ORIGINAL ARTICLE

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Applicability of bag squeezing and zeep maneuvers in mechanically ventilated patients

Aplicabilidade das técnicas de bag squeezing e manobra zeep em pacientes submetidos à ventilação mecânica

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ABSTRACT

Objectives: To evaluate the applicability of the bag squeezing and zeep maneuvers in mechanically ventilated patients.

Methods: Twenty stable mechanically ventilated patients were studied. All patients were randomly allocated to either bag squeezing technique followed by zeep maneuver, or the reversed sequence. Each group crossed to the other sequence four hours later. Heart rate, respiratory rate, peripheral oxygen saturation and blood pressure were measured before, during and after each technique use. The suctioned secretions were collected and measured. The data were analyzed by pairwise statistical analysis for inter-group comparisons, and ANOVA for each group results analysis.

Results: The heart rate was significantly increased, from 92.6 ± 18.3 bpm to 99.8 ± 18.5 bpm and the peripheral oxygen saturation significantly decreased from 96.9 ± 3.0% to 94.5 ± 4.3% during the bag squeezing maneuver, although the values remained within the normal range. No significant changes were seen for the zeep maneuver. Peripheral oxygen saturation during the maneuvers was found to change when the techniques were compared. No differences were found for the suctioned secretions amounts.

Conclusion: The results suggest that both techniques are feasible as they cause few hemodynamic changes, and both are effective for bronchial secretions removal.

Keywords: Respiratory therapy/methods; Physical therapy modalities; Respiration, artificial; Bronchi/secretion

INTRODUCTION

One of the main reasons for patients admission to the intensive care unit (ICU) is their ventilatory support need[1] either supporting or replacing spontaneous ventilation. However, invasive mechanical ventilation (MV) is directly related to several complications, including pulmonary mechanics and respiratory function changes.[2-4]

The role of physiotherapy is wide, and part of the multidisciplinary attention provided to ICU patients,[5] and is considered an effective therapeutic resource for mechanically ventilated patients, aiming to promote clearance of pulmonary secretions, reduce the intra-pulmonary shunt, recruitment of collapsed areas, in addition to improve the respiratory system compliance.[6-8]

Bronchial clearance maneuvers aim the remotion of bronchial secretions, one of the main physiotherapeutic targets in a MV patient.[9] The

Received from University of Fortaleza – UNIFOR - Fortaleza (CE), Brazil.

Submitted on September 22, 2008
Accepted on May 8th, 2010

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artificial airway renders difficult the natural secretion elimination mechanisms, such as cough and mucociliary function,[10,11] and this favors additional secretion production[12] and may lead to increased pulmonary complications, with secretion retention and pneumonia.[11]

Among bronchial clearance and pulmonary expansion maneuvers in invasive MV patients, hyperinflation can be performed either manually, using a ventilatory bag, or using the mechanic ventilator.[13] Manual hyperinflation, also known as bag squeezing or bagging, aims to increase the alveolar ventilation, to mobilize bronchial secretion, to revert collapsed areas, and additionally to improve the static compliance. However, this results in some hemodynamic changes, with potential effects on the cardiovascular system and intrapleural pressures.[14-16]

The zeep maneuver is also considered an alternative for bronchial secretion clearance, and in addition to improve the static pulmonary compliance, has the advantage of no need for disconnecting the patient from the MV during the procedure.[13,17] Thus, this study aimed to evaluate the feasibility of the bag squeezing (BS) and zeep (MZ) maneuvers in MV patients.

METHODS

A prospective, randomized, crossover, controlled study was conducted in the ICU of the Hospital Dr. Carlos Alberto Studart Gomes – Hospital of Messejana, in the city of Fortaleza, Ceara State, from February 2006 to May 2007. This study was approved by the institution's Ethics Committee, and complied with the ethical principles according to the National Health Council's resolution 196/96, which established the principles form human research in Brazil,[18] and all legally accepted representatives signed an Informed Consent Form.

Patients under MV, intubated, hemodynamically stable, older than 18 years-old, both genders, with respiratory physiotherapy medical prescription were enrolled into this study. Patients with positive end-expiratory pressure (PEEP) ventilatory support above 8 cmH_2O, closed-system endotracheal suctioning, bronchospasm, increased intracranial pressure, or psychomotor agitation were excluded. In case of hemodynamic instability during the technique, the protocol was discontinued.

