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Bronchial hygiene technique with manual hyperinflation and thoracic compression: effectiveness and safety

Efetividade e segurança da técnica de higiene brônquica: hiperinsuflação manual com compressão torácica

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ABSTRACT

Objectives: To evaluate the effects of the manual hyperinflation with thoracic compression (MHTC) maneuver on the clearance of secretions, pulmonary mechanics, hemodynamics and oxygenation in mechanically ventilated patients.

Methods: This was a controlled, crossover study that included twenty patients who were under invasive ventilation for more than 48 hours. Four hours after the last airway suctioning procedure, the patients underwent the study interventions, Suction alone or MHTC plus Suction, in sequence at four hour intervals. The sequence order for the procedures was established by randomization. Data were collected before, during and 5, 15, 30 and 60 minutes after each intervention. The suctioned secretions were collected and weighed.

Results: No significant differences between the procedures were found regarding tidal volume, plateau pressure and pulmonary compliance ($p > 0.05$).

The hemodynamic variables showed increased pressures and heart rate during the procedures and returned to baseline values five minutes after the end of the procedure ($p \leq 0.001$). No significant hemodynamic differences were seen between the interventions ($p > 0.05$). For the duration of the study, oxygen saturation was 99% with only two exceptions during the MHTC + Suction procedure, where saturation was 98% ($p < 0.05$). No significant differences were observed between the techniques regarding the weight of the suctioned secretion.

Conclusion: The results suggest that MHTC, as performed in this study, adds no benefit with respect to oxygenation optimization, pulmonary mechanics and clearance of secretions. However, the MHTC maneuver did not result in hemodynamic changes when compared to the suctioning procedure alone.

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

This study was conducted at Universidade Federal do Triângulo Mineiro – UFTM – Uberaba (MG), Brazil.

Conflicts of interest: None.

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INTRODUCTION

Patients under invasive mechanical ventilation (IMV) frequently retain pulmonary secretions because the normal airway clearance mechanisms (mucociliary transport and cough) are impaired.⁽¹⁾ Pulmonary secretion accumulation may cause increased airway resistance and partial or total obstruction, resulting in alveolar hypoventilation and atelectasis, hypoxemia and increased respiratory load. Additionally, secretion stasis and atelectasis constitute a favorable environment for bacterial colonization and pulmonary infections.^(1,2) Therefore, it is clear that

pulmonary secretions are a relevant complicating factor that may prolong IMV time and, consequently, negatively impact the patient's prognosis.

In this context, physiotherapy in IMV patients may be considered to be a strategy for the prevention and treatment of lower respiratory tract infections because it is aimed at removing bronchial secretions, consequently maintaining appropriate ventilation and gas exchange.⁽³⁾ Of the available physiotherapeutic techniques used to aid the removal of secretions, manual hyperinflation with thoracic compression (MHTC), also known as bag squeezing, was first described in 1968 by Clement and Hübsch.⁽⁴⁾ Based on the original description, MHTC is comprised of manual hyperinflation (MH) using a manual resuscitator and expiratory thoracic compression (TC), and it is completed with the removal of the displaced secretion by tracheal suctioning. MH, in turn, consists of three steps: 1) slow high tidal volume inflation; 2) a two to three second inspiratory pause; and 3) the fast release of the resuscitator.⁽⁵⁾ Steps 1 and 2 aim to promote pulmonary expansion and uniform gas distribution, providing ventilation of previously collapsed areas, and step 3 aims to provide high expiratory flow, causing the displacement of peripheral secretions toward more central areas. Therefore, by simulating coughing, MHTC promotes clearance of bronchial secretions.⁽⁶⁾ The combination of TC and MH aims to optimize the maneuver, thus, increasing expiratory flow. In turn, the higher the peak expiratory flow, the more effective that the maneuver is.

