Risk Factors Evaluation and the Cuff Leak Test as Predictors for Postextubation Stridor

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Objective: *To determine the risk factors and the cuff-leak test for predicting postextubation stridor.*
Material and Method: *A prospective, clinical investigation in 543 patients in intensive care units at Buddhachinaraj Hospital, a 908-bed hospital in Thailand, with patients who were considered by their physician to extubate the endotracheal tube. The cuff leak test was done and recorded as presence of leak or absence of leak. After extubation, postextubation stridor and reintubation were determined.*
Results: *Of the 543 patients studied, 26(4.8%) had postextubation stridor, 45(8.3%) required reintubation, 21(80.8%) of 26 patients with postextubation stridor required reintubation, and 21(46.7%) of 45 reintubated patients had postextubation stridor. Postextubation stridor was associated with female, asthmatic patients, patients with excessive tube mobility due to insufficient fixation, and those who were fighting against the tube. Twenty-eight out of 543 patients had absence of leak. The absence of leak was observed in four (15.4%) of 26 patients with postextubation stridor and 24 (4.6%) of 517 patients without postextubation stridor. The sensitivity and the specificity of the cuff leak test were 15.4% and 95%, respectively. The positive and negative predictive values were 14.3% and 95.7%, respectively.*
Conclusion: *The method of cuff leak test in the present study is not a good predictor for extubation with postextubation stridor. Risk factors for developing postextubation stridor are female, asthma, excessive tube mobility due to insufficient fixation, and fighting against the tube.*

Keywords: *Cuff leak test, Postextubation stridor, Reintubation*

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Endotracheal intubation may generate local complications, laryngeal edema manifests itself by respiratory distress and inspiratory whistling after extubation called "postextubation stridor"[1-3]. The frequency of this complication is estimated to range between 2 and 37%[4-11].This complication may result in emergency reintubation in rather difficult circumstances with increased in morbidity and mortality. Treatment options for postextubation stridor include nebulized racemic epinephrine, helium-oxygen mixture, and corticosteroids. Reintubation is reported in up to 10% of patients who require treatment for postextubation stridor[4-7,10]. The cuff leak test, which involves demonstrating a leak around the endotracheal tube with the cuff deflated, has been proposed as a simple method of predicting the occurrence of this complication[6,7,10,12,13]. This test consists of deflating the balloon cuff of the endotracheal tube in order to assess the air leak around the tube, which permits an indirect evaluation of upper airway patency. A small leak or absence of leak would be suspicious of an occurrence of airway obstruction after extubation, which would lead the clinician to consider preventive treatment before extubation and/or to initiate treatment after extubation as soon as possible. Cuff leak test has been studied in several methods. The endotracheal tube balloon cuff was deflated, the tube was then obstructed with a finger, and the absence of leak was monitored. The absence of leak was observed in 100% of extubation with postextubation stridor and in 20% of extubation without postextubation stridor[14]. Potgieter and Hammond[15] reported that laryngeal edema was likely when they were unable to hear the patient's breath

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around the tube during a brief obstruction maneuver. Similarly, Fisher et al[7] reported that hearing a leak was predictive of successful extubation, although a failure to hear breaths did not preclude extubation. Another method consists of measuring the expiratory tidal volume with and without the deflating cuff. A relatively large difference between this two values indicates that the cross sectional area of the trachea and upper airway is large enough to render the occurrence of postextubation stridor, and therefore, the possibility of reintubation due to airway obstruction will be unlikely[4,6,10,16]. However, the cut-off point of leak volume differed substantially between studies. The incidence of laryngotracheal edema was increased among female patients, particularly those with a long duration of intubation[8,9], traumatic intubation, excessive tube size, excessive tube mobility due to insufficient fixation, patient fighting against the endotracheal or trying to speak, too frequent or too aggressive tracheal aspiration[17].

