

Does Tracheostomy Affect the Mortality and Morbidity Rate After Cardiac Surgery?

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ABSTRACT

Objective: This retrospective study aims to investigate the timing and outcomes of tracheostomy, mortality and morbidity rates, length of in-hospital and cardiovascular intensive care unit (ICU) stay in patients with post-cardiac surgery.

Patients and Methods: Between October 2014 and October 2016, a total of 401 cardiac surgery were performed in our hospital. Thirteen patients who needed post-operative prolong ventilation (7 female; 6 male; mean age was 67.7 ± 9.8 years; range 47 to 86 years) undergoing tracheostomy procedure, were included in this retrospective study.

Results: The mean intubation time between the cardiac surgery and tracheostomy was 14.5 ± 2.9 days (range 11 to 21). The mean intensive care unit stay time was 27.4 ± 9.4 days (range 12 to 49) and the mean in-hospital stay was 43.1 ± 23.7 days (range 16-91). 8 patients passed away and the in-hospital mortality rate was 61%. After a mean follow-up of 161.4 ± 151.1 days (range 57 to 417), 3 patients (7%) passed away while one patient (7%) was decannulated. One patient (7%) is currently under follow-up at home using a home-type ventilator. Regarding patients who passed away after discharge, the overall mortality rate was 84.6%. In addition, the number of extubation attempts was 0.65 ± 1.12 (range 0 to 4).

Conclusion: Tracheostomy is performed in need of prolonged mechanical ventilation in patients with post cardiac surgery. We thought that tracheostomy does not decrease the incidence of nosocomial pneumonia in hospital/ICU stay and morbidity/mortality as expected.

Key words: Cardiac surgery, tracheostomy, outcomes, intensive care unit, pneumonia.

INTRODUCTION

The need of prolonged mechanical ventilation after cardiac surgery is rising due to the advanced age, comorbidities, and complex surgeries. Early extubation after cardiac surgery is desired however, it is not always possible. For this reason, tracheostomy is an alternative technique for prolonged mechanical ventilation to facilitate adequate airway management and ventilatory weaning [1]. Up to 20% of patients who required prolonged mechanical ventilation needs a tracheostomy [2]. Tracheostomy provides several potential advantages such as reducing the airway resistance, facilitating to wean from mechanical ventilation, providing early oral nutrition, reducing trauma to the oropharynx and larynx, reducing dead space, decreasing the delirium, improving overall patient's comfort, providing

efficient tracheal aspiration, decreasing the need for sedation, reducing ventilator-associated complications, improving mobilisation, reducing infection risk and reducing the risk of extubation [2,3]. Additionally, most important potential advantages of tracheotomy are early discharge from Intensive Care Unit [ICU] and shortening the length of in-hospital stay. The treatment and timing strategy for tracheostomy has been evolved in past decades. The timing of tracheostomy is varying between two days and three weeks, however, there is no consensus regarding optimal timing for performing a tracheostomy [1-3]. The decision of tracheostomy should depend on clinical conditions and the physician's judgment [1,2]. The American 2001 consensus advocates the use of early tracheostomy in patients who require prolonged mechanical ventilatory assistance [4]. Existing diseases,

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potential re-intubation risk, expected recovery time, potential procedural risks should be particular investigated to every individual patient. In addition, oesophageal injury, cannula dislocation, tracheal stenosis and granulation, bleeding, deep sternal wound infection, hypoxemia, and pneumothorax are the potential complications of tracheostomy procedure [5-7]. There are lots of studies that investigated the benefits and optimum time for tracheostomy, however, there is no common view about the effects of tracheostomy on the duration of mechanical ventilation, time of hospital stay, time of intensive care unit (ICU) stay and nosocomial pneumonia. In this study, we evaluated the risk of ventilation-associated pneumonia, the length of ICU and in-hospital stay, complications, the length of weaning from mechanical ventilation and the optimum timing of tracheostomy of patients who undergoing tracheostomy in our Cardiovascular ICU.

