

Original Article

Endotracheal tube cuff pressure alteration after changes in position in patients under mechanical ventilation^{*,**}

Alteração da pressão intra-cuff do tubo endotraqueal após mudança da posição em pacientes sob ventilação mecânica

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Abstract

Objective: The purpose of this study was to investigate endotracheal tube cuff pressure (Pcuff) alteration in patients under mechanical ventilation after changes in position. **Methods:** All selected patients were initially placed in the 35° semi-Fowler position, with Pcuff adjusted to 20 mmHg, and randomly divided into two groups. Group A, in which patients were moved to the lateral decubitus position, facing away from the ventilator (measurement designated Pcuff A1), returned to the initial position (measurement designated Pcuff A2), moved to a lateral decubitus position, facing the ventilator (measurement designated Pcuff A3) and then returned to the initial position (measurement designated Pcuff A4); and Group B, in which patients were moved to the lateral decubitus position, facing the ventilator (measurement designated Pcuff B1), returned to the initial position (measurement designated Pcuff B2), moved to the lateral decubitus position; facing away from the ventilator (measurement designated Pcuff B3) and then returned to the initial position (measurement designated Pcuff B4). **Results:** The study comprised 70 patients, 31 allocated to group A and 39 allocated to group B. Values >22 mmHg were observed in 142(50.7%) of the 280 Pcuff measurements taken, and values <18 mmHg were observed in 14 (5%). When moved from the 35° semi-Fowler position to the lateral decubitus position, facing away from the ventilator, 58 (82.2%) of the patients presented mean Pcuff values in the higher range (>22 mmHg). **Conclusions:** Changes in body position can cause significant Pcuff variations in patients under mechanical ventilation.

Keywords: Pressure; Intubation, intratracheal; Posture; Supine position.

Resumo

Objetivo: O objetivo deste trabalho foi investigar a alteração da pressão intra-cuff (Pcuff) do tubo endotraqueal em pacientes sob ventilação mecânica, após alteração de sua posição corporal. **Métodos:** Todos os pacientes selecionados eram inicialmente colocados em posição de semi-Fowler (35°), Pcuff em 20 mmHg, e divididos aleatoriamente em dois grupos. Grupo A: a Pcuff era medida após mover-se o paciente para decúbito lateral, costas voltadas para o ventilador (denominada Pcuff A1); após retornar o paciente à posição inicial (denominada Pcuff A2); após mover o paciente para decúbito lateral, de frente para o ventilador (denominada Pcuff A3); e após retornar o paciente, novamente, à posição inicial (denominada Pcuff A4). No Grupo B: a Pcuff era medida após mover-se o paciente para decúbito lateral, de frente para o ventilador (denominada Pcuff B1); após retornar o paciente à posição inicial (denominada Pcuff B2); após mover o paciente para decúbito lateral, costas voltadas para o ventilador (denominada Pcuff B3); e após retornar o paciente, novamente, à posição inicial (denominada Pcuff B4). **Resultados:** Foram incluídos 70 pacientes no estudo, 31 no grupo A e 39 no grupo B. Valores >22 mmHg foram observados em 142 (50,7%) das 280 medidas de Pcuff realizadas, e valores <18 mmHg, em 14 (5%). Quando movidos da posição de semi-Fowler (35°) para decúbito lateral, costas voltadas para o ventilador, 58 (82,2%) dos pacientes apresentaram valores médios de Pcuff mais altos, >22 mmHg. **Conclusões:** Mudanças na posição corporal dos pacientes sob ventilação mecânica podem alterar significativamente a Pcuff.

Descritores: Pressão; Intubação intratraqueal; Postura; Decúbito dorsal.

Introduction

In mechanically ventilated patients, the endotracheal tube cuff should remain inflated in order to prevent gas leakage and aspiration of oropharyngeal contents into the lungs.⁽¹⁾ It is important that the cuff pressure (Pcuff) be appropriate (recommended range, 18-22 mmHg) and remain constant, since it is well known that the tracheal

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wall can be damaged by high Pcuffs,^(2,3) and that low Pcuffs can promote microaspiration of oropharyngeal contents, predisposing to the occurrence of nosocomial pneumonia and poor ventilation efficiency due to gas leakage.⁽³⁻⁵⁾

Various factors are thought to promote Pcuff variations: changes in tracheal muscle tone; hypothermia; hyperthermia; diffusion of anesthetic gas into the tube cuff; and changes in endotracheal tube position.⁽⁴⁻⁶⁾

The purpose of this study was to investigate Pcuff alterations in adult patients under mechanical ventilation during changes in patient position.