The aims of the present study were to evaluate the risk factors and the accuracy of the cuff leak to predict postextubation stridor in an intensive care unit population. The cuff leak test was performed by auscultation at the trachea to detect air leak around the trachea during expiration after deflating the balloon cuff of the endotracheal tube to detect postextubation stridor

Material and Method

Patients

The Ethical Committee for Human Study at Buddhachinaraj Hospital, Pitsanulok, Thailand approved this prospective clinical investigation study. Informed consent was obtained either from the patients or from their next of kin. All patients who were hospitalized in the hospital 8 adult ICUs who were intubated for more than 12 hours and considered by their physician to be ready for extubation were included in the present study. The study lasted 10 months between March 1st, 2007 and January 1st, 2008

Data collection

On admission to the unit and/or at the time of intubation, the following parameters were recorded: age, sex, indication for intubation, trauma and/or difficult intubation, history of unplanned extubation, balloon cuff pressure more than 25mmHg after intubation, excessive tube mobility due to insufficient fixation and fighting against the tube. Immediately and 24 hours after extubation, the following parameters were documented: the result of cuff-leak test, the duration of intubation and the occurrence of an episode of self-extubation during the hospitalization. After the extubation, the occurrence of postextubation stridor, respiratory distress and need for reintubation were monitored. Postextubation stridor was defined as the presence of an audible high-pitched inspiratory wheeze localized in the trachea or larynx occurring within 24 hours of extubation associated with a respiratory rate greater than 30 per minute or increase by greater than 10 per minute from baseline[6].All assessments for stridor, respiratory distress, treatment with epinephrine aerosolization and/or steroid and need for reintubation were made by the ICU physicians who were blinded to the measurements obtained by the nurses.

Cuff leak test

The cuff leak test was systematically preceded by a careful endotracheal and oral suctioning. Briefly, after the cuff was deflated and applying the ambu bag, the presence of leak around the trachea was detected by auscultation at the trachea if the sound of respiratory flow was detected, and absence of leak was detected if the sound was not detected. The cuff leak test was performed and recorded by the experienced ICU nurses who were routinely assigned to take care of the patients.

Statistics

Data were analyzed with commercially available software (SPSS for Windows, version 13.0, SPSS, Chicago, Illinois). All continuous variables were reported as means $\pm$ SD. Frequencies were used to describe categorical data. The unpaired *t* test was used to compare differences between patients with and without postextubation stridor for continuous variables, and Chi-square test or Fishers' exact test was used for categorical variables.

The accuracy of the test is represented as sensitivity [SE = TP x 100/(TP + FN)], specificity [SP = TN x 100/(TN + FP)], positive predictive value [PPV = TP x 100/(TP + FP)] and negative predictive value [NPV = TN x 100/(TN + FN)] where TP(true positive) is absence of leak and stridor, TN(true negative) is presence of leak and no stridor, FP(false positive) is absence of leak and no stridor, FN(false negative) is presence of leak and stridor[18,19].

Results

Five hundred forty three extubations and cuff leak test done between March 1, 2007 and January 1,

2008 were studied. The incidence of postextubation stridor was 4.8% (26). Forty-five (8.3%) of 543 patients required reintubation, 21(80.8%) of 26 patients with postextubation stridor required reintubation, and 21 (46.7%) of 45 reintubated patients had postextubation stridor. Post extubation stridor was detected within a mean duration of 46.9 minutes (mean 46.9, SD = 45.2, range 3-165 minutes) after extubation. Characteristics of patients who developed postextubation stridor with those who did not develop postextubation stridor are shown in Table 1.

Risk factors for developing postextubation stridor are female (p-value = 0.01), asthma (p-value = 0.003), excessive tube mobility due to insufficient fixation (p-value = 0.001), and those who were fighting against the tube (p-value = 0.01).

The distribution of presence of leak and absence of leak according to the occurrence of post-extubation stridor is shown in Table 2.

