Ege Tıp Dergisi /Ege Journal of Medicine 48(3): 167-173, 2009

Surgical versus percutaneous tracheostomy after cardiac surgery

Kalp cerrahisinden sonra cerrahi ve perkütan trakeostominin karşılaştırılması

Calkavur I T[1] Yagdi T[1] Posacioglu H[1] Apaydın A[1] Askar F Z[2] Durmaz I[1]

[1]Ege Üniversitesi Tıp Fakültesi, Kalp-Damar Cerrahisi Anabilim Dalı, İzmir, Türkiye
[2]Ege Üniversitesi Tıp Fakültesi , Anestezi ve Reanimasyon Anabilim Dalı, İzmir, Türkiye

Summary

Aim: Elective tracheostomy after cardiac surgery is increasingly used in patients who require long-term mechanical ventilatory support. The aim of the present study is to compare percutaneous dilatational with surgical tracheostomy in cardiosurgical patients when both procedures were performed in cardiac surgery intensive care unit.

Material and Methods: We retrospectively evaluated 63 patients who had surgical (n=24) or percutaneous dilatational (n=39) tracheostomy technique following cardiac surgery. Comparisons of the complications, oxygenation index, stomal closure time and time consumption of both technique is the main target.

Results: Percutaneous dilatational tracheostomy was performed more quickly than surgical tracheostomy (p=0.0012). With regard to preoperative and postoperative oxygenation index, there was no significant difference between percutaneous dilatational tracheostomy and surgical tracheostomy groups (p=0.318 and p=0.9 respectively). When oxygenation indexes before and after tracheostomies compared within each group, we found also no statistical difference (p=0.77 and p=0.425 respectively). Overall complication rate for surgical tracheostomy and percutaneous dilatational tracheostomy were 25% and 12.8%, respectively. Wound infection in tracheostomy site was seen in 16.6% of the surgical tracheostomy, whereas no infection was found in percutaneous dilatational tracheostomy (p=0.018). Stomal closure times after decannulation in percutaneous dilatational tracheostomy group were shorter than in surgical tracheostomy group (p=0.0021).

Conclusion: Percutaneous dilatational tracheostomy have some advantages relative to surgical tracheostomy including more rapid of performance and stomal closure and lower incidence of postoperative wound infection. Percutaneous dilatational tracheostomy as the procedure of choice for performing elective tracheostomy in the appropriately selected cardiosurgical patient requiring long-term mechanical ventilation.

Keywords: Surgical, percutaneous, and tracheostomy.

Özet

Amaç: *Kalp cerrahisinden sonra elektif trakeostominin kullanımı, uzun süreli mekanik solunum desteği gerektiren hastalarda artmıştır. Çalışmanın amacı, kalp cerrahisi sonrasında kalp cerrahisi yoğun bakımında gerçekleştirilen perkütan dilatasyon trakeostomi(PDT) ve cerrahi trakeostominin (CT) karşılaştırılmasıdır.*

Yöntem ve Gereç: *Kalp cerrahisi sonrasında 24 CT ile 39 PDT yapılan 63 hastanın sonuçları retrospektif olarak değerlendirildi. Her iki teknikteki komplikasyon oranlarını, oksijenizasyon indekslerinin, stomal kapanma sürelerinin ve işlem için harcanan sürenin karşılaştırılması yapıldı.*

Yazışma Adresi:İ.Tanzer ÇALKAVUR
Ege Üniversitesi Tıp Fakültesi Kalp-Damar Cerrahisi Anabilim Dalı Bornova-İzmir-Türkiye
Makalenin Geliş Tarihi: 03.11.2008 Kabul Tarihi:20.01.2009

