Tracheostomy After Cardiac Surgery With Median Sternotomy and Risk of Deep Sternal Wound Infections: Is It a Matter of Timing?

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Objective: **To assess the impact of timing of percutaneous dilatational tracheotomy (PDT) on incidence of deep sternal wound infections (DSWI) after cardiac surgery with median sternotomy.**

Design: **Retrospective study between 2003 and 2013.**

Setting: **Single-center university hospital.**

Participants: **Eight hundred seventy-nine patients after cardiac surgery with extracorporeal circulation and median sternotomy.**

Interventions: **PDT using the Ciaglia-technique with direct bronchoscopic guidance.**

Measurement and Main Results: **Mean time from surgery and (re)intubation to PDT was 6.7 ± 9.9 and 3.8 ± 3.3 days, respectively. Incidence of DSWI was 3.9% (34/879). The incidence of DSWI was comparable between patients with PDT performed before postoperative day (POD) 10 and those with PDT after POD 10 (29/755 [3.8%] *v* 5/124 [4.0%], p = n.s.). However, the authors observed an association of timing of PDT and DSWI: The incidence of DSWI was significantly higher in patients with PDT performed ≤ POD 1 compared to those with PDT after POD 2 (12/184 [6.52%] *v* 22/695 [3.16%], p = 0.046). In multivariate analysis, obesity, use of bilateral internal mammary arteries, ICU stay >30 days and PDT <48 hours after surgery (OR 3.519, 95% CI 1.242-9.976, p = 0.0018) were independent predictors of DSWI. In 15/34 patients (44.1%), similarity of microorganisms between sternotomy site and tracheal cultures was observed, indicating a possible cross-contamination.**

Conclusions: **PDT within the first 10 postoperative days after cardiac surgery with median sternotomy can be performed safely without an increased risk of DSWI. In contrast, very early PDT within 48 hours after surgery is associated with an increased risk of mediastinitis and should, therefore, be avoided.**

KEY WORDS: *percutaneous dilatational tracheotomy, mediastinitis, cardiac surgery, deep sternal wound infection*

TRACHEOSTOMY regularly is considered as airway access in patients after cardiac surgery requiring prolonged mechanical ventilation to facilitate adequate airway management and ventilatory weaning. Several advantages for tracheostomy over endotracheal intubation have been proposed, including reduced risk of laryngeal injury, less sedation, improved patient comfort, communication, and better oral hygiene and potentially decreased patients' time in the intensive care unit and improved mobilization.[1] Although some authors suggested that early tracheostomy decreases mortality rates and reduces the cost and length of hospitalization, there is no clear evidence for early versus delayed PDT.[2–4] On the other hand, it generally is presumed that tracheostomy might be associated with an increased risk for mediastinitis with prolonged hospital stay as well as increased hospital and long-term mortality. This may apply in particular for patients undergoing cardiac surgery after median sternotomy, with a possible cross-contamination of the tracheostomy and sternotomy wounds. Previous studies investigating the association between early tracheostomy and deep sternal wound infection after median sternotomy showed divergent results: Whereas Ngaage et al reported post-sternotomy PDT to be associated with an approximately 3-fold risk for deep sternal wound infections, others could not demonstrate any relationship between tracheostomy and mediastinitis.[5,6] However, most studies included patients with percutaneous and open surgical tracheostomy and had a small sample size, and the definition of "early" varied significantly (from insertion within 48 hours to up to 10 days). Consequently, the relationship between percutaneous tracheostomy and sternal wound infections in patients who have had cardiac surgery through a median sternotomy is not clear. Therefore, it was the aim of the present study to assess the incidence of DSWI in patients undergoing PDT after sternotomy as a function of timing.

MATERIALS AND METHODS

Between January 1, 2003, and February 2013, data were collected on all consecutive patients undergoing PDT in the cardiothoracic ICU, Department of Thoracic and Cardiovascular Surgery, West German Heart Centre Essen. A retrospective analysis then was performed. The study was approved by the Institutional Review Board. All of the patients previously had granted permission for use of their medical records for research purposes. Within the observation period, all patients with expected prolonged mechanical ventilation were evaluated primarily for PDT. Surgical tracheotomy only was performed in case of contraindication for PDT (nonpalpable anatomic landmarks due to an extremely short neck, goiter, or tumor). Patients not undergoing cardiac surgery with median sternotomy and use of extracorporeal circulation were excluded. Likewise, all patients suffering from mediastinitis before PDT were excluded. For the purpose of analysis, patients were divided into 2 groups: patients who developed deep sternal wound infection after PDT (group 1) and patients who healed normally without evidence of infection (group 2).

Infection Prophylaxis and Operative Technique

Patients were showered and shaved the day before surgery. Preoperative nasal Mupiracin® was not used in the

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authors' cohort. Antibiotic prophylaxis was given as cefazolin, 2 grams intravenously 30 minutes before skin incision and again after 4 hours. Perioperative antibiotic prophylaxis was continued for 24 hours. The operative field was sterilized with an alcohol-containing solution, and the skin was covered with an adhesive drape. Primary sternal closure after sternotomy was performed using 6 to 8 overlapping figure-of-8 PDS sutures. Internal mammary arteries (IMAs) for CABG were harvested in a non-skeletonized, pedicle-fashion. In the immediate 24-hour postoperative period, an insulin infusion titrated to a blood glucose of 110 mg/dL to 150 mg/dL was administered if blood glucose levels exceeded 180 mg/dL. The insulin infusion was discontinued once the patient was transferred to the cardiac surgical intermediate care unit. Routine microbiologic screening from tracheal aspirate was performed twice a week. All tracheal cultures underwent complete microbiologic analysis. All cultures from the sternotomy wound obtained twice a week were compared with the tracheal cultures of the individual patients. In this way, the authors sought to detect cross-contamination of the sternal and tracheal wounds.