However, there is evidence that increasing the clearance of secretions is dependent not only on high expiratory flow peaks but also on the ratio or difference between inspiratory and expiratory peak flows.⁽⁷⁻⁹⁾ According to Kim et al., to displace secretions toward the oropharynx, the expiratory peak flow should be 10% above the inspiratory peak flow.⁽⁷⁾

During MHTC, the generation of low inspiratory flows depends on the tidal volume and the operator's inflation time, i.e., for a given volume, the longer the inflation, the lower the inspiratory flow.^(10,11) Yet, the expiratory peak flow depends on respiratory system compliance, fast resuscitator release, optimal TC and tidal volume.^(10,11) The tidal volume, in turn, depends on the size and type of resuscitator, the size of the operator's hands and the use of one or both hands for MH.⁽¹⁰⁾

Because the procedure simulates coughing, this maneuver appears to be particularly indicated for IMV patients who have a reduced or absent coughing reflex, ineffective cough and/or pulmonary hypersecretion. Although bedside evaluation of coughing effectiveness can be particularly simple but not error-free (by measuring the peak flow of a cough⁽¹²⁾ or subjectively during tracheal suctioning), hypersecretion has, thus far, not been clearly defined. The difficulty in specifying the precise indications for the maneuver makes it difficult to evaluate the results of studies that explored the efficacy of MHTC, as well as the results of studies that investigated other bronchial clearance maneuvers or the suctioning procedure alone.^(13,14)

The literature on MH not associated with TC is extensive.^(3,5,14-16) According to recent European Task Force recommendations, MH used to increase the clearance of secretions in IMV patients has a level B recommendation on an A to D scale, i.e., there are published controlled and randomized trials on this subject; however, there is a limited body of evidence.⁽³⁾ However, no recommendations were made concerning the use of MHTC, likely due to the paucity of studies on this subject.⁽³⁾

This study was aimed at evaluating the effects of the MHTC bronchial hygiene technique on the clearance of bronchial secretions, pulmonary mechanics, hemodynamics and the oxygenation of IMV patients.

METHODS

A prospective, controlled and randomized crossover trial was conducted in a non-intentional probabilistic sample of patients in an adult general intensive care unit (ICU) at the Hospital das Clínicas da Universidade Federal do Triângulo Mineiro (MG, Brazil). This trial was approved by the institution's ethics committee. An informed consent form was signed by the appropriate, responsible persons.

We included patients who met the following criteria: above 18 years of age, under IMV for ≥ 48 hours, positive end-expiratory pressure (PEEP) ≤ 10 cmH₂O, inspired oxygen fraction (FiO₂) ≤ 0.6 and peripheral oxygen saturation (SpO₂) $> 92\%$. Patients with hemodynamic instability, characterized by mean blood pressure < 60 mmHg and acute arrhythmias; pneumothorax that had not been drained; bronchopleural fistulae and/or bubbling

chest tubes; bronchospasm; costal arch fractures; suspected or confirmed intracranial hypertension and burn patients were excluded.

The study protocol consisted of two phases with a four hour interval between them. Four hours before the first phase, a zero time was established. At this time, patients underwent tracheal suctioning. At phase 1 (P1), the patient underwent either suctioning (SUC) alone or the MHTC plus SUC procedure. The order in which the procedures were performed was based on randomization, which was performed by allotment using opaque envelopes in blocks of 10. During the second phase (P2), the patient was crossed to the alternative technique not used during P1 (Figure 1).

Procedures description

SUC: During the SUC alone procedure, immediately after ventilator disconnection, 2 mL of 0.9% saline solution (SS0.9%) was instilled into the airway, and the trachea was suctioned. Next, the patient was reconnected to the ventilator and allowed five ventilator cycles. This procedure was repeated three times, yielding a total infused volume of 6 mL of SS0.9%.

MHTC + SUC: MHTC + SUC was conducted using a manual self-inflating resuscitator (OXIGEL®) with 1,200 mL internal volume, enriched with 15 L/min O₂. During the maneuver, a slow and deep inflation was performed, followed by a 2-3 second inspiratory pause; it was completed with fast resuscitator release combined with expiratory TC. The maneuver was repeated ten times; the first five times the compression was made on the right lung base, and the remaining five times, it was conducted on the left base. Next, 2 mL of SS0.9% was instilled into the airway, and SUC was performed. At the end of the SUC, the patient was reconnected to the ventilator and allowed five ventilator cycles. The procedure was repeated three times, yielding a total infused volume of 6 mL of SS0.9%. The peak inspiratory pressure (P_{IP}) generated during the maneuver was monitored using a manovacuometer connected to the resuscitator, which was limited at ≤ 40 cmH₂O. MH and TC were conducted by the same investigator; the hyperinflation was performed using the right hand, while the TC was performed using the left hand.

Three investigators were involved in the procedures: one performed SUC, another instilled

the SS0.9% and conducted the MHTC (only for MHTC + SUC) procedure, and the third collected data.

