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

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Objectives:

The objectives of this study are to - 1) explore the use and function of a fenestrated tracheostomy tube along with the advantages and disadvantages associated with its application in establishing phonation, 2) evaluate the different types of fenestrated tracheostomy tubes currently available in the market, their indications, contraindications, short-term complications, and long-term complications, and 3) compare fenestrated to non-fenestrated tracheostomy tubes to determine the effectiveness of their application.

Methods:

A systematic review of literature was conducted by retrieving 160 articles from Grey literature, 5 major databases (PubMed, CINAHL, Scopus, Cochrane, and Web of Science) and the bibliographies of included studies using keywords such as tracheostomy, fenestrated, speech, decannulation, and quality of life. The full texts were reviewed and a Population, Intervention, Comparison, Outcomes (PICO) analysis was conducted for sixteen articles that met inclusion criteria based on abstract and title review. Inclusion criteria were journals only, English language and presence of keywords, and exclusion criteria were poster abstracts, dissertations, conference proceedings, literature reviews, editorials or author replies, and studies involving transcutaneous fenestration or Blom-Singer tracheostoma valves. Quality appraisal and risk for bias were assessed with the Cochrane Handbook criteria which is based on a level system and in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) checklist. Two independent researchers abstracted data regarding study variables with a standardized extraction table, after which a third researcher cross-checked this information for accuracy. A total of 15 articles that were identified for final synthesis. Of them, there were 7 studies that presented case reports of 13 patients, 6 studies that were patient-based studies (104 patients); 3 bench studies conducted using various trachea models and simulations, and one that comprised of a national survey of clinicians. Data from case studies and non-case studies were synthesized separately.

Results:

The patients that had fenestrated tracheostomy tubes were either in the process of weaning from mechanical ventilation or from tracheostomy, or they had previously experienced difficulties in establishing audible phonation, voice intelligibility, and swallowing. In both patient based and non-patient based studies, the types of tubes that were analyzed were Shiley™ fenestrated tracheostomy tube (n = 4), Blom® tracheostomy tube with fenestrated speech inner cannula (n = 3), Portex® Blue Line Ultra® fenestrated tracheostomy tube (n = 1), Tracoe® Twist tracheostomy tube (n = 1), and Rusch® Tracheofix® tracheostomy tube (n=1).

Studies reviewed were conducted within wards, laboratory/simulation, outpatient, ICU and nursing home/rehab settings. Eleven studies reported a combination of both short (60%) and long-term (67%) complications associated with the use of fenestrated tracheostomy tubes. The most common short-term complications were anxiety/shortness of breath (20%), subcutaneous emphysema (14%), tracheomalacia (14%), bleeding, tube displacement and pneumothorax while the long-term complications generally included tube displacement/oclusion (27%), granulation tissue formation (20%), infection (20%) and stenosis (0.7%).
Although there are complications with fenestrated tracheostomy tubes, clinicians report that there is a need for them in order to improve phonation (47%), to decrease the work of breathing (27%), and to improve the overall quality of life. Fenestrated tubes were also used as a bridge for decannulation. Customizing the site of fenestration, using the right size tubes, using non-fenestrated inner cannulas when suctioning, or using fenestrated tracheostomy tubes only for short term are measures that can be taken to prevent these complications. The usage of the correct size for the fenestrated tubes also prevents transfenestration gas leakage.

Conclusion:

Fenestrated tracheostomy tubes have potential short-term and long-term complications, but these tubes may be beneficial in certain circumstances if other measures to facilitate phonation fail with other types of tracheostomy tubes. The establishment of selection criteria and safety measures is crucial to prevent these short-term and long-term complications. Additional prospective research is necessary to validate the advantages of fenestrated tracheostomy tubes and to outline a protocol that will educate clinicians on their safe use in decannulation and establishing phonation.

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

Keywords:
Fenestrated, Speech and Tracheostomy

References:


A systematic review of literature was conducted to explore the application of fenestrated tracheostomy tubes. While there is risk for complications, fenestrated tracheostomy tubes can potentially be beneficial in certain circumstances, especially for weaning patients from mechanical ventilation and in patients who have previous complications with other tracheostomy tubes.

Content Outline:

I. Introduction
   A. Tracheostomy helps relieve upper airway obstructions, reduces the work of breathing with mechanical ventilation, reduces aspiration in an unprotected airway, and assists in removing airways secretions which is why it is being performed more frequently in critically-ill patient populations.
   B. Fenestrated tracheostomy tubes are regarded favorably for patients who are weaning from mechanical ventilation and patients who have experienced difficulties establishing audible phonation, voice intelligibility and swallowing.
   C. The safe use of fenestrated tracheostomy tubes has been debated despite potential benefits.

II. The Review
   A. Aim
      a. The aims of this systematic review was to describe the following for fenestrated tracheostomy tubes:
i. Describe the form and function of a fenestrated tube
ii. How it permits phonation
iii. Differentiate between non-fenestrated and fenestrated tracheostomy tubes
iv. List the types of fenestrated tracheostomy tubes available in the market
v. Indications and contraindications
vi. Benefits
vii. Short-term and long-term implications

B. Design
a. A systematic review of literature regarding fenestrated tracheostomy tubes was conducted.
b. It was guided by the Cochrane Handbook for Systematic Reviews [10] and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) statement.