Performance of PDT

The decision to perform tracheostomy was made by the executive consultant or the head of the department. The indication for tracheostomy was respiratory failure attributed to a variety of underlying medical conditions, most commonly exacerbation of chronic lung disease, muscle weakness, neurologic deterioration, pulmonary infection, and acute lung injury with an expected length of mechanical ventilation exceeding 7 to 10 days. Prediction of need for prolonged mechanical ventilation mainly was based on the clinical experience and subjective physician evaluation. Informed consent from the patient's next of kin was obtained to undertake the percutaneous tracheostomy.

All procedures were performed at the bedside in the intensive care unit, using the Ciaglia technique, by an experienced consultant in cardiothoracic surgery or critical care (at least 50 PDTs performed) or a senior ICU trainee under consultant supervision. Two physicians and at least 1 nurse were always present; the cardiothoracic surgery team provided surgical coverage. One physician provided video bronchoscopic guidance, and the other performed the procedure.

Patients were sedated as needed. Commonly used sedatives were remifentanil, propofol, and midazolam. Neuromuscular blockade was achieved in most cases by using rocuronium. Fraction of inspired oxygen was increased to 1.0, and ventilator settings were kept unchanged apart from patients on pressure-support ventilation in whom a controlled mode of ventilation was initiated for the period of the intervention and maintained until reversal of paralysis. Continuous monitoring of heart rate, arterial oxygen saturation, and invasive arterial blood pressure was performed in all patients. Resuscitation and difficult airway equipment was present at the bedside.

Patients were placed in the supine position with their necks extended and were prepared and draped in a sterile manner. Flexible bronchoscopic visualization routinely was utilized in all patients to facilitate insertion. A bronchoscope was advanced to the end of the ET tube. After deflating the cuff, the ET tube was withdrawn slowly until the bronchoscope light illuminated the planned tracheostomy site or digital manipulation of the trachea over the site could be seen through the bronchoscope.

A 16-gauge introducer needle was advanced into the trachea in the midline between the first and second or the second and third tracheal cartilage rings. A J-tipped wire was advanced inferiorly through the needle, and the introducer needle was removed. A small skin incision (approximately 1.0-1.5 cm) was made with a scalpel at the entry site of the wire. A 14F introducer dilator then was advanced. Depending on the kit used, 1 large hydrophilic dilator was advanced over the guiding catheter and wire until the stoma was dilated appropriately for passage of the cannula, and the dilatator was removed. A tracheostomy cannula, loaded onto a guiding catheter, was advanced over the J-wire into the trachea. The guiding catheter and J-tipped wire were removed, leaving the tracheostomy cannula in place. After balloon insufflation, ventilation was switched from the ET tube to the tracheostomy tube. Regions of the trachea superior and inferior to the cannula were examined, blood was aspirated if needed, and the ET tube was removed. The tracheostomy tube was secured with neck ties. Chest x-ray after finishing the PDT was performed to rule out a pneumothorax.

According to the Centers for Disease Control and Prevention, DSWI is defined as the presence of one of the following criteria: (1) an organism isolated from culture of mediastinal tissue or fluid, (2) evidence of mediastinitis seen during surgery, (3) presence of either chest pain, sternal instability, or fever ($>38^{\circ}C$) and either purulent drainage from the mediastinum, isolation of an organism present in a blood culture, or culture of the mediastinal area.[7]

Assessment of Complications

Complications related to PDT, such as death, hypoxemia, pneumothorax, bleeding, tracheal injuries (posterior wall perforation, fractures of tracheal rings), cannula dislocation, premature decannulation, and stomal infections, were documented. Acute bleeding was defined as endobronchial or exobronchial bleeding occurring during tracheostomy (between skin incision and insertion of the tracheostomy tube). Acute bleeds were subclassified as mild (exobronchial: 1-5 mL, endobronchial: 1–2 blood-covered sponges or presence of some blood on the posterior tracheal wall not requiring intratracheal suction); moderate (exobronchial: 5-20 mL, endobronchial: PDT site blood-covered or segmental bronchus obstructed by blood); severe (exobronchial: 20-50 mL, endobronchial: mainstem bronchus obstructed by blood), and major (>50 mL and/or surgical intervention/transfusion required). Insertion of the tracheostomy tube was graded as easy, moderately difficult, very difficult, or impossible. Obesity was defined as BMI >30 kg/m^2. Optimal puncture side was defined as puncture between the 1st/2nd or 2nd/3rd tracheal ring; low PDT puncture was defined as puncture below the fourth tracheal ring. Patients were considered to have a coagulopathy if 1 or more of the following criteria were met: (1) platelets $<50.000/\mu L$, (2) prothrombin time (PT) $>50\%$ of the normal reference value, and/or (3) activated partial thromboplastin time (aPTT) >50 seconds. Grading of PDT difficulty