Risk Factors for Tracheostomy Infection in Ventilator-dependent Patients

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Abstract

Tracheostomy is a common procedure in mechanically ventilated patients. The incidence of tracheostomy stoma infection (TSI) varies among different institutes. The aim of this study was to investigate whether patients' characteristics, peri-operative data and tracheostomy cuff deflation were associated with TSI. Patients receiving tracheostomy operation in respiratory intensive care unit of our institution from April 2005 to May 2006 were studied retrospectively. Some of them received tracheostomy cuff deflation after operation. Patients' characteristics, peri-operative conditions and tracheostomy cuff deflation were reviewed from their medical records. TSI was defined as erythematous change, swelling around wound, purulent discharge from wound and discharge culture with bacterial growth. The difference among those factors in TSI and non-TSI patients and those with and without tracheosotmy cuff deflation was examined. Eighty-six patients who received tracheostomy were included. TSI occurred in 12 patients (13%). Leukocytosis before tracheostomy was associated with TSI (15993 ± 1730 vs 11134 ± 415 cells/ μ l, P = 0.004). Persistent or increased pulmonary infiltrates were more common in TSI than in non-TSI patients (91.7% vs 64.9% P = 0.094). The rates of TSI were similar between patients with and without tracheostomy cuff deflation (5/43 vs 7/43,P = 0.378) but mortality rate was higher in patients without tracheosotmy cuff deflation (23.3% vs 7%, P = 0.034). None of mortality cases died of tracheostomy. Surgeons should be aware of the possibility of TSI if the patient has leukocytosis and residual pulmonary infiltrates were found on CXRs before operation. In this study, tracheostomy cuff deflation did not reduce TSI. The casual relationship between tracheosotmy cuff deflation and mortality needs further study.(J Intern Med Taiwan 2008; 19: 508-515)

Key Words：Tracheostomy, Wound infection, Tracheostomy cuff deflation

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Introduction

The standard tracheostomy (ST) technique was first described in 1909.[1] Though tracheostomy provides many benefits for long-term ventilator dependent patients, it has also been associated with some complications such as bleeding, pneumothorax, tracheal stenosis, stoma infection, tracheomalacia, tracheoinnomiate artery fistula, pneumomediastinum, tracheoesophageal fistula. Wound infection is related to the tissue destruction by surgical procedure and this may be reduced by percutaneous dilatation tracheostomy (PDT).[2] However, wound infection occurs after tracheostomy with both methods: PDT (0-10%) and ST (0-63%).[3]

The tracheostomy tube cuff deflation procedure allows perfusion of tracheal mucosa. The secretion around and above cuff can be suctioned during deflation.[4,5,6] However disadvantages of routine cuff deflation may include risk of aspiration and hypoxemia, lack of effect on tracheal wall pressure, and potential overinflation of cuff on reinflation.[4] We devised a standard protocol but it was a time- and labor-consuming procedure for nurses in intensive care unit. Moreover, this procedure was not widely adopted by all surgeons in our institution. To date, no studies have reported that showed tracheostomy tube cuff deflation decreases post-operative wound infection. In addition to patient characteristics, we evaluated whether tracehostomy tube cuff deflation was also a risk factors for TSI.

Material and Methods

This study was conducted retrospectively in a 24-bed respiratory intensive care unit (RICU)of Taichung Veterans General Hospital (TCVGH) from April 2005 to May 2006. The protocol was reviewed and approved by the Ethics Committee/ Institutional review board of TCVGH and informed consents was waived. Patients who received tracheostomy were enrolled. Exclusion criteria included incomplete stoma wound record, previous tracheostomy and intubation more than 2 months. We reviewed the medical and nursing records for tracheostomy stoma wound condition, including erythematous change, swelling around wound, purulent discharge from wound, and wound healing for 7 days after tracheostomy or till death if the patient died within 7 days after operation. If the above conditions of tracheostomy stoma appeared, bacterial culture of the discharge from tracheostomy stoma would be done in our unit according to standard procedure. TSI was defined as all of the above wound conditions plus discharge culture with bacterial growth.[7]