Bulgular:*Perkütan dilatasyon trakeostomi, CT oranla daha hızlı yapılmaktadır (p=0.0012). Preoperatif ve postoperatif oksijenizaston indekslerine bakıldığında PDT ve CT arasında anlamlı fark bulunmadı (p=0.318 ve p=0.9). Trakeostomi öncesi ve sonrası oksijenizasyon indeksleri grupların kendi içlerinde karşılaştırıldığında yine istatistiksel olarak anlamlı fark bulunmadı(p=0.77 ve p=0.425). Genel komplikasyon oranlarına bakıldığında CT %25, PDT % 12.8 olarak bulundu. Trakeostomi yara yeri infeksiyonu CT'den sonra %16.6 olarak bulunurken, PDT grubunda infeksiyon tespit edilmedi (p=0.018). Dekanülasyondan sonra stomal kapanma süresi PDT grubunda CT oranla anlamlı olarak daha kısaydı (p=0.0021).*

Sonuç: *Perkütan dilatasyon trakeostominin CT göre işlem süresinin daha kısa olması, stomal kapanma süresinin daha kısa olması ve postoperatif yara yeri infeksiyon oranını daha düşük olması gibi göreceli avantajları vardır. Bu nedenle PDT kalp cerrahisinden sonra uzun süreli mekanik solunum desteği gereken hastalarda elektif trakeostomi için tercih edilmesi gereken tekniktir.*

Anahtar Kelimeler : *Cerrahi, perkütan ve trakeostomi.*

Introduction

Long-term ventilatory support requirement (>5 days) occurs in an about % 2,5 of patients following primary coronary artery surgery[1]. Although initial airway control of these patients can manage with endotracheal intubation, tracheostomy is considered the procedure of choice for long-term ventilatory support [2]. Tracheal ulceration and stenosis, airway infection and prolonged weaning from mechanical ventilation are common complications of prolonged endotracheal intubation and can be eliminated by the use of tracheostomy[3-5]. Compared with endotracheal intubation, tracheostomy also affords more effective pulmonary toilet, and increased airway security[6].

Conventional open surgical tracheostomy (ST) performed with Jackson's technique is considered safe and simple surgical procedure([7]. Transportation of critically ill patients to operating room is the most important disadvantage of this technique[8,9]. To eliminate this disadvantage and common complications of open tracheostomy, percutaneous dilatational tracheostomy (PDT), a minimal invasive alternative to ST, was described by Ciaglia in 1985[10]. PDT using with Seldinger technique may be performed at patient's bedside and because of no need extensive surgical experience, this technique gained widespread popularity in recent years. To evaluate potential benefits of PDT in cardiosurgical patints, we performed a retrospective comparison of ST and PDT. The aim of this study is to compare the complications, oxygenation index (proportion of arterial oxygen partial pressure to fraction of inspired oxygen), stomal closure time and time consumption of the PDT with that of open surgical tracheostomy when both procedures were performed in cardiac surgery intensive care unit (ICU).

Patients and Methods

Between 2004-2008, 2553 adult patients had been undergone open heart surgery, of who 63 (2.46%) required elective tracheostomy because of prolonged mechanical ventilatory support at the Department of Cardiovascular Surgery, Ege University Medical Faculty Hospital. Tracheostomies were performed with PDT technique in 39 patients and ST technique in 24 when the patients were not expected to be extubated within the following 7 days. Informed consent was obtained from patients or first-degree relatives of patients. Previous tracheostomy or neck surgery, goiter, infection at tracheostomy site and severe coagulopathy were considered contraindications for both tracheostomy techniques. PDT were performed or supervised by cardiac intensivists whereas surgeons performed ST. Both PDT and ST performed at the patient's bedside in cardiac surgery intensive care unit. An anesthesiologist was present to manage the patient's ventilation, oxygenation and sedation throughout procedure in all cases.

Fentanyl was used to induce short-term sedation and analgesia during all procedures. Neuromuscular relaxation was achieved with pancuronium (0.1mg/kg) to avoid cough reflex, which can lead to accidental laceration of posterior tracheal wall during PDT. Lidocaine (1%) with adrenaline was used for local anaesthesia and vasoconstriction of subcutaneous tissue in all patients. All patients were ventilated with 100% oxygen ten minutes before operation and inspired oxygen fraction was reduced initial level immediately after procedure. During procedure, continuous

electrocardiography, blood pressure monitoring with indwelling arterial line and pulse oxymetry was routinely carried out. Suction of blood possible aspirated during procedure was performed through tracheostomy tube. Fiberobtic bronchoscopy was carried out through the tracheostomy tube at the end of procedure if necessary. Postprocedural chest radiography was obtained to confirm appropriate tracheostomy tube placement and evaluate for the presence of a pneumothorax.

