Is post-sternotomy percutaneous dilatational tracheostomy a predictor for sternal wound infections?

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Abstract

Objective: Early post-sternotomy tracheostomy is not infrequently considered in this era of percutaneous tracheostomy. There is, however, some controversy about its association with sternal wound infections. Methods: Consecutive patients who had percutaneous tracheostomy following median sternotomy for cardiac operation at our institution from March 1998 through January 2007 were studied, and compared to contemporaneous patients. We identified risk factors for tracheostomy, and investigated the association between percutaneous tracheostomy and deep sternal wound infection (mediastinitis) by multivariate analysis. Results: Of 7002 patients, 100 (1.4%) had percutaneous tracheostomy. The procedure-specific rates were: 8.6% for aortic surgery, 2.7% for mitral valve repair/replacement (MVR), 1.1% for aortic valve replacement (AVR), and 0.9% for coronary artery bypass grafting (CABG). Tracheostomy patients differed vastly from other patients on account of older age, severe symptoms, preoperative support, lower ejection fraction, more comorbidities, more non-elective and complex operations and higher EuroScore. Risk factors for tracheostomy were New York Heart Association class III/IV (OR 6.01, 95% CI 2.28–16.23, \(p < 0.0001\)), chronic obstructive pulmonary disease (OR 1.84, 95% CI 1.01–3.37, \(p = 0.05\)), preoperative renal failure (OR 3.57, 95% CI 1.41–9.01, \(p = 0.007\)), prior stroke (OR 3.08, 95% CI 1.75–5.42, \(p < 0.0001\)), ejection fraction < 0.30% (OR 2.73, 95% CI 1.23–6.07, \(p = 0.01\)), and bypass time (OR 1.008, 95% CI 1.004–1.012, \(p < 0.0001\)). The incidences of deep (9% vs 0.7%, \(p < 0.0001\)) and superficial sternal infections (31% vs 6.5%, \(p < 0.0001\)) were significantly higher among tracheostomy patients. Multivariate analysis identified percutaneous tracheostomy as a predictor for deep sternal wound infection (OR 3.22, 95% CI 1.14–9.31, \(p < 0.0001\)). Conclusions: Tracheostomy, often performed in high-risk patients, may further complicate recovery with sternal wound infections, including mediastinitis, therefore, patients and timing should be carefully selected for post-sternotomy tracheostomy.

Keywords: Median sternotomy; Percutaneous tracheostomy; Sternal wound infections; Mediastinitis

1. Introduction

Tracheostomy was traditionally considered in patients requiring prolonged mechanical ventilation after cardiac surgery to facilitate adequate airway management and ventilatory wean [1–3]. In this era of percutaneous tracheostomy there is a tendency to use this method of respiratory management even after cardiac operations [4–6]. However, there is still controversy about the influence of tracheostomy on superficial and deep sternal wound infections in patients who have had cardiac surgery through median sternotomy [4,5,7–9]. Previous studies that investigate the association between tracheostomy and deep sternal wound infection often included patients who have had open surgical tracheostomy and in some cases, were hindered by small sample size; hence the perceived advantages of percutaneous dilatational over open surgical tracheostomy in this regard have not been substantiated. Consequently, the relationship, if any, between percutaneous tracheostomy and sternal wound infections in patients who have had cardiac surgery through a median sternotomy is not clear. Also, the association with superficial sternal wound infection and its potential to increase operative morbidity has not been studied.

We started performing percutaneous tracheostomy for cardiac surgery patients who require prolonged mechanical ventilation at our institution from 1998. This study was therefore conducted to determine the risk factors for post-sternotomy percutaneous tracheostomy, and to investigate the association between post-sternotomy percutaneous tracheostomy with superficial and deep sternal wound infections.

2. Materials and methods

After approval by the medical and ethics committee of our institution, we identified all patients who, following primary cardiac surgery through median sternotomy, had tracheost-
therefore, tracheostomy patients were at a higher operative
dynamic support. Also, they often had comorbidities like
left ventricular systolic function, and preoperative haemo-
by higher prevalence of controlled heart failure, impaired
more severe symptoms, greater cardiac morbidity reflected
without involvement of the sternum and mediastinum.

Deep sternal wound infection or mediastinitis was present
in patients with localised, partial or complete sternal
breakdown, purulent discharge from the mediastinum, with
or without fever, raised or rising C-reactive protein. Microbial
organisms were not always isolated on cultures in sternal
wound infections because antibiotic therapy was often
started empirically once infection was suspected on clinical
grounds.

