A Systematic Review of Literature on the Use of Fenestrated Tracheostomy Tubes

Sarah Boisen, BA; Shifali Mathews BS Student; Vinciya Pandian PhD, MSN, RN, ACNP–BC, FAAN
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Background

► Fenestrated tracheostomy tubes do not necessitate cuff deflation
► Aids in early restoration of speech for mechanically-ventilated patients
► Clinical practices vary—lack of scientific consensus
► Need exists to identify benefits and challenges associated with its use
Purpose

- To summarize evidence from multiple studies regarding use of fenestrated tracheostomy tubes in various settings

- To summarize benefits and challenges of use in mechanically ventilated patients
Study Methodology

- PubMed: 102 Citation(s)
- CINAHL: 20 Citation(s)
- Scopus: 146 Citation(s)
- Cochrane: 2 Citation(s)
- Web of Science: 76 Citation(s)

160 Non-Duplicate Citations Screened

Inclusion/Exclusion Criteria Applied

- 98 Articles Excluded After Title/Abstract Screen

62 Articles Retrieved

Inclusion/Exclusion Criteria Applied

- 41 Articles Excluded After Full Text Screen
- 5 Articles Excluded During Data Extraction

16 Articles Included
Results

- Patient-based research studies = 6
- Non-patient-based research studies = 4
  - Three bench-science research
  - One survey of clinicians
- Case studies = 6
- Mixed (Patient-based data + case study) = 1
## Findings: Research Studies (Patient Based)

<table>
<thead>
<tr>
<th>Author (Year)</th>
<th>Country</th>
<th>Setting</th>
<th>Research Design</th>
<th>Outcomes Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adam (2015)</td>
<td>United States</td>
<td>Hospital, inpatient</td>
<td>Prospective, Pre and Post Cohort Study</td>
<td>Heart rate, Respiratory rate, Oxygen saturation, duration and intensity of speech, functional verbal communication rating</td>
</tr>
<tr>
<td>Leder (2013)</td>
<td>United States</td>
<td>Long-Term ventilator facilities</td>
<td>Prospective, Case-series</td>
<td>Maximum phonation duration, speech intelligibility, and oxygen saturation</td>
</tr>
<tr>
<td>Kunduk (2010)</td>
<td>Turkey</td>
<td>ICU</td>
<td>Prospective, Case-series</td>
<td>Phonation, suctioning frequency, peak pressures, BP, &amp; oxygen saturation</td>
</tr>
<tr>
<td>Merritt (1997)</td>
<td>United States</td>
<td>Hospital, inpatient</td>
<td>Prospective Case-series</td>
<td>Fiberoptic laryngoscopy for airway alterations</td>
</tr>
<tr>
<td>Andersson (1993)</td>
<td>Sweden</td>
<td>Home</td>
<td>Prospective Cohort Study</td>
<td>Phonation</td>
</tr>
<tr>
<td>Snyder (1983)</td>
<td>United States</td>
<td>ICU</td>
<td>Cohort Study</td>
<td>Fiberoptic laryngoscopy for airway alterations</td>
</tr>
</tbody>
</table>
# Findings:
## Research Studies (Patient Based)

<table>
<thead>
<tr>
<th>First Author (Year)</th>
<th>Sample Size</th>
<th>Mean Age (years)</th>
<th>Sex</th>
<th>Reason for Tracheostomy</th>
<th>Diagnosis</th>
<th>Mean ventilation (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adam (2015)</td>
<td>30</td>
<td>62.8</td>
<td>Male: 16; Female: 14</td>
<td>Chronic Ventilator Dependence</td>
<td>15 Head and neck cancer; 9 Respiratory failure; 6 Other</td>
<td>101</td>
</tr>
<tr>
<td>Leder (2013)</td>
<td>23</td>
<td>56.2</td>
<td>Male: 14; Female: 9</td>
<td>Chronic Ventilator Dependence</td>
<td>Mixed Diagnosis</td>
<td>149.8</td>
</tr>
<tr>
<td>Kunduk (2010)</td>
<td>10</td>
<td>54.7</td>
<td>Male: 5; Female: 5</td>
<td>Chronic Ventilator Dependence</td>
<td>4 Muscle weakness; 4 COPD; 1 Pulmonary embolism; 1 Trauma</td>
<td>41.5</td>
</tr>
<tr>
<td>Merritt (1997)</td>
<td>10</td>
<td>4.68</td>
<td>Male: 8; Female: 2</td>
<td>Airway Protection</td>
<td>6 BPD; 2 Craniofacial abnormalities; 1 Laryngotracheomalacia; 1 Muscular dystrophy</td>
<td>-</td>
</tr>
<tr>
<td>Andersson (1993)</td>
<td>16</td>
<td>-</td>
<td>Male: 11; Female: 5</td>
<td>Chronic Ventilator Dependence</td>
<td>Spinal Cord Injury</td>
<td>-</td>
</tr>
<tr>
<td>Snyder (1983)</td>
<td>15</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Mixed Diagnosis</td>
<td>-</td>
</tr>
</tbody>
</table>
## Findings: Research Studies (Patient Based)