The tracheostomy tube cuff deflation was performed every four hours and as needed. The procedure included: 1. tracheal suctioning via tracheosotmy tube and then oropharynx suctioning via oral with the first suction tube. 2. introducing the 2nd suction tube through tracheostomy and suctioning when the tracheostomy cuff was deflated. 3. inflating the cuff with the same amount of air as was used in procedure 2 after suctioning.[5,6]

The following data of each patient were collected: sex, age, Acute Physiology and Chronic Health Evaluation II (APACHE II) score at admission and their co-morbidities such as diabetes mellitus (DM), hemodialysis, congestive heart failure, cerebral vascular accident, chronic obstructive pulmonary disease (COPD), and cancer. Their hospital course and outcome were also evaluated, including mortality, length of hospital stay, days from initial intubation to tracheostomy, reason for intubation. Laboratory data included white blood cell count, percentage of neutrophil, platelet count, CRP three days before operation, prothrombin time (PT), international normalized ratio (INR), albumin, and creatinine. We record the laboratory data, which were the worst within three

Table 1. Demographic data for patients with and without tracheostomy stoma infection

	Total (n=86)	Stoma infection (n=12)	No Stoma infection (n=74)	P value
Age	75.8 ± 12.1	76.4 ± 10.2	75.7 ± 12.5	0.708
Sex (male/female)	68/18	8/4	60/14	0.218
In hospital days	48.5 ± 25.4	56.4 ± 19.3	47.2 ± 26.1	0.206
Period time*	25.4 ± 15.5	23.6 ± 7.7	25.7 ± 16.4	0.98
APACHE II at admission	23.5 ± 6.1	23.8 ± 5.0	23.4 ± 6.3	0.622
In hospital mortality	13 (15.1%)	3 (25%)	10 (13.5%)	0.26
Comorbid conditions				
Diabetes mellitus	25 (29%)	4 (33.3%)	21 (28.4%)	0.482
COPD	43 (50%)	6 (50%)	37 (50%)	0.622
Stroke	30 (34.9%)	4 (33.3%)	26 (35.1%)	0.597
Hemodialysis	12 (13.9%)	2 (16.7%)	10 (13.5%)	0.528
Congestive heart failure	24 (27.9%)	2 (16.7%)	22 (29.7%)	0.288
Malignancy	13 (15.1%)	1 (8.3%)	12 (16.2%)	0.275
Reasons for intubation				
pneumonia	59 (68.6%)	8 (66.7%)	51 (68.9%)	0.559
non-pneumonia	27 (31.4%)	4 (33.3%)	23 (31.1%)	0.582

Data are presented as number/total (%) or mean ± SD. *days from intubation to tracheostomy. APACHE II, Acute Physiology and Chronic Health Evaluation II.

days before tracheostomy op. The management of each patient included steroid use (>10 mg/d at least one week before tracheostomy), use of antibiotics before and continue after tracheostomy, tracheostomy cuff deflation procedure and usage of Y-gauze number for wound care. The counting of Y-gauze is the average of total amount of Y-gauze within seven days. CXRs were read by an expert on chest radiography who was blinded to the patient's clinical condition. Pulmonary infiltration was defined as persistence or increase of infiltration found on 3 series of CXRs before tracheostomy.

Statistical analysis

Quantitative variables were described as mean ± standard deviation (mean ± SD). Statistical evaluation was performed using the X^2 test for classification variables and Mann-Whitney U test for continuous variables. Diagnostic accuracy of the parameters was evaluated with the determination of diagnostic sensitivity and specificity, the likelihood ratio (LR), and the receiver operating characteristics (ROC) curve of each. Data was analyzed using the Statistical Package for the Social Sciences Software (version 11.0) for Windows. Statistical significance was defined as $P < 0.05$.