Methods

This study was carried out in the Emergency Room of the State University at Campinas University Hospital, and the protocol was approved by the Hospital Ethics Committee. Patients were recruited and selected sequentially. Inclusion criteria were being at least 18 years of age, being under mechanical ventilation for no more than 24 h and being orotracheally intubated with an endotracheal tube that has a high-volume/low-pressure cuff. Patients in which changes from the recumbent position were contraindicated were excluded. Each patient was evaluated only once. The Pcuff was calibrated using a three-way stopcock: the pilot balloon of the endotracheal tube was connected to one of the stopcock ports; an analogical manometer, previously calibrated (in mmHg) using a reference manometer, was connected to one of the two remaining ports; and a 5-mL syringe was connected to the third port, allowing the Pcuff to be regulated by adjusting the plunger of the syringe. The measurement set remained connected to the pilot balloon during the maneuvers for changes in patient position.

In all cases, patients were intubated with Portex endotracheal tubes (Portex Ltd., Hythe, UK). All selected patients were initially placed in the 35° semi-Fowler position with the Pcuff adjusted to 20 mmHg. Patients were randomly allocated to one of two study groups, designated groups A and B. The only difference between the two groups was the sequence of changes in body position. In group A, the first measurement, designated Pcuff A1, was taken after the patient had been moved from the 35° semi-Fowler position to the lateral decubitus position, facing away from the ventilator.

The second measurement, designated Pcuff A2, was taken after the patient had been returned to the 35° semi-Fowler position. The third measurement, designated Pcuff A3, was taken after the patient had been moved to the lateral decubitus position facing the ventilator. The fourth measurement, designated Pcuff A4, was taken after the patient had again been returned to the 35° semi-Fowler position. In group B, the maneuvers were the same as those employed in Group A but followed a different sequence: Pcuff B1 was taken after the patient had been moved from the 35° semi-Fowler position to the lateral decubitus position, facing the ventilator; Pcuff B2 was taken after the patient had been returned to the 35° semi-Fowler position; Pcuff B3 was taken after the patient had been moved to the lateral decubitus position, facing away from the ventilator; and Pcuff B4 was taken after the patient had again been returned to the 35° semi-Fowler position. The entire process followed a cross-over design in which all patients were submitted to the same changes in position with the only difference being in the initial maneuver to move the patient into the lateral decubitus position: facing away from the ventilator in group A and facing the ventilator in group B.

In the statistical analyses, mean Pcuff values were compared using analysis of variance in the BioEstat program, version 3.0 for Windows (*Conselho Nacional de Desenvolvimento Científico e Tecnológico*, Brasília, Brazil). Values of $p \leq 0.05$ were considered statistically significant.

Results

Between January and March of 2006, a total of 70 patients were selected for inclusion in the study: 31 were allocated to group A, and 39 were allocated to group B. Table 1 shows the means, standard deviations and Pcuff ranges, according to the changes in patient position, stratified into those in which the mean was above 22 mmHg and those in which it was below 18 mmHg.

Values >22 mmHg were observed in 142 (50.7%) of the 280 Pcuff measurements taken, and values <18 mmHg were observed in 14 (5%).

As can also be seen in Table 1, 58 (82.2%) of the patients presented mean Pcuff values in the higher range (>22 mmHg) when moved from the 35° semi-Fowler position to the lateral decubitus position, facing away from the ventilator. In comparison with

Table 1 – Means, standard deviations and ranges of values above 22 mmHg and below 18 mmHg in mechanically ventilated patients after changes in position.