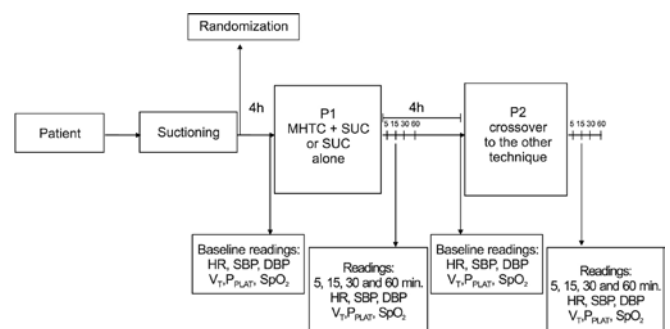
One minute before starting and during the procedures (SUC and MHTC + SUC), FiO₂ was increased and kept at 1.0; the remaining ventilator parameters and mode were not changed during the trial, including during the data recording. The tracheal suctioning technique for both phases was conducted as recommended by the American Association for Respiratory Care.⁽¹⁷⁾

The patients remained in the supine position for 20 minutes before, during and for 60 minutes after each procedure. During the intervals Zero time-P1 and P1-P2, no tracheal suctioning procedures were performed. In addition, no bronchodilators were given, and no procedures requiring the patient to be mobilized, e.g., bathing, were conducted.

The studied variables consisted of hemodynamic data (heart rate [HR], systolic blood pressure [SBP] and diastolic blood pressure [DBP]), oxygenation (SpO₂), respiratory mechanics (tidal volume [V_T], plateau pressure [P_{PLAT}] and respiratory system static compliance [Cst]) and suctioned bronchial secretion weight.

Mechanical data were recorded before starting (baseline) and 5, 15, 30 and 60 minutes after the end of the procedure. If the patient had spontaneous ventilation, controlled cycles were awaited to record mechanics data. At each study time, five values were collected for V_T and for P_{PLAT} and the mean was considered to be the observed value (Figure 1).

The hemodynamic and SpO₂ data were recorded at the same times described for the collection of



HR – heart rate; SBP – systolic blood pressure; DBP – diastolic blood pressure; V_T – tidal volume; P_{PLAT} – plateau pressure; SpO₂ – peripheral oxygen saturation; P1 – Phase 1; P2 – Phase 2.

Figure 1 – Diagram of the study protocol.

the mechanical data and just after each suctioning procedure during the phases P1 and P2. Blood pressures, HR and SpO₂ were read from the patient's monitor, and respiratory variables were obtained directly from the mechanical ventilator's screen (Interplus®, Intermed®). P_{PLAT} was read after a 1-3 second respiratory pause. Cst was calculated using the formula $V_T/P_{PLAT} - PEEP$.

Suctioned bronchial secretions were collected directly from the suction tube into a collector bottle. After each phase's third SUC, the suction tube was rinsed with 2 mL of SS0.9% to remove any residual secretion. Immediately after the collection, the secretion was weighed on a digital scale. The secretion weight was obtained by taking the total weight and subtracting the empty bottle's weight.

The analysis of the mechanic and hemodynamic variables associated with the interventions (MHTC + SUC versus SUC alone) was conducted using a repeated-measures analysis of variance (ANOVA), followed by contrast analysis for multiple comparisons, where applicable. SpO₂ data were analyzed using the Wilcoxon pairwise samples non-parametrical test. The bronchial secretion weights were compared using Student's t test. The significance level was 5%, i.e., $p < 0.05$.

RESULTS

Twenty patients were included; their baseline characteristics are described in Table 1. During the study, no patient used vasoactive drugs, and most (60%) of the patients were under continued sedation with the combination of fentanyl + midazolam. Four patients were on IMV due to chronic obstructive pulmonary disease, three for pneumonia, one for stroke, four for head trauma, two for surgery, one for cardiorespiratory arrest, one for decreased consciousness level, three for exogenous intoxication and one for septic arthritis.

No significant changes were found for the variables V_T , V_{PLAT} , and Cst after both procedures ($p=0.995$; $p=0.63$ and $p=0.675$, respectively). In addition, during the course of the procedures, there was minimal change in these parameters (Figure 2). V_T was reduced no more than 11 mL, P_{PLAT} less than 0.5 cmH₂O and Cst less than 2 mL/cmH₂O, indicating that the combination of MHTC and SUC did not offer an additional mechanics benefit in the optimization of pulmonary mechanics.