The subjects were randomly selected and randomized according to their medical chart number. The patients with even chart numbers started with the bag squeezing protocol, which involved the use of the BS technique, while the patients with odds chart numbers started with the zeep protocol, involving the MZ technique use.

For the BS technique, the patient was positioned in dorsal decubitus position, and manual rhythmic hyperinflations were performed using a Hudson RCI® bag in tandem with an oxygen (O_2) flowmeter at 5 L/min, alternating with manual vibrocompressions during expiration.[19]

For the MZ maneuver, the PEEP was increased to 15 cmH_2O by the inspiration start, with the peak pressure limited to 40 cmH_2O. After five respiratory cycles with the predetermined pressure, the PEEP was suddenly reduced to zero, followed by manual vibrocompression maneuver.[20,21]

Each protocol lasted five minutes, followed by open system endotracheal suctioning, with a sterile suction catheter, size 12. By the end of the study, all patients underwent both studied protocols, having as the only difference of the order of the maneuvers. The interval between each protocol was four hours, and both maneuvers applied in a same day.

The suctioned secretion after each technique was collected by mini-bronchoalveolar lavage using aseptic technique and 3 mL saline instillation. Following, the suctioned material was measured in milliliters (mL) in a sterile Besse® cup. The saline and secretion were not separated.

The variables analyzed were systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), respiratory rate (RR), peripheral oxygen saturation (SpO_2), measured and recorded in three different times: before, during (after two and half minutes of the protocol) and just after each maneuver, by means of observation of a Dixtal® heart monitor, before endotracheal suctioning.

The data were analyzed using pairwise statistical analysis for groups comparisons. The analysis of variance for repeated measures (ANOVA) was used for comparison of the results for each group. The differences were considered statistically significant when the P value was ≤ 0.05.

RESULTS

Demographic characteristics

Twenty patients were studied, six male and fourteen female, mean age 63 ± 20 years and mean orotracheal intubation time of 35 ± 48 days. Twelve patients used antibiotics, and seven, vasodilators. Five patients underwent MV due to chronic obstructive pulmonary disease, three after acute myocardial infarction, three for congestive heart failure, two had stroke, one respiratory failure, one myocardiopathy, one head trauma, one cerebral palsy, one post upper right lobotomy, one with amyotrophic lateral sclerosis, and one with spinal trauma. Of these, thirteen had respiratory infection, nine respiratory failure, one acute pulmonary edema and one renal failure.

All patients were ventilated using the Interplus® (Intermed®) mechanical ventilator. Concerning sedation, three patients used fentanyl 2 mL/hour/kg in association with midazolam 5 mL/hour/kg. The other patients used sedation/analgesia as needed, under medical discretion (Table 1).

Table 1 - Demographic characteristics

Variable	Result
Gender (M/F)	6/14
Age	63.0 ± 20.0
OTI days	35.0 ± 48.0
OTI causes	
Respiratory	8 (40)
Cardiac	6 (30)
Neurological	6 (30)
Comorbidities	
Respiratory infection	13 (65)
Respiratory failure	9 (45)
Acute pulmonary edema	1 (5)
Renal failure	1 (5)
Ventilatory therapy	
VCV	3 (15)
SIMV	14 (70)
PSV	3 (15)
PEEP	5.5 ± 0.8
FiO_2	39 ± 9.6
Drug therapy	
Antibiotics	12 (60)
Vasodilator	7 (35)

M – male; F – female; OTI- orotracheal intubation; VCV- volume-controlled ventilation; SIMV- synchronized intermittent mandatory ventilation; PSV – pressure support ventilation; PEEP – positive end-expiratory pressure; FiO_2: inspired oxygen fraction. Results expressed as mean ± standard deviation or number (%).

Cardiorespiratory variables

When the HR was compared between the three times, in the BS maneuver group, statistically significant differences were found for the values between before and during, and between before and after the technique (p=0.008). However, the same was not seen for the MZ maneuver group (p=0.141). Also, no significant differences were seen when the maneuvers were compared (Table 2).

