

Tracheal Stenosis and Cuff Pressure: Comparison of Minimal Occlusive Volume and Palpation Techniques

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Background: Tracheal stenosis, which has received more emphasis recently, is a common post intubation complication and may develop due to different reasons. One important reason is the endotracheal tube cuff pressure. Therefore, this study sought to examine the accuracy of diagnostic test for palpation and minimal occlusive volume techniques to measure the endotracheal tube cuff pressure.

Materials and Methods: In this cross sectional study, the accuracy of diagnostic tests for palpation and minimal occlusive volume techniques to measure the endotracheal tube cuff pressure was assessed in 101 patients aged over 18 years who had undergone open heart surgery and post-surgical mechanical ventilation in the ICU.

Results: In the palpation technique, the cuff pressure of 27 patients (26.7%) was reported to be out of the permissible range and for the rest of them (74 patients, 73.3%) it was within the permissible range. Then, the cuff pressure was checked by the standard method using a manometer and after comparing the results it was found that the cuff pressure of 92 patients (91.1%) was not in the permissible range and only nine patients (8.9%) had a cuff pressure within the permissible range (20-30 cm H₂O). In minimal occlusive volume method compared with the standard method, 22 patients (21.7%) had cuff pressure within the permissible range of 20-30 cm H₂O, and 79 of them (78.2%) had cuff pressure out of the permissible range and higher than the upper limit.

Conclusion: This study recommends that the best way to measure the endotracheal tube cuff pressure is to use a cuff manometer, and when it is not available, the minimal occlusive volume would be a better alternative compared to the palpation technique to keep the cuff pressure within a proper range to avoid tracheotomy complications such as tracheal stenosis.

Key words: Trachea; Tracheal stenosis; Cuff pressure

INTRODUCTION

Endotracheal intubation is the quickest way to obtain a safe and secure airway either in anesthesia and surgeries or in patients with low level of consciousness and compromised airways. The intubation rate in the United States is about 13-20 million cases per year. Post intubation tracheal stenosis usually appears in larynx and trachea, and is seen more frequently in young traumatic patients injured in accidents, who need endotracheal intubation

and mechanical ventilation support due to low level of consciousness (GCS<8) (1).

Regardless of hospitalization reasons such as motor accidents, fall from height, intoxication, cardiovascular disorders, surgical procedures, pulmonary infections or cerebrovascular accident, any patient who has been intubated and undergone mechanical ventilation for some time may develop tracheal stenosis and its incidence varies from 0.1 to 20% (2, 3).

Tracheal stenosis may develop due to different reasons. One important reason is the endotracheal tube cuff pressure. The optimal cuff pressure is determined to be about 20-30 cm H₂O so that aspiration pneumonia due to low cuff pressure and tracheal stenosis due to high cuff pressure are avoided as much as possible (4). Tracheal stenosis, which gets more emphasis recently, is a common post intubation complication all over the world.

The pressure and the stimulatory effect of endotracheal tube cuff are the direct factors causing the stenosis; however, the pressure and the stimulatory effect of other parts of the tube can be effective, as well (5, 6). Stenosis usually occurs in the cervical trachea, and in some cases involves the subglottis as well (7). In most cases of post intubation stenosis, the signs and symptoms appear very late and often after the patients are discharged from the hospital (8, 9). It has been shown in a study that the average time of noting the signs and symptoms of tracheal stenosis is about 7 months. These signs are mild at first and can be mistaken for asthma, but then the stenosis becomes more intense, and severe signs such as hoarseness and contraction of accessory respiratory muscles will appear. Finally, in critical stenosis, tracheostomy may be required (10).

In long duration surgeries such as heart and brain surgeries, the patients may have unstable hemodynamics and therefore difficult weaning and separation from mechanical ventilation. In these patients, the risk of tracheal stenosis will be higher and measuring the endotracheal tube cuff pressure is an important and critical issue.

Measuring the cuff pressure may seem to be of little importance, but it is very important as it can be very helpful in decreasing the morbidity by providing basic nursing care, and decreasing the mortality rate if possible.

As the cuff pressure can be estimated approximately using palpation and minimal occlusive volume techniques, the accuracy of these techniques should be studied so that in absence of a manometer a precise technique can be used to measure the cuff pressure of intubated patients.

Therefore, this study sought to examine the accuracy of these techniques in order to prevent the complications resulting from cuff pressure out of the optimal range.

MATERIALS AND METHODS

Design

This was a cross sectional study which assessed the accuracy of diagnostic test for palpation and minimal occlusive volume techniques to measure the endotracheal tube cuff pressure.

Setting and Population

This study was done in open heart ICU of Rajaei Cardiovascular Medical and Research Center in Tehran. The population under study included all patients aged over 18 who had undergone open heart surgery and were all intubated and connected to the mechanical ventilator. A total number of 101 patients who met the study requirements and their legal guardians had signed the letter of consent, were studied.

Study Protocol

At the first stage of this study, after the intubated patients were transferred from the operating room to the ICU, the nurses estimated their cuff pressure with the palpation technique taking the cuff cushion between their thumb and index fingers. They then reported whether the pressure was within the normal range or not. At the next stage, the cuff pressure was measured with a manometer. The optimal value was determined to be 20-30 cm H₂O. Then the results were compared to test the accuracy of the palpation technique.

The same procedure was repeated with the minimal occlusive volume technique. For this purpose, the mouth, throat and trachea of the patients were suctioned and the cuff was deflated. Then the stethoscope was placed in supra sternal notch and the patient's respiratory sounds were auscultated. Then the cuff was gradually inflated until the respiratory sounds ceased. This volume would provide the proper cuff pressure. At the next stage, the cuff pressure was measured using the gold standard technique, which is measurement with a manometer. Then again the

results were compared to check the accuracy of the minimal occlusive volume (MOV) method.