The absence of leak that was detected from the cuff leak test was assumed as positive cuff leak test. The sensitivity and the specificity of the cuff leak test were 15.4% and 95%, respectively. The positive and negative predictive values were 14.3% and 95.7%, respectively.

Discussion

The cuff leak test in the present study was different from other studies. The cuff leak test in the present study was designed to be simplified for the ICU nurses who routinely take care of the patients to predict postextubation stridor. The tube was not

Table 1. Patient characteristics

	Presence of postextubation stridor (n = 26)	Absence of postextubation stridor (n = 517)	p-value
Age (years)	67 ± 16	60 ± 18	0.08
Sex (M/F)	9/13	311/206	0.01
Indication for mechanical ventilation			
Pneumonia	5	106	0.87
ARDS	0	8	0.52
COPD	5	73	0.46
Asthma	2	5	0.003
CHF	3	103	0.29
Ventilation failure	9	117	0.15
Other	2	105	0.11
Trauma and/or difficult intubation	2	33	0.79
History of unplanned extubation	2	19	0.30
Balloon cuff pressure > 25mmHg after intubation	13	291	0.52
Excessive tube mobility due to insufficient fixation	5	22	0.001
Fighting against tube	12	123	0.01
Duration of intubation (days)	5.3 ± 3.2	3.9 ± 3.8	0.08
Reintubation	21	24	<0.001

Table 2. The distribution of presence of leak and absence of leak according to the occurrence of postextubation stridor

	Presence of postextubation stridor (n)	Absence of postextubation stridor (n)	Total (n)
Absence of leak	4	24	28
Presence of leak	22	493	515
Total	26	517	543

obstructed with a finger as described by the previous author[14] because our nurses thought that it might be harmful to the patients. The cuff leak test in the present study was systematically preceded by a careful endotracheal and oral suctioning. Briefly, after the cuff was deflated and applying the ambu bag, the presence of leak around the trachea was detected by auscultation at the trachea, when the sound of respiratory flow was detected. The absence of leak was when the sound of respiratory flow was not detected. Absence of leak detected before extubation permits the identification of patients with an increased risk of postextubation stridor. The sensitivity in the present study was 15.4%, the specificity was 95%, the positive predictive value was 14.3%, and the negative predictive value was 95.7%. The method of cuff leak test in the present study is not a good predictor of postextubation stridor.

The present study results of the cuff leak test differ from those of previous authors, the test failed to predict accurately in cases of extubation with postextubation stridor. Difference in results between this present study and the others may be due to the tests being performed differently. The tube was not obstructed with a finger as in the previous author[14], the presence of sound by auscultation may be the sound of respiratory flow in the lumen of endotracheal tube. That was the reason to record as the presence of air leak around the endotracheal tube in the cases of actually absence of air leak around the endotracheal tube, in these cases, they recorded a false negative. Maury et al[14] studied 115extubation, their cuff leak test was different from the present study. In spontaneously breathing patients, immediately before extubation, the tracheal tube was deflated and the absence of cough was monitored. The tube was then obstructed with a finger and the absence of leak was monitored. Extubation was then performed. The absence of leak was observed in 100% of extubation with postextubation stridor and in 20% of postextubation stridor free extubation. They concluded that the presence of leaking around the endotracheal tube rules out postextubation stridor, whereas the absence of cough and leak are good predictors of postextubation stridor. Many authors suggest that leak volume may predict the occurrence of postextubation stridor and might thus identify the subset of patients at risk of reintubation due to upper airway obstruction[4,6,16]. However, the cut-off point of leak volume differed substantially between studies. A measured cuff leak volume of less than 15.5%[4], 12%[16], or 10% of predetermined tidal volume[10] has been used to identify patients at risk for postextubation stridor.