The variables SBP, DBP and RR did not show significant differences at any moment of the BS (p=0.351; p=0.375; p=0.414, respectively) and MZ (p=0.526; p=0.460; p=0.595, respectively) maneuvers. In addition, were not seen also statistically significant differences for these variables when the techniques were compared (Table 2).

A statistically significant SpO_2 reduction was seen in the values before and after the BS maneuver comparison (p=0.002). However, this significant reduction was not seen at any time of the MZ maneuver (p=0.549). When the maneuvers were compared, a statistically significant difference was found only during both techniques application (p=0.021) (Table 2).

Removed secretion volume

For the techniques comparison, no statistically significant difference was found for the removed secretion volume (BS: 5.85 ± 4.02 mL and MZ 6.1 ± 3.79 mL; p=0.818).

Table 2 – Cardiorespiratory variables for bag squeezing (BS) and zeep (MZ) maneuvers

	Before			During (2 ½ minutes)			p*		After			p*	
	BS	MZ	p†	BS	MZ	p†	BS	MZ	BS	MZ	p†	BS	MZ
HR	92.6 ± 18.3*	96.5 ± 20.9	NS	97.9 ± 21.3*	98.7± 21.8	NS	0.01	NS	99.8 ± 18.5*	102.2 ± 25.9	NS	0.01	NS
SBP	130.0 ± 29.4	135.4 ± 25.2	NS	131.3 ± 32.1	134.1 ± 30.4	NS	NS	NS	136.2 ± 27.0	135.3 ± 26.7	NS	NS	NS
DBP	68.3 ± 20.7	72.0 ± 17.6	NS	69.9 ± 20.2	73.0 ± 21.0	NS	NS	NS	72.6 ± 23.4	74.1 ± 20.6	NS	NS	NS
RR	20.8 ± 6.7	19.2 ± 5.7	NS	24.5 ± 11.6	20.1 ± 5.9	NS	NS	NS	23.6 ± 9.0	19.4 ± 5.6	NS	NS	NS
SpO_2	96.9 ± 3.0*	97.3 ± 1.5	NS	94.5 ± 4.3†*	97.3 ± 1.6†	0.02	0.00	NS	96.1 ± 2.6	97.2 ± 1.7	NS	NS	NS

HR – heart rate; SBP – systolic blood pressure; DBP – diastolic blood pressure; RR – respiratory rate; SpO_2 – peripheral oxygen saturation; NS – non significant. Values expressed as mean ± standard deviation. † P values are in regard of the BS/MZ comparison; * P values refer to comparison between before and during and between before and after, in each group.

DISCUSSION

Manual hyperinflation is used as a recruitment therapy for collapsed pulmonary areas, and to mobilize retained secretions.[22,23] The effects of the manual hyperinflation use regarding secretions mobilization and static pulmonary compliance had been established,[13] however few evidences are available for BS and MZ comparisons.

Singer et al.[24] studied the manual hyperinflation technique in subjects under MV, and found a significant cardiac output (CO) reduction when the intra-thoracic pressure was increased, due to reduced venous return, however without incremental HR. On the other hand, in this study there was a significant HR increase when the BS maneuver was applied, probably compensating for a possible CO reduction. Additionally, in the Singer et al.[24] study, manual hyperinflation was not followed by chest vibrocompression, which may also have contributed for the increased HR seen in our study.

Regarding MZ, the HR change was not significant, as the vibrocompression was only performed each five respiratory cycles. Comparing both techniques, there was no significant HR difference at any technique time. These results are similar to the Rodrigues' et al.[17] findings, who compared BS and MZ and found a post-therapy HR increase in both groups, although not clinically significant.

Analyzing the results for RR, no significant changes were found for any studied technique. During MZ use, the RR is assured by the MV, thus justifying the lack of changes. However, it was expected to find significant changes in the BS group, as the RR is influenced by this technique. Likely, when this technique was used according to a coordinated ventilatory bag inflation/disinflation rhythm, this didn't stimulate the patient's RR regulatory centers.