Data Extraction

The data extraction tools included a questionnaire and a manometer. The demographic information and medical history of the patients were obtained through their hospital records.

Data Processing

The collected data were categorized into minimal occlusive volume (MOV) and Palpation groups and their quantitative measures were calculated and evaluated comparing with the results of the standard method. Then, the sensitivity and specificity of each technique were calculated and evaluated separately. At the end, the results of both techniques were compared and it was found that which technique had a higher diagnostic accuracy.

RESULTS

A total number of 101 patients consisting of 65 males (64.4%) and 36 females (33.6%) were studied. Seventy of them (69.3%) were non smokers; 59 patients (58.4%) had undergone a Coronary Artery Bypass Graft (CABG), 34 patients (33.7%) had valve operation and 8 of them had both operations. All of them were intubated in the operating room and then transferred to the ICU. The cuff pressure of the patients was measured by trained nurses using the palpation technique. The cuff pressure of 27 patients (26.7%) was out of the permissible range and for the rest of them (74 patients, 73.2%) it was within the permissible range. Then the cuff pressure was checked by the standard method using a manometer and after comparing the results it was noted that the cuff pressure of 92 patients (91.1%) was not in the permissible range and only 9 patients (8.9%) had an appropriate cuff pressure within the permissible range (20-30 cm H₂O). Among those who did not have a permissible cuff pressure, only one had a low pressure and the rest had a cuff pressure higher than the permissible limit. Furthermore, among the patients for whom the nurse had reported to have an appropriated cuff pressure using the palpation technique, only 8 of them

(11.6%) showed a permissible (optimal) cuff pressure when checking with a manometer, and for the rest of them (88.4%) it was out of the permissible range. On the whole, the average endotracheal tube cuff pressure taken by palpation technique was 54.09 cm H₂O, and the range was 12-100 cm H₂O.

Then the mentioned procedure was repeated using the minimal occlusive volume method and compared with the standard method. Twenty-two patients (21.7%) had their cuff pressure within the permissible range of 20-30 cm H₂O, and 79 of them (78.2%) had their cuff pressure out of the permissible range, and all higher than the upper limit. The average cuff pressure in minimal occlusive volume was 43.9 cm H₂O with a range of 22-100 cm H₂O.

DISCUSSION

Based on the data analysis and findings of this study, when comparing the results of the palpation technique to those of the standard technique, only 8.9% of the patients had their cuff pressure in the permissible range of 20-30 cm H₂O. The remaining 91.1% had a cuff pressure out of the permissible range and the cuff pressure in most of them was higher than the upper limit. Meanwhile, in 88.4% of the cases, with cuff pressures were first reported to be in the permissible range, the values were found to be out of the range when measured with the standard technique. Thus, it can be concluded that the palpation technique can not be a suitable alternative to the standard technique, and in most cases, the cuff pressure was higher than the maximum limit resulting in some complications such as tracheal cartilage necrosis and granulation tissue formation, and ultimately tracheal stenosis.

In a study carried out by Modirian and colleagues, cuff pressure of 100 patients evaluated initially by palpation of pilot balloon and then by manometer. Mean cuff pressure was 69.2±29.8 cm H₂O and only 6% of the patients had measured pressures within the recommended range of 20-30 cmH₂O. Thus, they concluded that in order to prevent adverse effects of cuff overinflation, it is better to recheck

the pressure using a manometer, regardless of place, time and the inserter of the endotracheal tube (11).

Stewart et al. compared endotracheal cuff pressure obtained by estimation techniques with direct cuff pressure measurements. Pressures was ranged 6-60 cm H₂O and fewer than one third of anesthesia providers inflated the cuff within an ideal range (12). In a research on monitoring the cuff pressure by the staff of an intensive care unit (ICU), 100 employees were studied and it was found that 52% of them monitored the cuff pressure every 6-12 hours, 32% every 2-4 hours, 15% only when they noticed the air leakage, and 1% never monitored it (13).

According to the results of the current study, the cuff pressures estimated by minimal occlusive volume technique were within the optimal range in 26.7% of cases when compared to the standard technique. The remaining 73.3% had a cuff pressure higher than the normal range with a mean of 43.9 cm H₂O. However, with minimal occlusive volume (MOV) technique more patients were in normal cuff pressure range compared to palpation method, and those who were not in the normal range, were closer to normal range.

In other study conducted by Kumar and Hirsch, 25 intubated patients were selected randomly. Then the common technique of inflating the tracheal tube cuff until no air leak is heard through the mouth, and minimal occlusive volume technique were examined separately. According to their results using the common technique the tracheal tube cuff pressure was 28-40 cm H₂O, while in minimal occlusive volume (MOV) technique it was 20-26 cm H₂O (14). High cuff pressures will decrease the blood flow in the area and causes necrosis, which may ultimately result in a delayed stenosis (15).

In this study, palpation and minimal occlusive volume (MOV) techniques were compared with the standard technique of measuring endotracheal tube cuff pressure, and based on the results it can be concluded that the number of patients with a cuff pressure within the normal range was significantly more in minimal occlusive volume

(MOV) group ($P < 0.05$). The average cuff pressure in minimal occlusive volume (MOV) group was closer to the normal range.

Finally, this study recommends that the best way to measure the endotracheal tube cuff pressure is to use a cuff manometer, and when there is no access to it, the minimal occlusive volume would be a better alternative compared to palpation technique, so that the cuff pressure is kept in within a proper and ideal range to avoid tracheotomy complications such as tracheal stenosis.

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