Body position in relation to ventilator	Range	Cuff pressure in mmHg			
		>22 (mmHg)		<18 (mmHg)	
		n (%)	Mean (SD)	n (%)	Mean (SD)
A1/B3*	14-32	58 (82.8)	29.3 (2.3)	6 (8.5)	15.7 (0.8)
A2/B4	12-26	8 (11.4)	24.5 (1)	3 (4.2)	14.7 (2.3)
A3/B1	16-26	38 (54.2)	25.2 (1)	1 (1.4)	16 (0)
A4/B2	14-26	38 (54.2)	24.2 (1.4)	4 (5.7)	14 (0)

SD: standard deviation; A1/B3: from the 35° semi-Fowler position to the lateral decubitus position, facing away from the ventilator; A2/B4: from the lateral decubitus position to the 35° semi-Fowler position, facing away from the ventilator; A3/B1: from the 35° semi-Fowler position to the lateral decubitus position, facing the ventilator; and A4/B2: from the lateral decubitus position to the 35° semi-Fowler position, facing the ventilator. * $p < 0.01$ vs. all other positions.

the other positions, the difference was significant ($p < 0.01$).

Discussion

Our results suggest that changing patient position during mechanical ventilation can lead to significant alterations in P_{cuff}.

Various factors can induce lesions in the respiratory tract of mechanically ventilated patients. Such factors include the following: inadequate airway humidification; a high fraction of inspired oxygen; insufficient heating of administered gases; frequent tracheal suction; prolonged endotracheal intubation; prolonged mechanical ventilation; and inappropriate P_{cuff} values.⁽⁷⁻¹¹⁾ Some researchers suggest that, among these factors, inappropriate P_{cuff} values (P_{cuff} variation) is of great importance in the genesis of postintubation injuries diagnosed in the respiratory tract. Variations in P_{cuff} can damage the tracheal wall and promote oropharyngeal content aspiration, leading to nosocomial pneumonia.⁽⁷⁻⁹⁾ When P_{cuff} remains between 18 and 22 mmHg, damage to the tracheal wall tends to be minimized or averted. However, after 2-12 h at a P_{cuff} of approximately 20 mmHg, a local inflammatory process can begin in areas that are in direct contact with the cuff. The severity of the process is proportional to the duration of intubation.⁽⁸⁾ Conversely, if P_{cuff} is kept below 18 mmHg, microaspirations of oropharyngeal content can occur.⁽¹²⁾ The section immediately above the cuff collects oropharyngeal and upper airway secretions, being the source of material for microaspirations if the air cuff loses pressure.^(13,14)

Previous studies have reported several prophylactic measures that should be taken in order to avoid

the damage to the respiratory system caused either simply by the presence of the endotracheal tube or by P_{cuff} variation: regular and periodic control of the P_{cuff}⁽¹⁾; use of endotracheal tubes that are of an appropriate diameter⁽⁶⁾; use of a P_{cuff} regulating valve in the pilot balloon; use of high-volume/low-pressure cuffed endotracheal tubes; and continuous aspiration of the oropharyngeal content.⁽¹⁾ Although the advent of high-volume/low-pressure cuffed endotracheal tubes in the early 1970s decreased the frequency of postintubation tracheal injuries, this type of cuff, when inflated with great volumes, can reach pressures that damage tissues after 2-4 h.⁽¹⁵⁾

To our knowledge, there have been no studies investigating changes in patient position associated with P_{cuff} variation during mechanical ventilation. In the present study, we found P_{cuff} values above 22 mmHg and below 18 mmHg in the two groups studied. The variation in P_{cuff} might have been due to compression or decompression of the endotracheal tube over the cuff caused by movement and changes in the position of the mechanical ventilator circuit. However, P_{cuff} variation can also be attributed to the cuff membrane lying in folds, independent of changes in patient position.⁽¹⁾ The mean P_{cuff} values, as well as the number of P_{cuff} values above or below reference values, observed for P_{cuffs} A1 and B3 (after the patient had been moved from 35° semi-Fowler position to the lateral decubitus position, facing away from the ventilator) were higher than those observed for P_{cuffs} A3 and B1 (after patient had been moved from 35° semi-Fowler position to lateral decubitus position, facing the ventilator). This difference, which was significant ($p < 0.05$), might be attributable to the greater strain put on the ventilator air circuit by facing patients away from the ventilator.

Various authors have recommended that, in order to prevent scarring and nosocomial pneumonia, mechanically ventilated patients should be submitted to regular and periodic changes in position.^(5,11,16) However, we believe that, during such changes in position, special care should be taken to monitor and, if necessary, recalibrate the Pcuff.

Moving mechanically ventilated patients from the 35° semi-Fowler position to the lateral decubitus position can cause significant variations in Pcuff. In the routine care of such patients, regular Pcuff measurement and adjustment after changes in body position should be encouraged.

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