Results

Ninety four patients who received conventional surgical tracheostomy were evaluated. Eight patients were excluded because of previous tracheostomy (n=1), incomplete stoma wound record (n=5) and chronic respiratory failure with prolonged intubation at another hospital (n=2, 3 and 5 months in a respiratory care ward respectively). After these exclusions, 86 patients were enrolled in the study. Reasons for admission included pneumonia (n=57), sepsis other than pneumonia (n=7), COPD with respiratory failure (n=5), congestive heart failure (n=4), poison intoxication (n=3), lung cancer (n=2) and others (n=7). Their

Table 2. Data for patients with and without tracheostomy stoma infection

	Total (n=86)	Stoma infection (n=12)	No Stoma infection (n=74)	P value
Before and continue after operation				
Antibiotics use*	63 (73.3%)	9 (75%)	54 (72.9%)	0.596
Steroid use+	2.9 ± 1.3	3.4 ± 1.6	2.7 ± 1.1	0.134
Before operation				
Infiltration‡	59 (68.6%)	11 (91.7%)	48 (64.9%)	0.094
Haemoglobin (g/dl)	9.9 ± 1.5	9.8 ± 1.7	10 ± 1.4	0.672
Albumin (g/dl)	2.6 ± 0.5	2.7 ± 0.5	2.6 ± 0.5	0.863
Creatinine (mg/dl)	1.0 ± 0.9	1.2 ± 1.2	1.0 ± 0.8	0.743
WBC (cells/ μ l)	11812.2 ± 4296.	15993.3 ± 1729.9	11134.2 ± 414.9	0.004
Neutrophil (%)	78.5 ± 10.6	82.6 ± 7.6	77.8 ± 10.9	0.159
Platelet (cell x 10^3/ μ l)	345.2 ± 159.2	320.8 ± 158.8	349.1 ± 159.9	0.832
CRP	6.5 ± 5.5	7.7 ± 8.6	6.4 ± 5.1	0.674
PT (INR)	1.2 ± 0.2	1.2 ± 0.143	1.24 ± 0.187	0.704
After operation				
Cuff deflation	43 (50%)	5 (41.7%)	38 (51.4%)	0.378
Y-gauze number	53 (61.6%)	8 (66.7%)	55 (74.3%)	0.404

Data are presented as number/total (%) or mean ± SD. PT, Prothrombin time; INR, International normalized ratio; WBC, White blood cell.*antibiotics use: any antibiotics use before and after tracheostomy, +steroid use: prenisolone≧ 10 mg/d for at least 1 week before tracheostomy. ‡infiltration: increased or persistent lung infiltration found on 3 series of CXRs before tracheostomy.

demographic data and peri-tracheostomy data are shown in table 1 and (table 2), respectively. None of them died within one week after tracheostomy operation. The reasons for in-hospital mortality were not related to TSI (Table1).

Fourteen patients experienced redness, swelling and wound discharge The discharge was collected for bacterial culture. Eight of 12 patients with TSI were initially intubated due to severe pneumonia. However, the incidence of TSI was similar between patients with and without pneumonia at admission. Increased or persistent infiltration was found on CXRs before operation in eleven patients with TSI and 48 patients without TSI (91.7% vs 64.9% p = 0.094). Patient with TSI had a significantly higher white blood cell count within 3 days before operation than those without TSI (15993 ± 1730 cells / μ l vs 11134 ± 415cells / μ l, p=0.004). With a cut-off value of 12100 cells / μ l, white blood cell count predicted wound infection with sensitivity of 83.3% and specificity of 66.2%.

Bacterial culture of tracheostomy wound was performed in 14 patients and yielded bacteria in 12 of them. Eight specimens yielded more than one organism, and total of 22 organisms were isolated. Pseudomonas aeruginosa (P.A)(n=7) was most common followed by Klebsiella pneumoniae (K.P)(n=4), Staphylococcus aureus (S.A)(n=3), Acinetobacter baumanni (A.B)(n=3) and others (n=5). The antibiotics sensitivity test of these organism: P.A resistant to Carbapenem (14%); P.A resistance to Ceftazidime (28%); K.P with extended-spectrum β-lactamase (75%); S.A with methicillin-resistance (100%).