Theoretically, hyperinflation should improve the lung elastic behavior, allowing increased alveolar gas distribution and improved surfactant activity.[25] However, a significant SpO_2 reduction was found during the BS technique, and was not for the MZ technique. The literature[17,26-28] with respect to SpO_2 during the BS maneuver is controversial.

PEEP restores or increases the patient's residual functional capacity, improving oxygenation.[29] When the patient is disconnected of MV, this pressure is lost; then, although the oxygen offer is kept in the BS technique, it appears not being enough to keep the alveoli inflated, with consequent impairment of the gas exchanges. Additionally, our sample included several respiratory infection and failure patients, which explain the significant SpO_2 drop in our study. During the MZ maneuver, PEEP was lost only during the chest vibrocompression time, each five respiratory cycles, and immediately returned to 15 cmH_2O. Additionally, the patients remained connected to the MV for the entire maneuver time, which was fundamental to keep appropriated gas exchange and SpO_2.

It should be highlighted that, although HR values had changes during the BS maneuver, the values compared are within the normal range. The same was seen for SpO_2, which were within the normal range.

Literature data[17,24] show no evidence of significant SBP and DBP changes during either BS or MZ techniques, as we found in this study.

We expected that the BS maneuver would mobilize more secretions than MZ due to use a higher inspiratory flow; however, both methods removed similar amounts of secretion. A similar study by Berney and Denehy,[13] who used manual and mechanic hyperinflation, also didn't show a significant change in the secretions volumes removed. The secretions mobilization is dependent on the inspiratory and expiratory flow relationship, the gas flow frequency, and the secretion's viscoelastic properties; additionally, the expiratory flow must be at least 10% faster than the inspiratory flow.[30,31] Thus, the question remains if either the BS oxygen flow we used in our study was low, or if both techniques are equally effective respecting secretions removal.

This study had some limitations, such as the reduced sample size, the lack of mechanic ventilation analysis, and comparisons concerning the patients' sedation status, in addition to the heterogeneous population. However, we think that it approached an important MV area, where additional research is warranted. We suggest that other studies should be performed to add information to these findings.

CONCLUSION

This study has shown that the bag squeezing and zeep maneuvers are similar regarding bronchial secretions removal, and that both are practically feasible, causing no significant hemodynamic changes during their use.

ACKNOWLEDGEMENTS

The authors are grateful to the physiotherapist Alana Maria Costa do Nascimento, from the Cardiopulmonary Unity of the Hospital of Messejana for her support and assistance during this study data collection.

RESUMO

Objetivos: Avaliar a aplicabilidade das manobras de *bag squeezing* e *zeep* em pacientes sob ventilação mecânica invasiva.

Métodos: Foram estudados vinte pacientes sob ventilação mecânica invasiva e hemodinamicamente estáveis. Os pacientes foram randomizados e alocados em uma das duas sequências de tratamento (*bag squeezing* ou *manobra zeep*). A ordem de aplicação da sequência foi invertida após quatro horas. Foram avaliadas frequência cardíaca, frequência respiratória, saturação periférica de oxigênio e pressão arterial, antes, durante e após a execução de cada técnica. A secreção aspirada foi coletada e mensurada. Os dados foram avaliados utilizando análise estatística pareada para comparação entre os dois grupos e ANOVA para comparar os resultados obtidos em cada grupo nas avaliações.

Resultados: Houve um aumento significativo na frequência cardíaca, de 92,6 ± 18,3 bpm para 99,8 ± 18,5 bpm e uma redução significativa na saturação periférica de oxigênio, de 96,9 ± 3,0% para 94,5 ± 4,3% durante a aplicação da técnica *bag squeezing*, embora os valores tenham se mantido dentro da normalidade. Não houve alterações durante a manobra zeep. Quando comparadas as duas técnicas foi encontrado diferença na saturação periférica de oxigênio durante a aplicação das mesmas. Não houve diferença na quantidade de secreção removida.

Conclusão: Os resultados sugerem que ambas as técnicas são viáveis no tocante a sua aplicação, pois causam poucas alterações hemodinâmicas, e ambas as técnicas são eficazes na remoção de secreção brônquica.

Descritores: Terapia respiratória/métodos; Modalidades de fisioterapia; Respiração artificial; Bronquios/secreção

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