<table>
<thead>
<tr>
<th>Author (Year)</th>
<th>Type of Trach</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adam (2015)</td>
<td>Blom® with fenestrated speech inner cannula</td>
<td>None reported</td>
</tr>
<tr>
<td>Leder (2013)</td>
<td>Blom® with fenestrated speech inner cannula</td>
<td>Anxiety</td>
</tr>
<tr>
<td>Kunduk (2010)</td>
<td>Blom® with fenestrated speech inner cannula</td>
<td>Decrease in oxygen saturation, Increase in blood pressure, Anxiety, Chest tightness/discomfort, Increased peak pressures, Air leak between tracheostomy tube and inner cannula</td>
</tr>
<tr>
<td>Merritt (1997)</td>
<td>Pediatric Shiley™ Manually Fenestrated</td>
<td>None reported</td>
</tr>
<tr>
<td>Andersson (1993)</td>
<td>Customized metal / silicone; Customized to fit the tracheal diameter</td>
<td>Not measured</td>
</tr>
<tr>
<td>Snyder (1983)</td>
<td>Shiley™ Fenestrated / customized</td>
<td>10/15 partial or complete obstruction of the fenestration by anterior or posterior tracheal wall impairing phonation</td>
</tr>
</tbody>
</table>
## Findings: Research Studies (Laboratory/Simulation Based)

<table>
<thead>
<tr>
<th>Author (Year)</th>
<th>Country</th>
<th>Simulation</th>
<th>Type of Trach, Size, &amp; Cuff</th>
<th>Outcomes Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berlet (2016)</td>
<td>Switzerland</td>
<td>1 tracheostomy simulator (144 measurements)</td>
<td>Fenestrated Portex® Blue Line Ultra, TRACOE® twist, Rusch® Traceofix; Size 8, 8.5; Cuffed</td>
<td>Leakage characteristics to simulate risk for subcutaneous emphysema</td>
</tr>
<tr>
<td>Hussey (1996)</td>
<td>United States</td>
<td>1 Average and 1 large sized tracheal models 2 types of tracheostomy tubes</td>
<td>Shiley™ Fenestrated; Size 4, 6, 8, 10; Cuffed</td>
<td>Inspiratory pressures to generate inspiratory flow to simulate work of breathing</td>
</tr>
<tr>
<td>Beard (1993)</td>
<td>United States</td>
<td>4 types of tracheostomy tubes</td>
<td></td>
<td>Airway resistance to simulate work of breathing</td>
</tr>
</tbody>
</table>
Findings:
Research Studies (Survey)

► Powell (2011)
• Online and telephone surveys of practices regarding use of fenestrated tubes
• 69 clinicians from 69 centers participated
Findings: Case Studies

Benefits
- Facilitation of phonation
- Improvement in pulmonary mechanics

Disadvantages
- Shortness of breath
- Anxiety
- Insomnia

Technical Challenges
- Malposition
- Fenestrated tube fracture
Advantages of Fenestrated Tracheostomy Tubes

- Phonation
- Bridge to decannulation
- Weaning from the ventilator
### Disadvantages of Fenestrated Tubes

<table>
<thead>
<tr>
<th>Subjective</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>► Shortness of breath</td>
<td>► Oxygen desaturation</td>
</tr>
<tr>
<td>► Anxiety</td>
<td>► Increase in BP and peak pressures</td>
</tr>
<tr>
<td>► Chest tightness</td>
<td>► Air leakage</td>
</tr>
<tr>
<td>► Insomnia</td>
<td>► Granulation tissue</td>
</tr>
<tr>
<td></td>
<td>► Subcutaneous emphysema</td>
</tr>
</tbody>
</table>
Challenges with Fenestrated Tracheostomy Tubes

► Factory manufactured fenestrated tube
  • Can be malfitting because of precut fenestrations
    – Partial or complete obstruction
    – Impaired phonation and ventilation
    – Increased risk of granulation tissue formation

► Forcing clinicians to customize it themselves
  • Using a scalpel to make a hole in the tracheostomy tube
  • Attempting cost efficiency
Considerations for Fenestrated Tracheostomy Tube Use

► Phonation and bridge to decannulation
► Timing of placement
  • Not recommended as 1st tube of choice following tracheostomy
► Trained professional involvement
  • In patient education and preparation—anxiety and excitement
► Customization of tubes
  • Highlights importance of ensuring proper tube fit
  • No FDA guidelines available
► Alternate options
  • Talking tracheostomy tubes
Summary

► Scientific evidence is limited

► Valuable lessons learned
  • Clinical use
  • Future research

► Additional research necessary
  • To study benefits and disadvantages of fenestrated tracheostomy tubes
  • To explore newer models of tubes available to facilitate phonation/decannulation