PATIENTS AND METHODS

We conducted a retrospective study and evaluated the data regarding patients who had prolonged mechanical ventilation after cardiac surgery in Ondokuz Mayıs University Hospital that underwent tracheotomy in the Cardiovascular Intensive Care Unit between October 2014 and October 2016. The study protocol was approved by the Ondokuz Mayıs University Institutional Ethics Committee and written consent was taken from patients relatives in each case. The study was conducted in accordance with the principles of the Declaration of Helsinki. In this period a total of 401 cardiac surgery were performed in our hospital and 13 patients (3.2%) (7 female; 6 male; mean age was 67.7 ± 9.8 years; range 47 to 86 years) underwent tracheostomy procedure. Patient's demographics features, surgical characteristics, effects of the preoperative risk factors, additional diseases, total mechanical ventilation time, preoperative ejection fraction, type of surgery, re-operation status, postoperative complications, decannulation time, the duration and number of attend of extubations, need for postoperative dialysis, inotropic support, microorganisms isolated from deep tracheal aspirate cultures, time of in ICU/hospital stay, mortality rates and intra-aortic balloon pump (IABP) insertion rates were evaluated for all patients. Demographic, clinical and infectious characteristics of patients are summarized in Table 1 and Table 2. The decision to perform tracheostomy was made by the attending intensivist and cardiac surgeon. There was no formal protocol to proceed with a tracheostomy. Tracheostomy decision was based on clinical criteria including the inability to wean-off from mechanical ventilation and/or multi-organ failure. Tracheostomy was performed as an open surgery in the operating room by the same cardiovascular surgeon. Continuous monitoring of heart rate, arterial oxygen saturation, and invasive arterial blood pressure was performed in all patients. Propofol and midazolam were commonly used as sedatives when needed. The decision of wean-off from mechanical ventilation after tracheostomy was based on the stepwise reduction of pressure

support ventilation and spontaneous breathing physiotherapy trials. Patients were discharged from ICU after a mandatory period of 48-72 hours of unsupported ventilation with reduced tracheal secretions and adequate gas exchange. Patients were decannulated if they had an acceptable respiratory rate and PaO₂ was above 80 mmHg in the room air. Primary end points were survival and weaning from the tracheostomy.

Operative technique

Under general anesthesia with the head extended, a routine preparation was done. A 2-cm horizontal incision was performed one or two tracheal rings below the cricoid cartilage. The subcutaneous tissues and the muscles were separated. Vessels were ligated and divided. After reaching the trachea, a 1.5 cm horizontal incision was performed with a scalpel and the upper tracheal ring was hooked in order to achieve an easier access. Herein, the endotracheal tube was slowly withdrawn to the level of the vocal cords and a tracheostomy tube was inserted. Inspired oxygen was increased to 1.0 shortly after the procedure. Chest X-ray was done after the procedure to rule out the pneumothorax.

Statistical analysis

Statistical analysis was performed using the Microsoft Office, Excel software (Microsoft Office 2010). All numerical data were expressed in mean \pm standard error, while categorical variables were expressed in percentage.

RESULTS

Tracheostomy was performed in 13 (8 female, 7 male) (3.2%) of a total of 401 patients undergoing cardiac procedures over the 2-years study period (Demographic variables and surgical characteristics are presented in Table 1, 2). The mean body weight was 75.8 ± 12.9 kg (range, 62 to 102 kg). Coronary Artery Bypass Grafting (CABG) was performed in 6 (47%) patients, CABG+Carotid Endarterectomy (CEA) in 2 (15%), Aortic valve replacement (AVR) in 1 (7%), Bentall procedure in 1 (7%) and Bentall procedure+Mitral valve replacement (MVR) in 1 (7%) patient was performed. All patients underwent cardiopulmonary bypass (mean 127.2 ± 17.2 min, range 97 to 165) during operation. The mean intubation time between the surgery and tracheostomy were 14.5 ± 2.9 days (range 11 to 20). The number of extubation attempts was 3.2 ± 0.8 (range 2 to 5). The mean procedural time for tracheostomy was 26 ± 3.3 (range 18 to 41) minutes. No cardiac arrest related to the procedure was occurred. Of the 13 patients, post procedural complications were seen in 5 (38%) including subcutaneous emphysema 15% (2/13), bleeding into the trachea 15% (2/13) and cannula dislocation 7% (1/13). The mean follow-up time was 161.4 ± 151.1 days (ranges between 57 and 417 days). Early mortality rate was 61% (8 patients) while, 5 patients (38%) were discharged, while, one patient (7%) was decannulated. 4 patients (30%) had been followed-up at home

Tracheostomy After Cardiac Surgery

using a home-type ventilator. Late mortality (after 30 days) was seen in 3 patients (23.4%). All-cause mortality rate was 84% (11 of 13). The leading cause of death was ventilation associated pneumonia which led to progressive respiratory failure. *Staphylococcus hemolyticus* was incubated in 5 (38%) patients, *Enterococcus faecium* was incubated in 2 (15%) patients, *Corynebacterium striatum* was incubated in 2 (15%) patients, *Pseudomonas putida* was incubated in one patient (7%), *Acinetobacter baumannii* was incubated in one patient (7%), Yeast was incubated in one patient (7%) and no microorganism was incubated in 1 patient's (7%) deep tracheal aspirate cultures. No deep sternal wound infection or tracheostomy incision site infection was detected. Perioperative events are shown in Table 3.