The following data were documented: age; gender; indication for elective tracheostomy; type of cardiac intervention; arterial blood gas analysis 1 hour before and after procedure; coagulation parameters (platelets, partial tromboplastin time and International Normalized Ratio); procedure duration (from skin incision to insertion of the tracheostomy cannula); intraprocedural complications such as paratracheal insertion, subcutaneous emphysema, loss of airway control for more than 30 seconds, stomal bleeding, intratracheal bleeding; postprocedural complications such as accidental decannulation, infection, bleeding; mortality; duration of tracheostomy; decannulation; stomal closure postdecannulation. Stoma infection was considered when there were visible signs of infection such as purulent drainage, induration or surrounding erythema. The tracheostomy wound cultures were obtained only when infection was suspected. Bleeding of about 50-100 ml was defined as moderate stomal oozing, whereas severe bleeding was a loss of more than 100 ml.

Technique of Percutaneous Dilatational Tracheostomy :

After sedation and neuromuscular relaxation, patient's neck and head were slightly extended and surgical field was prepared. Horizontal skin incision of about 2 cm was performed over the area between first and second tracheal rings. The endotracheal tube was withdrawn to subglottic position (usually the cuff of endotracheal tube at the level of vocal cords) in order to avoid endotracheal tube puncture. While the needle was inserted slowly under continuous aspiration, free hand was used to stabilize the trachea in the midline in order to ensure central puncture. When air was aspirated, a Seldinger guidewire was passed and the needle removed. A series of dilatators were introduced over the guidewire to dilate the stoma. Tracheostomy tube was then advanced into trachea with the guidance of small dilatator and secured with fabric tape tied around the neck. Endotracheal tube was removed after the position of tracheostomy tube was ensured with pulmonary auscultation. A Sims Per-Fit percutaneous tracheostomy kit (Sims Medical Systems, Keene, New Hampshire) was used for all patients. The internal diameter of tracheostomy tubes used were 7.0 mm (n = 19) and 8.0 mm (n=20).

Technique of Surgical Tracheostomy :

Surgical tracheostomies were performed in cardiac surgery intensive care unit by using standard technique [6]. After adequate anaesthesia and neuromuscular blockage, patient's neck was positioned in hyperextension and surgical area was prepared. A 4-6 cm horizontal incision was made at the level of first and second tracheal interspace. The trachea was exposed using sharp and blunt dissection and using U shaped flap technique, tracheostomy tube was inserted under direct vision. Skin and subcutaneous tissues were sutured. Endotracheal tube was withdrawn after appropriate placement was confirmed by pulmonary auscultation. The tracheal tube was secured with nylon tape tied around the neck. The internal diameter of Portex tracheostomy tubes (Sims Medical Systems, Keene, New Hampshire) were 7.0 mm (n = 12) and 8.0 mm (n =12).

Statistical Analysis :

Descriptive statistics were expressed as mean value ± standard deviation or as percentages. Once the homogeneity was confirmed with Levene test, independent-samples t test was used to compare of the continuous variable. Chi-square or Fisher's exact test was used to compare dichotomous variables. Paired samples t test was used to compare oxygenation index before and after tracheostomy within each group. A p value < 0.05 was considered significant. All statistical analysis were perform with SPSS 9.0 for Windows statistical package (SPSS Inc, Chicago, Ill)

Results

In our cardiac surgery ICU, 63 patients required long-term mechanical ventilation was undergone elective tracheostomy in a 41-month period. Thirty-nine of patients received PDT and 24 patients ST. Both types of tracheostomies were performed in cardiac surgery ICU. Coronary artery bypass surgery is the most common cardiac intervention (55.6%) and adult respiratory distress syndrome is the reason of prolonged respiratory support in 41.3% of all patients. Types of cardiac interventions and indications for long-term ventilatory support are shown in Table 1.

