Percutaneous Dilational Tracheotomy in Solid-Organ Transplant Recipients

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Abstract

Objectives: Solid-organ transplant recipients may require percutaneous dilational tracheotomy because of prolonged mechanical ventilation or airway issues, but data regarding its safety and effectiveness in solid-organ transplant recipients are scarce. Here, we evaluated the safety, effectiveness, and benefits in terms of lung mechanics, complications, and patient comfort of percutaneous dilational tracheotomy in solid-organ transplant recipients.

Materials and Methods: Medical records from 31 solid-organ transplant recipients (median age of 41.0 years [interquartile range, 18.0-53.0 y]) who underwent percutaneous dilational tracheotomy at our hospital between January 2010 and March 2015 were analyzed, including primary diagnosis, comorbidities, duration of orotracheal intubation and mechanical ventilation, length of intensive care unit and hospital stays, the time interval between transplant to percutaneous dilational tracheotomy, Acute Physiology and Chronic Health Evaluation II score, tracheotomy-related complications, and pulmonary compliance and ratio of partial pressure of arterial oxygen to fraction of inspired oxygen.

Results: The median Acute Physiology and Chronic Health Evaluation II score on admission was 24.0 (interquartile range, 18.0-29.0). The median interval from transplant to percutaneous dilational tracheotomy was 105.5 days (interquartile range, 13.0-2165.0 d). The only major complication noted was left-sided pneumothorax in 1 patient. There were no significant differences in ratio of partial pressure of arterial oxygen to fraction of inspired oxygen before and after procedure (170.0 [interquartile range, 102.2-302.0] vs 210.0 [interquartile range, 178.5-345.5]; \( P = .052 \)). However, pulmonary compliance results preprocedure and postprocedure were significantly different (0.020 L/cm H\(_2\)O [interquartile range, 0.015-0.030 L/cm H\(_2\)O] vs 0.030 L/cm H\(_2\)O [interquartile range, 0.020-0.041 L/cm H\(_2\)O]; \( P = .001 \)). Need for sedation significantly decreased after tracheotomy (from 17 patients [54.8%] to 8 patients [25.8%]; \( P = .004 \)).

Conclusions: Percutaneous dilational tracheotomy with bronchoscopic guidance is an efficacious and safe technique for maintaining airways in solid-organ transplant recipients who require prolonged mechanical ventilation, resulting in possible improvements in ventilatory mechanics and patient comfort.

Key words: Heart, Liver, Kidney transplant, Pulmonary compliance, Complications
recipients after transplant. Respiratory complications account for significant morbidity and mortality in these groups of patients. Patients presenting with acute respiratory failure necessitating prolonged mechanical ventilation may require tracheotomy. There are potential advantages with tracheotomy compared with prolonged orotracheal intubation, and guidelines recommend bedside percutaneous dilational tracheotomy (PDT) as the standard method for tracheotomy in ICU patients. Although PDT has replaced surgical tracheotomy in many ICUs, the literature lacks data on its use in SOT recipients. The aim of this study was to evaluate the safety, benefits, and effectiveness of PDTs in SOT recipients in terms of changes in oxygenation, pulmonary compliance, and improvement in patient comfort.

**Materials and Methods**

We retrospectively collected data from the medical records of 31 SOT recipients who underwent PDT postoperatively from January 2010 to January 2015 at Baskent University Hospital. In all cases, the indication for PDT was prolonged mechanical ventilation. The decision to perform a tracheotomy on patients in ICU was made when a patient was expected to be ventilator dependent for more than 1 week.

The data reviewed included demographic features, primary diagnosis, comorbidities, presence of previous pulmonary infections, duration of orotracheal intubation and mechanical ventilation, length of ICU and hospital stays, the time interval between transplant to PDT, Acute Physiology and Chronic Health Evaluation II score and Sequential Organ Failure Assessment scores on the first 3 days of ICU admission, PDT-related complications, pulmonary compliance values and ratio of partial pressure of arterial oxygen to fraction of inspired oxygen (PaO$_2$/FiO$_2$) before and after PDT, patient mobilization, need for sedation, nutritional status before and after PDT, and mortality.

Statistical analyses were performed with SPSS software (SPSS: An IBM Company, version 17.0, IBM Corporation, Armonk, NY, USA). Results before and after PDT were compared using Wilcoxon signed rank test and McNemar test where appropriate. All values are expressed as median and interquartile range. The level of significance was set at $P < .05$.

**Results**

Our study included 31 patients who had undergone SOT (16 liver transplant recipients, 11 kidney transplant recipients, and 4 heart transplant recipients) and who had required PDT during the study period. The indication for PDT was prolonged mechanical ventilation for all patients. All PDTs were performed by experienced intensivists and under bronchoscopic guidance using PercuTwist (Rusch-Teleflex Medical, Kernen, Germany) or Griggs techniques (Portex, Kent, UK). Demographic characteristics of patients are shown in Table 1, primary indications for transplant are shown in Table 2, and comorbidities are shown in Table 3.
Median Acute Physiology and Chronic Health Evaluation II score on admission to ICU was 24.0. Patients had a median duration of orotracheal intubation of 6.0 days before PDT. Sequential Organ Failure Assessment scores and length of ICU and hospital stays are shown in Table 4.