The potential cause of increase in mortality were chronic obstructive pulmonary disease, coronary artery disease, smoking, need for inotropic agents, postoperative neurological events,

chronic renal failure, hypertension, diabetes mellitus, carotid artery stenosis, need of intra-aortic balloon pump (IABP) support, complication-related re-operations and emergency operations. Sepsis (n=8, 61%), neurological impairment (n=2, 15%), pleural effusion (n=5, 38%), ventilator associated pneumonia (n=8, 61%), postoperative atrial fibrillation (n=5, 38%) were detected. No pneumomediastinum or pneumothorax was detected following tracheostomy however, subcutaneous emphysema in the neck was developed in 3 patients (23.4%) which spontaneously disappeared in one week. Late tracheostomy complications such as tracheal stenosis were not observed in any patients during the follow-up period. The most common complication was partial or complete obstruction of the tracheostomy tube in 11 of 13 cases (84%), requiring either removal of the tube alone or replacement however, one patient (7%) had respiratory arrest and due to an unexpected decannulation in the first 24 hours after surgery. Replacement was usually with the same size tube. The tracheostomy tube conversion was done on the ward and ICU.

Table 1. Demographic, clinical and infectious characteristics of patients

Patient	Age	Sex	Bacterial Growth In The Blood Culture	Intubation Time (hr)	Time Period After Surgery (hr)
1	70	Male	Yeast	13	25
2	61	Male	No growth	11	49
3	70	Female	<i>Enterococcus faecium</i>	15	9
4	68	Male	<i>Staphylococcus epidermidis</i> , <i>Staphylococcus hemolyticus</i>	15	3
5	79	Female	<i>Enterococcus faecium</i>	20	27
6	62	Female	<i>Corynebacterium striatum</i>	12	23
7	72	Male	<i>Staphylococcus epidermidis</i> , <i>Corynebacterium striatum</i>	14	19
8	73	Female	<i>Pseudomonas putida</i>	13	1
9	73	Female	<i>Acinetobacter baumannii</i>	15	10
10	47	Female	<i>Staphylococcus hemolyticus</i>	12	12
11	86	Male	<i>Staphylococcus hemolyticus</i>	21	20
12	60	Female	<i>Staphylococcus hemolyticus</i>	14	9
13	60	Female	<i>Staphylococcus hemolyticus</i>	14	10

Table 2. Laboratory characteristics of the patients

Patient	Pre-op. Blood creatinin (mg/dL)	Blood creatinin during ICU	Post-op. WBC	Hematocrit (%)	Total cholesterol (mg/dL)	TSH (pg/mL)	ft3 (ng/dL)	ft4 (mIU/mL)
1	6.04	6.32	14.4	37.1	226.1	0.8	1.45	1.62
2	0.93	1.45	13.7	35	203	1.29	2.68	1.38
3	1.92	2.56	11.0	38.7	87.6	6.25	2.01	1.29
4	1.06	6.15	40.2	53	200	1.62	2.81	1.68
5	1.7	3.04	18.8	33.5	210	0.52	1.18	1.29
6	0.98	0.79	19.2	45.5	247.1	1.68	1.9	1.11
7	1.14	5.13	18.9	48.2	194.1	0.46	2.77	1.3
8	1.43	4.22	19.0	41.6	205.8	0.81	2.65	1.38
9	1.7	6.16	20.9	45.3	365.2	14.8	1.85	0.88
10	0.68	3.47	26.2	34.1	210	1.21	1.76	1.53
11	1.39	3.75	19.1	40	273.8	1.69	2.5	1.65
12	1.39	3.70	18.7	41.1	280	1.43	2.1	1.13
13	1.39	3.8	17.7	44.5	265	1.78	3.5	1.78