A total of 43 patients received tracheostomy cuff deflation. The patients' demographic data was

Table 3. Demographic data for patients with and without tracheosotmy cuff deflation

	Cuff deflation (n=43)	No Stoma infection (n=43)	P value
Age	75.4 ± 15.2	76.3 ± 8.1	0.382
Sex(male/female)	30/13	38/5	0.031
In hospital days	50.3 ± 27.2	46.8 ± 23.7	0.736
Length from intubation to tracheostomy (days)	25.3 ± 18.8	25.5 ± 11.5	0.196
APACHE II at admission	22.2 ± 6.2	24.7 ± 5.7	0.058
In hospital mortality	3 (7.0%)	10 (23.3%)	0.034
Comorbid condition			
Diabetes mellitus	12 (27.9%)	13 (30.2%)	0.5
COPD	18 (41.9%)	25 (58.1%)	0.098
Stroke	16 (37.2%)	11 (25.6%)	0.176
Hemodialysis	14 (32.6%)	9 (20.9%)	0.165
Congestive heart failure	12 (27.9%)	12 (27.9%)	0.595
Malignancy	5 (11.6%)	8 (18.6%)	0.419
Reasons for intubation			
pneumonia	30 (69.8%)	29 (67.4%)	0.5
non-pnuemonia	13 (30.2%)	14 (32.6%)	0.5

APACHE II, Acute Physiology and Chronic Health Evaluation II.

similar in both groups as shown in (table 3). Their clinical conditions shortly before and right after the tracheostomy were also similar The rates of TSI were not different significantly between those with and without tracheostomy cuff deflation (5/43 vs 7/43, p=0.378). However, the mortality rate of patients without cuff deflation was higher than those with cuff deflation (23.3% vs7%, p = 0.034).

Discussion

Though we could not demonstrate that tracheostomy tube cuff deflation decreased the incidence of TSI, we found that white blood cell count before operation predicted the development of TSI. Those data help us to identify the patients with high risk for TSI and provided us the evidence of stopping routine cuff deflation after tracheostomy operation.

The incidence of TSI was 13% in this study which is reasonable. Although the incidence of TSI varied from 0% to 60% in the study by Durbin,[3] it was around 10% to 20% in most studies.[8] Wound infection is one of the tracheostomy complications and can be severe enough to cause patient mortality.[2] All of wound infections in this study were minor and none of them progressed to necrotizing fascilitis, myositis or sepsis. We defined days from tracheostomy to bacterial culture growth as the time of TSI, and there are similar between cuff deflation and no cuff deflation. The bacteria growing in wound culture is not always the pathogen which cause wound infection. Their patterns of antibiotic resistance were similar to the organisms in our ICU. The bacteria of wound culture might be colonized organisms in those patients.

Percutaneous dilatational tracheostomy was devised 20 years ago. It has the same advantages as conventional surgical tracheostomy but with a lower rate of TSI.[8] Wound infections seldom occur with percutaneous tracheostomy was due to avoidance of dissection of tissue which decreases space where tracheobronchial secretion can

Table 4. Summary data in 13 mortality cases

	sex	age	Admission diagnosis	Cuff deflation	Intubation days*	Death days✣	Cause of death
Case 1	Male	82	Pneumonia	no	34	17	Pneumonia
Case 2	Male	77	Pneumonia	no	36	43	Peritonitis
Case 3	Male	82	Pneumonia	no	46	72	Wound infection‡
Case 4	Male	63	Pneumonia	no	8	10	Urosepsis
Case 5	Female	64	Thyroid cancer	no	10	8	HHS§
Case 6	Male	79	Uremia	no	19	70	Ischemic bowel
Case 7	Male	79	AMI	no	55	10	Heart failure
Case 8	Male	85	Pneumonia	no	42	21	Pneumonia
Case 9	Male	86	COPD	no	25	15	Fournier's gangrene
Case 10	Male	67	Hepatoma	no	17	41	hepatoma
Case 11	Male	79	Pneumonia	yes	24	63	Pneumonia
Case 12	Male	77	Pneumonia	yes	21	24	Sepsis
Case 13	Male	67	Meningitis	yes	34	11	Liver abscess

*days from intubation to tracheostomy
✣days from tracheostomy to death
‡Bilroth II anastomosis with wound leakage and infection
§Hyperglycemic Hyperosmolar State.
AMI: Acute myocardial infarction

facilitate TSI.[7] The tracheobronchial secretions can be from lower airway, upper airway and around tracheostomy cuff area. In our study, tracheostomy cuff deflation improved stoma tissue perfusion and decreased the tracheobronchial secretions retained within the tracheostomy stoma.[6] Our data did not support the hypothesis that tracheostomy deflation reduces the likelihood of wound infection of tracheostomy stoma.

