How Does Cricotracheal Resection Affect the Female Voice?

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Cricotracheal Resection

- A very effective surgical procedure for laryngotracheal stenosis
- "Success rates" – 90+%:
  - Resolution of dyspnea
  - Decannulation from tracheostomy
  - Lack of stenosis relapse
  - Improvement in airway patency

Cricotracheal Resection

- Adult
  - 63% of 73 women with idiopathic SGS who underwent CTR reported either:
    - Reduced volume of the voice
    - Difficulty singing (Grillo et al, 2003)

- Pediatric
  - Mixed results (Monnier et al, 1998; Hartley et al, 2000)
  - Normal voice / mild to moderate dysphonia / aphonia
  - Normal intensity, pitch, maximum phonation time (Triglia et al, 2001)

CTR and the Voice

- 14 adult women who underwent CTR
  - Dx: Idiopathic subglottic stenosis
  - Ages 35-69
  - Standard voice recording made preoperatively and at least 3 months postoperatively
  - Acoustic measures of
    - Maximum phonation time (MPT)
    - Speaking F0
    - Sustained vowel F0 at comfortable pitch/loudness
    - Pitch range measured from pitch glide task
  - Descriptive statistical analysis
CTR and the Voice
Pre- and Post-op Examples

Patient 1
pre-CTR

CTR Procedure Variations

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Mucosal excision of posterior cricoid</th>
<th>Anterior cricoid pedicled hinge</th>
<th>Anterior cricoid ring excision</th>
<th>Inferior rim of posterior cricoid cartilage excision</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTR 1</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>CTR 2</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>CTR 3</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>CTR 4</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

CTR Procedure Groups

<table>
<thead>
<tr>
<th>Procedure Type</th>
<th>Number of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>CTR-1, CTR-2</td>
</tr>
<tr>
<td>Group B</td>
<td>CTR-3, CTR-4</td>
</tr>
</tbody>
</table>
Effects of CTR on Voice

Overall Results

Mean Sustained Vowel Phonation Frequency

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Pre-op</th>
<th>Post-op</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>184.1</td>
<td>215.8</td>
</tr>
</tbody>
</table>

p = .03

Mean Speaking Fundamental Frequency

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Pre-op</th>
<th>Post-op</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>185.9</td>
<td>165.0</td>
</tr>
</tbody>
</table>

p = .04

Preoperative Preoperative Postoperative Postoperative p-value

Maximum Phonation Time

<table>
<thead>
<tr>
<th></th>
<th>Preoperative</th>
<th>Postoperative</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.7 sec</td>
<td>8.7 sec</td>
<td></td>
<td>.6</td>
</tr>
</tbody>
</table>

Mean Semitone Range

<table>
<thead>
<tr>
<th></th>
<th>Preoperative</th>
<th>Postoperative</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.5 semitones</td>
<td>15.6 semitones</td>
<td></td>
<td>.05</td>
</tr>
</tbody>
</table>

CTR Effects on Voice

Surgical Group Results

Mean Speaking Fundamental Frequency by Surgical Group

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Group A</th>
<th>Post-op</th>
<th>Group B</th>
<th>Post-op</th>
</tr>
</thead>
<tbody>
<tr>
<td>176.2</td>
<td></td>
<td>175.4</td>
<td></td>
<td>190.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>199.5</td>
</tr>
</tbody>
</table>

p < .05
**CTR Effects on Voice**

**Surgical Group Results**

- **Mean Sustained Vowel Phonation Frequency by Surgical Group**

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-op</th>
<th>Post-op</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>207.2</td>
<td>211.8</td>
</tr>
<tr>
<td>B</td>
<td>200.6</td>
<td>168.7</td>
</tr>
</tbody>
</table>

*p < 0.05*

**CTR Effects on the Voice**

- Number of women with $F_0$ under 150 Hz
  - Preoperative – 0
  - Postoperative – 5 (36%)
- Pitch range effects
  - 50% of patients lost 10 or more semitones
  - Highest pitch less than 400 Hz
    - Preoperative – 2 (18%)
    - Postoperative 8 (73%)

**CTR Effects on Vocal Function**

- Disruption of cricothyroid muscles
- Alteration of cricothyroid joint function
- Shortening of trachea
- Laryngeal release maneuvers
- Alteration of subglottic contour
- Vocal fold paralysis

**CTR and the Voice Further Studies**

- Vocal intensity measures
- Laryngostroboscopy
  - Arytenoid hooding
- Aerodynamic measures
- Perceptual listener studies
- Patient based voice-related quality of life measures
- Modeling studies (e.g. computational, physical)
CTR and the Voice
Conclusions

- Significant impact on the voice in women
- Effect depends on extent of resection
- Speaking voice may lower into the male range
- Pitch range and highest attainable pitch may also reduce
- Discuss changes in speaking and singing voice in preoperative counseling
- At surgery, if possible, spare the anterior cricoid ring to minimize vocal impairment (CTR-1,2)