ICU: Intensive Care Unit, WBC: White Blood Count

Tracheostomy After Cardiac Surgery

Table 3. Perioperative overall conditions of the patients

Patient	Reintubation before tracheostomy	Inotropic agents	Postoperative hemodialysis	Postoperative infection	Cross Clamp Time (minutes)	Cardiopulmonary bypass time (minutes)	Elective surgery
1	0	+	+	+	114	143	+
2	1	+	-	+	130	165	+
3	0	+	-	+	94	125	+
4	1	+	-	+	83	117	+
5	0	+	-	+	91	132	+
6	1	+	-	+	82	122	-
7	0	+	-	+	101	127	+
8	1	-	-	+	84	113	+
9	0	+	-	+	112	140	+
10	0	+	-	+	76	97	+
11	4	+	-	+	115	141	+
12	0	+	-	+	80	111	+
13	0	+	-	+	92	124	+

DISCUSSION

The number of cardiac surgeries is making a plateau around the world in spite of the increasing coexistence of coronary artery disease with increasing life span in the last decades. Therefore, the numbers of patients with high comorbidities who required tracheostomy after complex cardiac surgery due to prolonged ventilation are increasing.

Furthermore, respiratory and airway complications are particularly common after cardiac surgery [8,9]. Other post-cardiac surgery related complications that affect the pulmonary function and the incidence of infection are including diaphragmatic paralysis secondary to phrenic nerve injury and vocal cord paralysis secondary to laryngeal nerve injury [10]. Tracheostomy has several potential advantages compared to the nasotracheal or orotracheal intubation procedures. Advantages of tracheostomy are considered as early weaning from mechanical ventilation, decreases the risk of cannula displacement, improves the patient comfort, reduces the workload during respiration, helps to remove the secretions easily, enables early mobilization and enteral feeding [11,12]. The main indications for tracheostomy are including the need for prolonged mechanical ventilation, preventing oropharyngeal intubation complications [13]. Chronic obstructive pulmonary disease (COPD), surgical complications, redo surgery, coronary artery disease, need of positive inotropic agents, hemodialysis, and postoperative neurological events increase mortality, morbidity and the length of in-hospital/ICU stay in patients with a tracheostomy [8-14].

The decision of tracheostomy is associated with expected mechanical ventilation duration and expected potential benefits of the procedure. Tracheostomy decision should be made particular

to the each patient's status. The characteristics and main diseases of patients may affect the timing of tracheostomy and the mortality rate. The perioperative mortality of tracheostomy procedure ranges from 0.2 to 0.7% [14]. However, in our study, no perioperative death occurred. Puentes et al. advocated that tracheostomy reduces the post-operative atrial fibrillation and reduces the renal failure and does not increase the rate of deep sternal wound infection. In addition, they stated that reduced atrial fibrillation and renal failure could be associated with short cardiopulmonary bypass time and the need of less sedation [2]. In contrast, tracheostomy did not change the post-operative atrial fibrillation rate, renal dysfunction/failure incidence in patients who died in our study. We found similar results with previous study for deep sternal wound infections like. Puentes et al. [2] reported that the rate of tracheostomy among the post cardiac surgery was 1.36% however, our results were higher 3.2%.

Either percutaneous or open surgical techniques of tracheostomy procedure has also some potential complications such as bleeding, infection, subcutaneous emphysema, pneumothorax, pneumomediastinum deep sternal wound infection, pneumothorax and tracheal damage/stenosis [15]. The reported early complication rate of tracheostomy was found 38% and the late complication rate was 8% [1]. In our study, bleeding was occurred in 2 patients (15%) and subcutaneous emphysema in the neck was developed in 3 patients (%23.4). We found partial or complete obstruction of the tracheostomy tube rate (84%) higher than previous study [16]. In the 1980s, 21 days after surgery was called as early tracheostomy [14]. Early tracheostomy was considered as the first seven days after intubation however, some authors advocated the first two, three, four, ten or even fourteen days after intubation. Turan et al. [17] reported that to assess the daily respiratory

status is essential for performing a tracheostomy. Scale et al. [9] reported in their 10,927-patient cohort study that delaying each day of tracheostomy increased the long-term mortality.