The only major complication noted was left-sided pneumothorax in 1 patient. Fifteen patients had minor, self-limited bleeding from the tracheotomy site, and bleeding continued for 2 patients on the second day after PDT (Table 5). There were no late complications (including peristomal infection) or deaths related to PDTs in these patients.

In our patient cohort, 23 patients (74.2%) died. Thirty-day mortality after PDT was 48.4% (n = 15 patients). The numbers of days from transplant to mortality and PDT to mortality are shown in Table 6.

There were no significant differences between PaO₂/FiO₂ results before and after PDT (170.0 [range, 102.2-302.0] and 210.0 [range, 178.5-345.5]; P = .052). However, pulmonary compliance results before and after PDT were significantly different (0.020 L/cm H₂O [range, 0.015-0.030 L/cm H₂O] and 0.030 L/cm H₂O [range, 0.020-0.041 L/cm H₂O]; P = .001). The number of patients who required sedation significantly decreased after PDT (from 17 patients [54.8%] to 8 patients [25.8%]; P = .004).

### Discussion

In our series of SOT recipients, a total of 31 patients required PDT during the study period. We analyzed our data to show the safety and potential benefits of PDT in SOT recipients by means of pulmonary compliance, PaO₂/FiO₂ ratio, nutritional status, need for sedation, and patient mobilization. After PDT, pulmonary compliance and need for sedation improved in SOT recipients after PDT. The only major complication noted was left-sided pneumothorax in 1 patient. There were no late complications or deaths associated with PDTs.

Tracheotomy has gained popularity in critically ill patients because it may facilitate weaning from mechanical ventilation and improve overall patient comfort. Percutaneous dilational tracheotomy is a safe and rapid procedure that is performed under bronchoscopic guidance at the bedside in the ICU.

Pulmonary complications are important causes of postoperative morbidity and mortality in SOT recipients, frequently requiring endotracheal intubation and subsequently tracheotomy. There are few data regarding the use of PDT in SOT recipients. Performing PDT in this group of patients is unique and challenging for 2 important reasons. First, these patients are invariably receiving immunosuppressive therapies that increase the tendency for developing infection-related complications. Second, they have an increased risk of bleeding due to their underlying disease, particularly in liver transplant recipients.

In ICU patients, it has been shown that PDT improves lung mechanics in terms of pulmonary compliance. In a previous study, our group demonstrated that, in adult burn patients, PDT...
improved both PaO2/FiO2 and pulmonary compliance.14 Similarly, in retrospective evaluation of a smaller group of SOT patients who required PDT, we showed that pulmonary compliance and PaO2/FiO2 were improved after PDT in these patients as well.10 In the present study, pulmonary compliance improved and the improvement in PaO2/FiO2 after PDT was close to statistically significant. Our present study also demonstrated a decreased need for sedation after PDT in SOT patients.

Short-term and long-term complications of PDT are minimized when the procedure is performed by a skilled operator and bronchoscopic guidance is used. In a review, Simon and associates reported that the incidence of lethal complications is only 1.7 per 1000 procedures.15 The main causes of death were hemorrhage (38.0%), airway complications (29.6%), tracheal perforation (15.5%), and pneumothorax (5.6%). In our study, a PDT-related pneumothorax was noted in 1 liver transplant recipient (3.2%). There were no PDT-related deaths or late complications in our patients. In other studies, minor complications included transient hypoxemia and mild bleeding, and major complications included bleeding, bradycardia, hypotension, tracheal ring fracture, cannula malfunction, and death.10,11

Other potential advantages reported with tracheostomy versus prolonged orotracheal intubation are improved mobilization and phonation, better oral hygiene, reduced respiratory work, more efficient cough, ease of suctioning, and initiation of oral intake.7,16 Our study did not demonstrate any significant improvements regarding these potential advantages of PDT in our patients.

Our study has some limitations. First, we used a retrospective design. Second, we did not investigate the potential advantages of PDT according to its timing (early versus late PDT). The effects of PDT on lung mechanics and benefits in terms of patient comfort, outcomes, and mortality may be better demonstrated by further analyses according to timing of PDT.

Conclusions

Solid-organ transplant recipients may require prolonged mechanical ventilation and tracheostomy. Percutaneous dilational tracheotomy with direct bronchoscopic guidance can be safely performed in SOT recipients with careful patient selection. This technique also may improve ventilatory mechanics and patient comfort in SOT recipients. Further investigations are required to identify potential benefits of PDT on patient outcomes with larger patient populations with further analyses according to timing of PDT.

References