C. Search Methods
a. Eligibility Criteria
i. The following were criteria for the studies to be eligible for inclusion:
   1. Mention of fenestrated tracheostomy tube
   2. Patients of any age group
   3. Conducted in a clinical or laboratory setting
   4. Published in English language
ii. Exclusion criteria included:
   1. Poster abstracts
   2. Dissertations
   3. Conference proceedings
   4. Review of literatures
   5. Editorial/author replies
   6. If the study focused on fenestrated tracheostoma valve or transcutaneous fenestration
b. Search Strategy
   i. Several electronic databases and Grey literature were searched systematically without limitations to particular years.
   ii. The Population, Intervention, Comparison, Outcomes (PICO) Framework was used to select and combine the search terms.
   iii. The keywords used for the literature search were fenestrated, speech, talking, Blom-Singer®, voice, and communication. Keywords were searched using Boolean operators “AND” and “OR” as well as Medical Subject Headings (MESH).
c. Search Outcomes
   i. A total of 16 studies met the eligibility criteria for in-depth analysis after title, abstract, and full-text review according to our inclusion and exclusion criteria.

D. Quality Appraisal
a. The risk for bias and quality of evidence for each study were assessed using the criteria for judging risk of bias as described in Cochrane Handbook, and the criteria included participant selection criteria, study replication, sampling, detection bias, attrition bias, avoidance of bias, and selective reporting.

E. Data Abstraction
a. Data were abstracted by two independent researchers using a standardized extraction table with variables. The table was cross-checked by a third researcher.

F. Synthesis
a. There were 6 articles that were case-studies, data for those articles was synthesized separately.

III. Results
A. Case Studies
a. Benefits included the facilitation of phonation, improvement in pulmonary mechanics such as an increase in chest expansion and a decrease in atelectasis.

b. Challenges with fenestrated tracheostomy tubes were shortness of breath, anxiety, insomnia, malpositioning of the fenestration against the tracheal wall, granulation tissue formation at the site of fenestration which causes other complications.

c. Issues with patient tolerance and safety called for customization of the fenestration for a better fitting tube.

B. Patient Based Research Studies
   a. All adult studies indicated that their patients received a tracheostomy for chronic ventilator dependence while the pediatric study suggested that their patients received a tracheostomy for airway protection.
   b. Other variables of the studies were country, settings, sample size, sex, age, and duration.

C. Non-Patient Based Research Studies
   a. There were three bench studies that all utilized different methodologies.

D. Types of Fenestrated Tracheostomy Tubes
   a. The tracheostomy tube types included:
      i. Shiley™ fenestrated tracheostomy tube
      ii. Blom® tracheostomy tube with fenestrated speech inner cannula
         Portex® Blue Line Ultra® fenestrated tracheostomy tube
      iii. Tracoe® Twist tracheostomy tube
      iv. Rusch® Tracheofix® tracheostomy tube
   b. The sizes of tracheostomy tubes used in the bench studies ranged from 4 – 10.

E. Clinical Outcomes
   a. Four reported short-term complications while the remaining studies either did not measure or notice any complications among the studies that measured outcomes in patients.

F. Customization of Tracheostomy Tubes
   a. Customizing the location of the fenestration on the tracheostomy tube is important in order to ensure safety and functionality according to three patient-based studies.

G. Bridge to Decannulation
   a. There were two bench science studies that reported the benefits of using a fenestrated tracheostomy tube in ventilated patients, especially when attempting to use the fenestrated tube as a bridge to decannulation.

H. Fenestration and Subcutaneous Emphysema
   a. Tube fenestration is thought to cause subcutaneous emphysema in patients due to air leak.

IV. Discussion
   A. Patient and fenestrated tracheostomy tube selections and on occasion, customized fenestrations, are key to the successful use of fenestrated tracheostomy tubes.
   B. Our review adds to literature by highlighting the benefits and risk factors of using fenestrated tracheostomy tubes to help clinicians identify right patient and tracheostomy tube type and size to facilitate phonation and decannulation safely.

V. Conclusion
   A. Future research with larger sample sizes is mandatory in order to educate clinicians on the safe use of fenestrated and non-fenestrated tracheostomy tubes to aid with phonation and decannulation.

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2012 – 2016, Nursing Director, Percutaneous Tracheostomy Service, The Johns Hopkins Hospital, Baltimore, MD
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2004 – 2007, Pulmonary Nurse Practitioner/Program Coordinator, Pulmonary Progressive Care Unit, Johns Hopkins Bayview Medical Center, Baltimore, MD

**Author Summary:** I have been a nurse for the last 21 years and a critical care nurse caring for mechanically ventilated patients with a tracheostomy since 2000. I have published 34 articles focusing on airway management of patients with artificial airways. My productivity is further reflected by the fact that I have published over 55 abstracts and presentations given at major national and international conferences.

Any relevant financial relationships? Yes

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