The rate of ventilation associated pneumonia was 28% of patients with prolonged mechanical ventilation in the ICU [18]. For this reason, some authors suggested that early tracheostomy was also associated with significantly reduced hospital mortality, pneumonia, length of ICU stay, duration of mechanical ventilation by reducing the work of breathing and improving the lung mechanics, reduces ventilator-associated pneumonia and ICU complications [19-23]. Ventilation associated pneumonia was detected on 12 of 13 patients [92%] in our study. Rumbak et al. [24] reported in their 120-patient study that early tracheostomy in two days improved mortality rates, reduced pneumonia, decreased ICU stay and reduced mechanical ventilator support rather than late tracheostomy. Besides that, Shaw et al. [25] compared early tracheostomy (< 7 days) and late tracheostomy (> 10 days) in ICU. A total 49,191 patients from 185 different medical centers were analyzed between 2007 and 2010. Patients who underwent tracheostomy between 7 and 10 days were excluded in this study. The survival rates were higher in patients who had early tracheostomy however, the incidence of ventilation-associated pneumonia ($P < 0.0001$), ICU stay ($P < 0.0001$), length in hospital stay ($P < 0.0001$) and mortality ($P < 0.0001$) was lower in patients who had early tracheostomy (25). Devarajan et al. [8] reported in their 114-patient study that early tracheostomy (< 10 days) was associated with lower mortality (21.1% vs 40.4%) and morbidity (14 vs 33%) rather than late tracheostomy (>14–28 days). Besides that, infection rates, tracheal aspiration and positive blood culture rates were statistically lower in the early tracheostomy [14,25]. Ibrahim et al. [26] stated that early tracheostomy improves outcomes in critically ill patients.

Furthermore, Young et al. [21] conducted a randomized study that investigated early versus late tracheostomy (The TracMan study). In this multicentre trial, patients from over 70 ICUs were randomized to early (within 4 days) or late tracheostomy (after 10 days) groups. No difference was noted in early and late mortality between groups. Authors concluded that early tracheostomy did not improve important clinical outcomes [21]. On the other hand, some authors suggest that tracheostomy may shorten the ICU length of stay, however, does not shorten the total length of in-hospital stay [27,28]. Additionally, Garcia-Urabayen et al. [29] conducted a retrospective study and analyzed the outcomes of tracheostomies in a Paediatric ICU during the period 2003-2013, including 25 patients in Spain, concluded that the post-operative course of a tracheotomy is associated with a higher rate of complications and mortality.

Zagli et al. [30] compared effects of early tracheostomy (<3days) and late tracheostomies in a 506-patient study and demonstrated that mechanical ventilation duration and length of in-hospital stay were shorter in the early tracheotomy group. On the other

hand, some authors suggested that tracheostomy did not reduce pneumonia and mortality, however, improves the patient's quality of life [1,2,18,22]. Besides that an open multicentered randomized clinical trial conducted between 2004 and 2011 involving 70 adult general and 2 cardiothoracic ICU in 13 University and 59 Non-University hospitals in the United Kingdom including a total of 899 patients and demonstrated that early tracheostomy (<4days) had no survival benefit [21]. In our study, the mortality rate of the patients who underwent tracheostomy following cardiac surgery remained high (61%) and sepsis was developed after pneumonia in all patients who died. Long intubation period, failed to wean, late tracheostomy time may predisposed to poor outcomes which may lead to ventilator-associated pneumonia. Most authors advocated that pneumonia can be treated more effectively with tracheostomy, however, we did not note any improvement in our patients with pneumonia.

In addition, there is an ongoing debate about the tracheostomy and the timing of tracheostomy that might increase the risk of deep sternal wound infections. Previous studies investigated that the association between early tracheostomy and deep sternal wound infection after a median sternotomy had different results. Some authors concluded that early tracheostomy (< 7 days) can be safely performed without any risk of sternal wound infection or dehiscence [2,14]. On the other hand, Ngaage et al. [23] reported that tracheostomy after cardiac surgery is associated with an approximately 3-fold risk for deep sternal wound infections. In our study, no deep sternal wound infection was noted.

Our study has some limitations. The study population is limited, reflects the experience of a single center and the follow-up period is short. This retrospective study lacks baseline pulmonary function data before tracheostomy, which might have influenced the duration of weaning. Patient condition on admission to the medical ICU might have influenced the decision to perform a tracheostomy late. We did not compare the precutaneous versus open surgical technique.

In conclusion, tracheostomy procedures may perform in patients with prolonged mechanical ventilation following cardiac surgery with a low perioperative complications rate, may increase the pulmonary care and patients comfort however, tracheostomy does not decrease the incidence of nosocomial pneumonia, in hospital/ICU stay and morbidity/mortality as expected. We thought that the timing of tracheostomy does not have a direct effect on patients after cardiac surgery.

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