Table 1. Surgical interventions and indications for elective tracheostomy.

	PDT	ST	Total
Cardiac procedure			
Coronary artery bypass grafting	24(61.5%)	11(45.8%)	35(55.6%)
Redo coronary artery bypass grafting	1(2.6%)	1(4.1%)	2(3.1%)
Valve repair or replacement	5(12.8%)	7(29.2%)	12(19%)
Aortic aneurysm or dissection	8(20.5%)	6(25%)	14(22.2%)
Indication for tracheostomy			
Adult Respiratory Distress Syndrome	14(35.9%)	12(50%)	26(41.3%)
Pneumonia	5(12.8%)	3(12.5%)	8(12.7%)
Sepsis	4(10.3%)	2(8.3%)	6(9.5%)
Low Cardiac Output	4(10.3%)	5(20.8%)	9(14.3%)
Cerebral Disorders	11(28.2%)	3(12.5%)	14(22.2%)

PDT: Percutaneous Dilatational Tracheostomy

ST: Surgical Tracheostomy.

Table 2. Comparison of patient characteristics

	PDT	ST	P value
Age(years)	64.21±11.36	60.21±8.43	0.075[1]
Male/Female	15/9	27/12	0.582[2]
Endotracheal intubation prior tracheostomy(days)	9.36±4.58	7.5±4.32	0.115[1]
Duration of tracheostomy(days)	29.46±27.01	21.75±17.67	0.176[1]
Procedure duration (minutes)	13.3±5.4	34.2±13.3	**0.0012[1]**
Platelet count, x 1000	226.8±66.7	231.5±69.7	0.791[1]
PTT (second).	35.1±2.7	34.7±2.8	0.67[1]
INR	1.4±0.27	1.42±0.19	0.677[1]

Data are expressed as mean ± standard deviation

PTT: Partial Thromboplastin Time

INR: International Normalised Ratio

[1] Independent samples student t test

[2] Chi square

Table 3. Oxygenation variables

	PDT	ST	P value
Oxygenation index before tracheostomy	204.17±50.5	219.7±71.7	0.318[1]
Oxygenation index after tracheostomy	206.7±61.8	208.8±63.8	0.9[1]
Chance within group (p value)	-2.56 (0.77)[2]	10.91 (0.425)[2]	

[1] Independent samples student t test

[2] Paired samples student t test

PDT was performed more quickly than ST (PDT, 13.3±5.4 mins; ST, 34.2±13.3mins; p=0.0012). There was no significant difference in duration of endotracheal intubation prior tracheostomy (PDT, 9.36±4.58 days; ST, 7.5±4.32 days; p=0.115). Clinical characteristics of two groups are shown in Table 2. Although operations time for ST were longer than PDT, with regard to oxygenation index, there was no significant difference between PDT and ST groups (p=0.318 and p=0.9 respectively). When oxygenation indexes before and after tracheostomies compared within each group, we found also no statistical difference (Table 3).

There was no major intraprocedural complication whereas one postprocedural complication that result in death in PDT group. In that patient, after 3 hours PDT, accidental decannulation of tracheostomy tube was recognised because of resistance to mechanical ventilation and presence of subcutaneous emphysema. Tracheostomy tube was removed and the patient was reintubated with orotracheal tube. Due to prolonged hypoxic period, patient had a cardiac arrest and died. In another PDT patient, minimal subcutaneous emphysema was noticed and resolved within a few days without any specific treatment. In PDT group, two patients had moderate bleeding during procedure. Bleeding from the tracheostomy wound edges was treated with simple compression and instillation of lidocaine and epinephrine. One patient in PDT group had bleeding from incision on the second postoperative day and it controlled with local compression. None of patients were required blood transfusion because of bleeding from tracheostomy skin edge. There were no stomal infections in PDT group. There were no specific complications of PDT that required conversion to ST.