In the present study, the incidence of postextubation stridor is 4.8%. Postextubation stridor incidence ranges from 2% to 37% depending on the patients studied and the definition used[4-11]. However, the large study on this topic, including 700 adult patients, reported an overall incidence of postextubation laryngeal edema of 4.2%[8]. Postextubation stridor can be life-threatening and may require prompt and sometimes difficult reintubation. Twenty-one (80.8%) patients of 26 patients who had postextubation stridor in the present study required tracheal reintubation. Rashkin et al reported that reintubation in 50% of extubation with postextubation stridor[2].The incidence of postextubation stridor was increased among females (p-value = 0.01), asthmatic (p-value = 0.003), patients with excessive tube mobility due to insufficient fixation (p-value = 0.001), and those who were fighting against the tube (p-value = 0.01).

Conclusion

The method of cuff leak test in the present study is not a good predictor for extubation with postextubation stridor. Risk factors for developing postextubation stridor are female, asthma, excessive tube mobility due to insufficient fixation, and fighting against the tube.

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การประเมินปัจจัยเสี่ยงและการทดสอบลมรั่วข้างท่อหลอดลมในการทำนายการเกิด postextubation stridor

สุรพงศ์ สุขุปัญญารักษ์

วัตถุประสงค์*: เพื่อค้นหาปัจจัยเสี่ยง และการทดสอบ ลมรั่วข้างท่อหลอดลม ในการทำนายการเกิด postextubation stridor*

วัสดุและวิธีการ*: เป็นการศึกษาแบบไปข้างหน้า ในผู้ป่วย543 รายในหอผู้ป่วยหนักในโรงพยาบาลพุทธชินราช พิษณุโลกที่แพทย์ผู้ทำการรักษาพิจารณาให้ถอดท่อหลอดลม ทดสอบลมรั่วข้างท่อหลอดลม และบันทึกผลเป็น มีลมรั่ว หรือไม่มีลมรั่ว หลังถอดท่อหลอดลมทำการสังเกตอาการ postextubation stridor และการใส่ท่อหลอดลมซ้ำ*

ผลการศึกษา*: ในจำนวนผู้ป่วยทั้งสิ้น 543 ราย มีผู้ป่วยที่มี Postextubation stridor 26ราย (4.8%) 45ราย (8.3%) จำเป็นต้องใส่ท่อหลอดลมซ้ำ 21 ราย (80.8%) ของผู้ป่วย 26 รายที่เกิด postextubation stridor จำเป็นต้องใส่ท่อหลอดลมซ้ำ 21 ราย (46.7%) ของผู้ป่วย 45 รายที่จำเป็นต้องใส่ท่อหลอดลมซ้ำพบpostextubation stridor พบ postextubation stridor มากขึ้นใน ผู้หญิง หอบหืด ผู้ป่วยที่ท่อหลอดลมเคลื่อนที่บ่อย ๆ จากการผูกมัดไม่แน่น หรือ พยายามกัด ขยับท่อหลอดลม การทดสอบ ลมรั่วข้างท่อหลอดลม พบไม่มีลมรั่ว 4 ราย (15.4%) ของผู้ป่วย 26 รายที่เกิด postextubation stridor พบไม่มีลมรั่ว 24 ราย (4.6%) ของผู้ป่วย 517 รายที่ไม่เกิด postextubation stridor ความไว และความจำเพาะของการทดสอบลมรั่วข้างท่อหลอดลมที่ไม่มีลมรั่วแล้วเกิด postextubation stridor เท่ากับ 15.4 และ 95% ตามลำดับ positive predictive value และ negative predictive value เท่ากับ 14.3 และ 95.7% ตามลำดับ*

สรุป*: การทดสอบลมรั่วข้างท่อหลอดลมโดยวิธีการในการศึกษานี้ ไม่สามารถใช้ในการพยากรณ์การเกิดภาวะ post-extubation stridor ได้ พบปัจจัยเสี่ยงในการเกิดpostextubation stridor ใน ผู้หญิง หอบหืด ผู้ป่วยที่ท่อหลอดลมเคลื่อนที่บ่อย ๆ จากการผูกมัดไม่แน่น หรือ พยายามกัด ขยับท่อหลอดลม*