Post-sternotomy percutaneous dilatational tracheostomy
was performed by patients' bedside in the intensive care unit
by the consultant anaesthetist/intensivist. Flexible broncho-
scopic visualisation was utilised to facilitate insertion. The
cardiothoracic surgery team provided surgical cover.

2.1. Data analysis

The baseline characteristics, operative data and post-
operative outcomes of post-sternotomy tracheostomy
patients are reported alongside contemporaneous patients
who did not have tracheostomy. Categorical variables are
reported as percentages and compared to ‘no tracheostomy’
patients with Pearson’s chi-square test, and continuous
variables are reported as median with 25th and 75th
percentiles as interquartile range (IQR), and compared using
Mann–Whitney U-test. Risk factors for tracheostomy were
identified, and the association between tracheostomy and
depth sternal wound infections determined using stepwise
multifactorial logistic regression model constructed with all
the variables in Table 1. Statistical analysis was performed
using the Statistical Package for the Social Sciences (SPSS)
version 14.0 for windows, (SPSS Inc. 2005, Chicago, IL). A
two-sided \( p < 0.05 \) was considered significant.

3. Results

3.1. Risk for tracheostomy

Of 7002 patients, who underwent cardiac surgery through
median sternotomy, 100 (1.4%) had percutaneous tracheoste-
omy postoperatively. Tracheostomy patients were older, had
more severe symptoms, greater cardiac morbidity reflected
by higher prevalence of controlled heart failure, impaired
left ventricular systolic function, and preoperative haemo-
dynamic support. Also, they often had comorbidities like
chronic obstructive pulmonary disease, renal insufficiency,
prior stroke and peripheral vascular disease. Expectedly,
therefore, tracheostomy patients were at a higher operative

<table>
<thead>
<tr>
<th>Variables</th>
<th>Median age</th>
<th>Preoperative NYHA class</th>
<th>Preoperative hypertension</th>
<th>Preoperative LVEF</th>
<th>Preoperative COPD</th>
<th>Preoperative diabetes</th>
<th>Preoperative Renal insufficiency</th>
<th>Prior myocardial infarction</th>
<th>Prior stroke</th>
<th>Peripheral vascular disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age &gt; 70y</td>
<td>68 (IQR 61–75)</td>
<td>35 (20)</td>
<td>70</td>
<td>&gt;0.50</td>
<td>21</td>
<td>24</td>
<td>13</td>
<td>52</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>Age &lt; 70y</td>
<td>67 (IQR 59–73)</td>
<td>1339 (20)</td>
<td>4269 (62)</td>
<td>5150 (76)</td>
<td>764 (11)</td>
<td>1150 (17)</td>
<td>122 (2)</td>
<td>1329 (19)</td>
<td>618 (9)</td>
<td>671 (10)</td>
</tr>
</tbody>
</table>

3.2. Postoperative morbidity and sternal wound infection

Tracheostomy was often performed in patients who have undergone complex procedures like replacement of aortic root and/or ascending aorta, MVR + CABG and AVR + CABG with longer ischaemic times and duration of cardiopulmonary bypass, and frequently suffered major postoperative morbidity like low cardiac output state requiring haemodynamic support, reopening for bleeding, perioperative myocardial infarction, renal failure and neurological dysfunction (Table 2).

Superficial sternal wound infection occurred in 6.8% \( (n = 477) \) and deep sternal wound infection in 0.8% \( (n = 54) \) of the entire study population. The procedure-specific rates for deep sternal wound infection for the commonly performed operations were 0.8% for CABG \( (n = 39) \), 0.4% each for AVR \( (n = 3) \) and MVR \( (n = 1) \), 0.8% for CABG + AVR \( (n = 4) \) and 0.7% for CABG + MVR \( (n = 1) \). The relationship between the incidences of post-sternotomy tracheostomy, deep sternal wound infections and operative mortality for these operations is displayed in Fig. 1. The incidence of deep sternal wound infection was highest for patients who had aortic surgery \( (3.1\%, \ n = 4) \).

Among tracheostomy patients superficial sternal wound infection was observed in 31% compared to 6.5% for other patients \( (p < 0.0001) \), and the corresponding deep sternal wound infection rates were 9% vs 0.7% \( (p < 0.0001) \). One patient in the tracheostomy group \( (1\%) \) and 21 \( (0.03\%) \) in the other group had sternal rewiring for mechanical breakdown. Procedure-specific rates for deep sternal wound infection were higher in tracheostomy patients for CABG \( (10.4\% \ vs \ 0.7\%) \), AVR \( (12.5\% \ vs \ 0.3\%) \) and CABG + AVR \( (7.7\% \ vs \ 0.6\%) \).