In one patient who had ST, accidental tracheostomy tube dislocation resulted in temporary loss of airway at the end of procedure but tracheostomy tube was reinserted uneventfully. Another patient had bleeding from tracheostomy wound edges one hour after procedure and bleeding was controlled with ligation of vessel. Four patients in ST group had clinical signs of tracheostomy wound infection and wound cultures were positive for bacteria, which was considered proof of infection (p=0.018).Methicillin-resistance *Staphylococcus aureus* was isolated from tracheostomy wound cultures in 3 of these patients. In one patient, wound culture was positive for *Pseudomonas aeruginosa.* In 3 of them, the indication for tracheostomy was pneumonia, and bacteria cultured from tracheostomy wound were identical to that found in the tracheobronchial aspirate. Tracheostomy wound infections were treated with local antiseptics and appropriate antibiotic treatment. There was no case of mediastinitis within both groups. The comparison of intraprocedural and postprocedural complications of both techniques is shown in Table 4.

Overall mortality rates were 48.7% for PDT and 58.3% for ST and there was no statistical significance between two groups (p=0.458). All survivors were successfully decannulated, and no patients required a permanent tracheostomy. Stomal closure times after decannulation in PDT group were shorter than in ST group (p=0.0021). The comparison of outcomes of both techniques is given in Table 5.

Table 4. Comparison of intraprocedural and postprocedural complications

	PDT	ST	P value[1]
Intraprocedural complications			
Paratracheal insertion	0	0	
Subcutaneous emphysema	1(2.56%)	0	1
Loss of airway	0	1(4.1%)	1
Intratracheal bleeding	0	0	
Moderate bleeding (stomal)	2(5.12%)	1(4.1%)	1
Severe bleeding (stomal)	0	0	
Postprocedural complications			
Accidental decannulation	1(2.56%)	0	1
Wound infection	0	4(16.6%)	0.018
Moderate bleeding	1(2.56%)	0	1
Severe bleeding	0	0	
Total	5(12.8%)	6(25%)	

[1] Fisher exact test

Table 5. Outcomes of tracheostomies

	PDT	ST	P value
Duration of tracheostomy(day)	29.46±27.01	21.75±17.67	0.176[1]
Tracheostomy related mortality	2.56%(1)	0	1[2]
Overall mortality	48.7%(20)	58.3%(10)	0.458[3]
Stomal closure time(day)	2.45±0.25	6.76±2.34	**0.0021**[1]

[1] Independent samples student t test

[2] Fisher exact test

[3] Chi square

Discussion

In spite of improvements in cardiac surgery technologies, complications requiring prolonged mechanical ventilation occur in about 2.5% of primary bypass and valve surgery patients' [1]. Most of these critically ill patients can manage with tracheostomy. Until 1985, surgical tracheostomy performed in operating room was the only available option. To eliminate common complications of open tracheostomy, PDT, a minimal invasive alternative to ST, was put into clinical practice [10].

Oxygen desaturation and tissue hypoxia during procedure was considered one of the major complications of tracheostomy. Transportation of critically ill patients from ICU to operating room for surgical tracheostomy increases impairment of gas exchange [8-9]. Likewise, cardiosurgical patients who have low cardiac output or coronary insufficiency are more susceptible to tissue hypoxia. To eliminate the risk of transportation, we prefer ICU to perform either ST or PDT. Oxygenation index (proportion of arterial oxygen partial pressure to fraction of inspired oxygen) is a suitable indicator for arterial oxygen tension. In spite of longer duration of surgical tracheostomy, there was no statistically significant difference in oxygenation index between PDT and ST groups and within each group. This can be explained with the elimination of risk related to unstable cardiosurgical patient's transport to operating room.