None of the enrolled patients died of infection around neck area or within 7 days after operation (Table 4). However, mortality rate was higher in no cuff deflation group significantly. In spite of no statistical significance, APACHE II score at admission was higher in the group of no cuff deflation than in the group of cuff deflation (24.7± 0.9 vs 22.2±0.9, p=0.058). The difference between both groups was probably confounded by the non-equality of disease severity. Further studies are necessary to determine whether the relationship of cuff deflation and mortality is causal.

The 1989 American College of Chest Physicians (ACCP) Consensus Conference on Artificial Airway in patients receiving mechanical ventilation suggested tracheostomy should be performed when mechanical ventilation is needed for more than 21 days.[9] In this study, the mean length of hospital stay was 25.4 days. It was longer from intubation to tracheostomy in TSI patients than in non-TSI but the difference was not statistically significant. Stoma wound infection was not associated with intubation duration before tracheostomy.

Higher white blood cell count (cut-off value: 12100 cell/ μl, p=0.004) was a risk factor for TSI. Neutrophils (%) and CRP level were also higher in TSI than non-TSI patients, even though these findings were not statistically significant. This may be due to insufficient control of infection or inflammation. Among the wound infection group, the CXR of eleven patients showed persistent or increased pulmonary infiltrates before operation

($p = 0.094$). If the patients had pulmonary infiltrates and high WBC counts before operation, it suggested that pulmonary infection had not well controlled. If they would received tracheostomy operation, their wound should be cared intensively or percutaneous dilatational tracheostomy should be chosen to reduce the incidence of TSI.

This study had some limitations. 1) It was retrospective; 2) Sample size was relatively small; 3) Definition of wound infection was relatively subjective because we evaluated wound infection according to nursing record of wound condition and discharge culture; and 4) Operator factors were not examined in the study because several surgeons were randomly consulted to perform tracheostomies.

In spite of the study limitations, our findings make a valuable contribution to the literature on tracheostomy and its relation to TSI. We should be aware of the possibility of TSI if the patient has leukocytosis and persistent or increased pulmonary infiltrates are found on CXRs before operation. The causal relationship between tracheosotmy cuff deflation and mortality needs further study.

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使用呼吸器且接受氣管切開術的病人其發生氣切傷口感染的危險因子之探討

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摘 要

氣管切開術在呼吸器依賴的病人是一種常見的手術方式，因氣切手術引起的傷口感染比率各家報告皆有差異，本研究將探討氣切手術前後病患的臨床特徵與氣切術後的氣囊釋放術是否可以預測氣切傷口感染的發生。從2005年4月到2006年5月，在呼吸加護病房中有些病人在氣切手術後曾接受氣切氣囊釋放術照護。我們收集所有接受氣切手術病人的臨床表徵與是否接受氣切氣囊釋放術的資料。定義氣切傷口感染爲傷口有紅、腫、膿樣的分泌物及有分泌物培養。然後分析這些病患的臨床表徵與氣切氣囊釋放術和氣切傷口感染的相關性。收集86位病人，其中有12位病人發生氣切傷口感染，比率爲13%。氣切傷口感染組的術前白血球偏高(15993 ± 1730 vs 11134 ± 415 cells/μl, p=0.004)。肺部浸潤持續或增加的情形在氣切傷口感染組也有增加的趨勢(91.7% vs 64.9%, p = 0.094)。以有無接受氣切氣囊釋放術分成兩組，他們的氣切傷口感染率相似(5/43 vs 7/43, p = 0.378)，但死亡率在沒有接受氣切氣囊釋放術的組別比較高(23.3% vs 7%, p=0.034)。沒有病人是因爲氣切手術的併發症直接導致死亡。當病人作氣切手術之前有白血球過高及肺部浸潤的情形時，外科醫師需要謹慎預防術後氣切傷口感染。氣切氣囊釋放術不會減少氣切傷口的發生率，但這些病人的死亡率較低。未施予氣切氣囊釋放術與病人死亡的因果關係需要進一步研究。