Multivariate logistic regression analysis identified tracheostomy \( \text{OR} 3.22, 95\% \text{CI} 1.11—5.86, p = 0.007 \) as determinants of post-sternotomy deep sternal wound infection.

In general the operative (30-day) mortality for patients with deep sternal wound infection was higher than patients who did not have deep sternal wound infection \( (9.3\% \ vs \ 2.9\%, p = 0.006) \). Among patients with deep sternal wound infection, tracheostomy patients had more operative deaths compared to ‘no tracheostomy’ patients \( (22.2\% \ vs \ 6.7\%, p = 0.14) \), but the difference was not statistically significant.

4. Discussion

Tracheostomy is infrequently used for airway management after cardiac surgery, as this study and other series \[7,9\] have shown. It was performed in 1.4% of our patients, predominantly in those who are older, with severe and unstable preoperative symptoms, increased cardiac morbidity and comorbidities like preoperative renal failure, previous stroke and chronic obstructive pulmonary disease. Patients undergoing complex and combined procedures tend...
to have a greater need for postoperative tracheostomy, as well.

In the present study, we found a strong association between post-sternotomy tracheostomy and deep sternal wound infection. In similar studies involving open tracheostomy patients, Curtis et al. [9] and Force et al. [7] reported higher rates of deep sternal wound infection after cardiac surgery, and identified tracheostomy as a risk factor for deep sternal wound infection and operative mortality. Unlike open surgical tracheostomy, percutaneous dilatational tracheostomy is expected to provide a good seal around the tracheostomy tube and prevent the contamination of a median sternotomy wound and as a result the risk of sternal wound infections is expected to be less. As have been reported with open tracheostomy, we found considerably higher rates of superficial and deep sternal wound infections in tracheostomy patients. In fact the incidence of deep sternal wound infection observed in our study is similar to that reported for open surgical tracheostomy [7], suggesting that the percutaneous approach though advantageous in other respects [10,11], does not confer substantial benefit in the reduction of deep sternal wound infections. The association between tracheostomy and superficial sternal wound infection has rarely been studied. The high rate of superficial wound infection among tracheostomy patients highlights the additional potential risk for mediastinitis posed by percutaneous tracheostomy. Usually antibiotic treatment is commenced as soon as superficial wound infection is suspected on clinical evaluation and often, this adequately controls the spread of the infection; hence the magnitude of the risk of mediastinitis is underestimated by reporting only the rate of deep sternal wound infection. In a series of percutaneous tracheostomy patients, Byhahn et al. [6] suspected superficial wound infection in 13 out of 144 patients (9%) but excluded 12 on the basis of a negative microbial culture, thereby understating the clinical problem.

The present study also shows that patients who often require tracheostomy are the very ones who are more likely to suffer devastating consequences of deep sternal infection. Septicaemia and infective endocarditis in patients who have undergone aortic surgery and valve repair/replacement are potentially fatal complications, and possibly explains the prominent role of septicaemia as a cause of death in tracheostomy (22%) compared to ‘no tracheostomy’ patients (6.4%, \( p < 0.0001 \)). Considering that the prognostic impact of tracheostomy in unselected patients requiring prolonged ventilation has been questioned [12], and the clinical advantage of early post-sternotomy tracheostomy put in doubt [13], careful patient selection and optimal timing are crucial if the number of patients who are put at the risk of sternal wound infections are to be reduced.

The limitations of this study include lack of direct comparison of the influence of open surgical and percutaneous tracheostomy on post-sternotomy sternal wound infections. The infrequent use of tracheostomy in cardiac surgery patients and the rarity of post-sternotomy mediastinitis make it difficult to acquire adequate sample size for such comparison. However, studies from other centres have shown a direct correlation between open surgical tracheostomy and mediastinitis.

5. Conclusion

High-risk patients and patients undergoing high-risk cardiac operations often experience a complicated post-operative recovery and are more likely to have tracheostomy. Consequently, post-cardiac tracheostomy patients are sicker and more prone to develop superficial and deep sternal wound infections. Our data show that percutaneous tracheostomy is a predictor for post-sternotomy deep sternal wound infection. Patients and timing of tracheostomy should, therefore, be carefully selected to reduce the number of patients put at risk.

References