Complication rates in our study are within the range reported in other series of tracheostomies [11,12]. The intraprocedural complication rates of PDT and ST were not significantly different. Surgical tracheostomy group did not have any major intraprocedural complications. PDT group had one accidental decannulation, which resulted in death. This complication occurred immediately after procedure and was due to placement of a tracheostomy tube that was shorter for morbid obese patient. This procedure-related mortality was observed in the initial period of our PDT experience. With adequate experience such complications can be avoided or at least held to a minimum. In literature, the incidence of accidental decannulation is approximately 4 % in PDT [11,13].

PDT was superior to ST as it had a lower postprocedural complication rate. Wound infection complications in ST were statistically significant higher than PDT. Although, wound infection rate in ST group was 16.6% in our study, the incidence of wound infection has been as high as 35% [14]. The indication for elective tracheostomy was pneumonia in three of four patients who had wound infection. The cultured organisms within the wound were almost identical to that found in tracheobronchial aspiration. We conclude that wound in ST contaminated with patient's own tracheobronchial bacteria. None of patients who were performed PDT had sings of infection. The minimal tissue disruption and consequent decreased exposure of skin surface is likely the reason for the decreased wound and stomal infections. The minimal tissue disruption may also be the reason for statistically significant more rapid stomal closure in the PDT patients who were decannulated.

In summary, PDT has gained widespread acceptance in patients requiring long-term mechanical ventilation. Our study comparing PDT and ST in critically ill cardiosurgical patients suggests that PDT have some advantages relative to ST including more rapid of performance and stomal closure and lower incidence of postoperative wound infection. For all of these reasons this study supports PDT as the procedure of choice for performing elective tracheostomy in the appropriately selected patient requiring long-term mechanical ventilation.

References

1. Society of Thoracic Surgeons: Data Analysis of the Society of Thoracic Surgeons National Cardiac Surgery Database: The Third Year-January 1994. Minneapolis, MN, Submit Medical System, 1994.
2. LoCicero J 3rd, McCaan B, Massad M, Joob AW. Prolonged ventilatory support after open-heart surgery. Crit Care Med 1992;20:990-2.
3. Stauffer JL, Olson DF, Petty TL. Complications and consequences of endotracheal intubation and tracheostomy. A prospective study of 150 critically ill adult patients. Am J Med 1981;70:65-76.
4. Berlauk JF. Prolonged endotracheal intubation vs. tracheostomy. Crit Care Med 1986;14:742-5.
5. Whited RE. A prospective study of laryngotracheal sequelae in long-term intubation. Laryngoscope 1984;94:367-77.
6. Kane TD, Rodriguez JL, Luchette FA. Early versus late tracheostomy in the trauma patient. Respir Care Clin N Am 2000;3:1-20.
7. Zollinger RM Jr, Zollinger RM. Atlas of Surgical Operations. Seventh Edition. New York, McGraw-Hill, 1993.
8. Smith I, Fleming S, Chenaianu A. Mishaps during transport from the intensive care unit. Crit Care Med 1990;18:278-81.
9. Indeck M, Peterson S, Smith J, Brotman S. Risk, cost and benefit of transporting ICU patients for special studies. J Trauma 1988;28:1020-25.
10. Ciaglia P, Firsching R, Syniec C. Elective percutaneous dilatational tracheostomy. A new simple bedside procedure; preliminary report. Chest 1985;87:715-9.
11. Friedman Y, Fildes J, Mizock B et al. Comparison of percutaneous and surgical tracheostomies. Chest 1996;110:480-85.
12. Heikkinen M, Aarnio P, Hannukainen J. Percutaneous dilational tracheostomy or conventional surgical tracheostomy? Crit Care Med 2000;28:1399-02.
13. Toursarkissian B, Zweng TN, Kearney PA Pofahl WE, Johnson SB, Barker DE. Percutaneous dilational tracheostomy: report of 141 cases. Ann Thorac Surg 1994;57:862-67.
14. Westphal K, Byhahn C, Rinne T, Wilke HJ, Wimmer-Greinecker G, Lischke V. Tracheostomy in cardiosurgical patients: Surgical tracheostomy versus Ciaglia and Fantoni methods. Ann Thorac Surg 1999;68:486-92.