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Original Article

Bleeding Complications Associated With Percutaneous Tracheostomy Insertion in Patients Supported With Venovenous Extracorporeal Membrane Oxygen Support: A 10-Year Institutional Experience

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Objectives: To evaluate the bleeding complications associated with percutaneous tracheostomy while a patient is receiving venovenous extracorporeal membrane oxygen (VV ECMO) support.
Design: Retrospective, observational analysis.
Setting: Single-center, tertiary, academic institution.
Participants: All consecutive patients on VV ECMO over a 10 year-period undergoing percutaneous tracheostomy.
Interventions: Percutaneous tracheostomy.
Measurements and Main Results: Fifty percutaneous tracheostomies were performed in patients requiring VV ECMO support over the 10-year period. The authors observed a 40% incidence of bleeding, with 32% of these incidences characterized as minor (self-limiting, localized stomal ooze) and 8% characterized as significant (necessitating surgical control and frequent packing or accompanied by a decrease in hemoglobin $> 20\%$).
Conclusions: Bleeding is associated with percutaneous tracheostomy and is self-limiting in the majority of patients.

Key Words: percutaneous tracheostomy; venovenous extracorporeal membrane oxygenation; bleeding; complications

TRACHEOSTOMY IN patients with prolonged duration of ventilation has recognized benefits and a percutaneous approach is used for most patients.[1–6] Patients requiring extracorporeal membrane oxygenation (ECMO) support may require tracheal intubation for prolonged periods and early tracheostomy is proposed as being beneficial in these patients.[2]

Bleeding is one of the most common complications seen in patients supported with ECMO and is most associated with mortality in this patient group.[7] The degree of bleeding often is disproportionate to the procedural intervention.[8]

The authors reviewed all bleeding complications that occurred over a 10-year period in patients supported with ECMO in the context of respiratory disease and who underwent percutaneous tracheostomy. The authors aimed to identify factors that potentially can increase the incidence of bleeding.

Methods

A retrospective, observational study was conducted in a single tertiary academic center and spanned over 10 years

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(January 2007 to December 2016). This study was approved by the institution's research and development department.

Patients requiring ECMO support over the period January 2007 to December 2016 were identified using the institution's ECMO database, which keeps a record of all patients admitted to the intensive care unit requiring ECMO support. Medical records of all consecutive patients who underwent percutaneous tracheostomy while receiving venovenous (VV) ECMO were then analyzed. A total of 770 patients were treated with VV ECMO during the study period.

The decision to perform the tracheostomy was at the discretion of the clinician after MDT consultation (involving at least 2 experienced consultants). All procedures were performed by qualified specialists and in the majority of cases were used to facilitate cessation of sedation with subsequent patient mobilization.

The standard technique was a single stage dilation using the Portex single stage dilator kit (Smiths Medical, Minneapolis, MN) aided by video bronchoscopy. It is the authors' institution's practice to avoid skin incision when possible and only perform serial dilations.

All patients were managed according to the institutional ECMO guidelines, as follows: hemoglobin was maintained above 80 g/dL and platelets above 100×10^9/L in the context of active bleeding. All ECMO circuits were heparin coated, and most patients were receiving continuous heparin infusion.

The decisions whether to stop the infusion, the duration of heparin cessation, and the administration of platelets were at the discretion of the clinician performing the procedure.

Baseline demographic data collected included the following: age, sex, indication for VV ECMO, and duration of VV ECMO before percutaneous tracheostomy. The following variables were collected: hemoglobin preprocedure and postprocedure, platelet count preprocedure and occurrence of platelet transfusion, activated partial thromboplastin time (aPTT) ratio (APR), duration of heparin cessation (< 4 h or ≥ 4 h before percutaneous tracheostomy), and timing of heparin recommencement (< 4 h or ≥ 4 h after percutaneous tracheostomy). Data on patients who were not exposed to heparin before percutaneous tracheostomy were recorded as heparin cessation ≥ 4 hours.

Outcome Variables

The main outcome variable was the incidence of bleeding secondary to percutaneous tracheostomy 1 month postprocedure. Bleeding was classified as minor or significant. Minor bleeding included localized stomal ooze and self-limiting intratracheal bleeding on suction.

Significant bleeding was defined as necessitating surgical control; frequent packing (requiring 1-2 hourly dressing changes); prolonged hypotension, defined as hypotension that is not self-limiting and necessitates commencement of vasopressors and/or fluid resuscitation that is documented in relationship to bleeding from the percutaneous tracheostomy site; and a decrease in plasma hemoglobin $> 20\%$.

A relationship between variables that may affect the incidence of either minor or significant bleeding was sought. The selected variables included hemoglobin level and platelet count before and after percutaneous tracheostomy, duration of heparin cessation before percutaneous tracheostomy, timing of heparin recommencement, and duration of ECMO run before percutaneous tracheostomy.

Statistical Analysis

Analyses were performed using GraphPad Prism 6 for Mac OS X (GraphPad Software Inc., La Jolla, CA). Descriptive statistics are reported as mean and standard deviation for continuous parametric data, median with interquartile ranges (IQR) for continuous nonparametric data, and proportions for categorical data. Quantitative variables were compared using an unpaired t test for parametric data or an unpaired Mann-Whitney test for nonparametric data. Categorical variables were compared using a Fisher exact test. A 2-tailed $p < 0.05$ was considered to be statistically significant.

Results

Demographic Data

A total of 770 patients received VV ECMO support during the study period. Fifty patients were identified as having undergone percutaneous tracheostomy while receiving VV ECMO support. The indications for VV ECMO are shown in Table 1.

Incidence of Bleeding

The mortality from percutaneous tracheostomy was 0%. The overall documented bleeding incidence was 40% (n = 20). Sixteen (32%) patients experienced minor bleeding, and 4 (8%) patients experienced significant bleeding. In the significant bleeding group, 1 patient required surgical control; 2 patients required frequent packing, and 1 patient experienced a decrease in hemoglobin $> 20\%$ in the first 48 hours after the

Table 1
Indication for VV ECMO

Variable	n = 50
Sex (% female)	46
Indication	
ARDS (%)	39 (78%)
PTE (%)	4 (8%)
Postoperative lung transplantation (%)	2 (4%)
Alveolar proteinosis (%)	1 (2%)
Bronchopleural fistula (%)	1 (2%)
Bronchiolitis (%)	1 (2%)
Exacerbation cystic fibrosis (%)	1 (2%)
Other (%)	1 (6%)

Abbreviations: ARDS, acute respiratory distress syndrome; ECMO, extracorporeal membrane oxygen; PTE, pulmonary thromboendarterectomy; VV, venvenous.