tr>
<tr>
<td>van Gogh et al. (2005)</td>
<td>Yes</td>
<td>2</td>
<td>Weighted k values range: 0.098 - 0.88</td>
</tr>
<tr>
<td>Verdonck-de Leeuw et al. (1999)</td>
<td>No</td>
<td>3</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Results - Efficacy of Stroboscopy

- 2 articles specifically discussed benefits of stroboscopy
- Tsunoda et al. (1997)
  - Useful follow-up clinical tool in patients post-radiotherapy for detection of recurrence
- Verdonck-de Leeuw et al. (1999)
  - Basic protocol for functional assessment of voice should include stroboscopic examination
Study Limitations

- 3 major limitations
  1) Used only published data available on 2 electronic databases
  2) Search terms may not have been comprehensive
  3) Results are descriptive in nature
Discussion Overview

- Same parameters are not reported across studies
- Rating scales are inconsistent across studies
- Number of raters and rater reliability are inconsistently reported across studies
Discussion: Parameters

- Same parameters are not reported across studies
  - A total of 24 parameters were reportedly used in 11 studies
  - Glottal closure and mucosal wave are the most frequently reported parameters (64% and 55%, respectively)
  - If we don’t report the same parameters from treatment studies, then we cannot compare treatment outcomes!
Discussion: Scales

- Rating scales are inconsistent across studies
  - Range from 2- to 6-levels in the 11 studies
  - If the same parameters are rated but different scales are used, we cannot compare treatment outcomes
- Don’t know how many levels of each feature of vocal fold vibration can be reliably rated by clinicians
  - Don’t have a basis for informing researchers or clinicians which rating scale should be used
Discussion: Rater Reliability

- Number of raters and rater reliability are inconsistently reported across studies
  - Important aspects of methodology in rating studies, such as number of raters and rater reliability, need to be reported
  - Rater reliability is known to be low in stroboscopy, despite several attempts to improve it (Poburka & Bless, 1998; Poburka, 1999; Rosen, 2005)
  - This makes it essential that inter- and intra-rater reliability is reported!
Clinical Implications

- Impedes ability to confidently interpret study findings
- Hinders communication within and between clinics
- Diminishes ability to identify changes following treatment
- Precludes meaningful comparisons of treatment studies evaluated for evidence-based practice

(Altman, 2011; Rosen, 2005)
Conclusions

- Stroboscopic findings are used as a voice outcome measure in patients treated for laryngeal cancer
- Differences in study method, interpretation, and report lead to equivocal findings about the effect of treatment on vocal fold function
- Need for empirical development of standardized, valid, and reliable method for interpretation and reporting of laryngeal stroboscopic findings
Support and Dissemination

- This project was supported by the South Carolina Clinical & Translational Research (SCTR) Institute, with an academic home at the Medical University of South Carolina, through NIH Grant Numbers KL2 RR029880 and KL2 TR000060
- PI: Heather S. Bonilha, Ph.D., CCC-SLP
- Accepted for publication in the *Journal of Medical Speech-Language Pathology*
References