Table 1 – Characteristics of the study subjects

Variables	Results (N=20)
Age	56 ± 24 years
Gender	
Male	09 (45%)
Female	11 (55%)
Time on MV (days) *	6.5 (4.0 – 15.3)
Indication for MV	
Pulmonary	7 (35%)
Neurological	5 (25%)
Other	8 (40%)
Pneumonia	9 (45%)
MV parameters	
PCV	20 (100%)
PIP	23 ± 2.9 cmH ₂ O
PEEP	7.0 ± 1.0 cmH ₂ O
RR/RR Total	14 ± 2 / 14 ± 2 breaths/min
FiO ₂	37 ± 5%

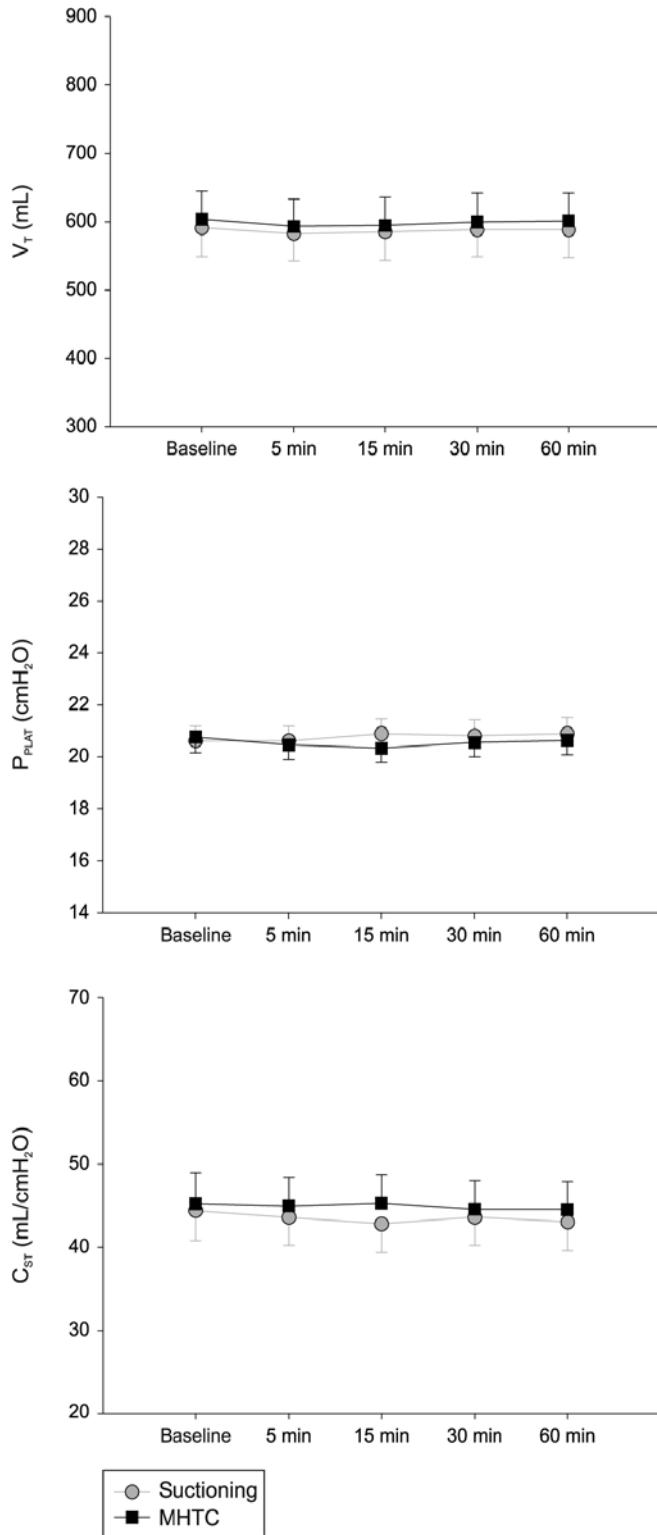
MV – mechanical ventilation; PCV – pressure controlled ventilation; PIP – positive inspiratory pressure; PEEP – positive end-expiratory pressure; RR – respiratory rate; FiO₂ – inspired oxygen fraction. Results expressed as mean ± standard deviation, median (percentile 25-75)* or number (%).

The mean P_{IP} generated during the MHTC was 27.8 ± 6.6 cmH₂O, with a range from 14 to 40 cmH₂O.

Regarding hemodynamics, SBP, DBP and HR values changed during the procedures, with increased blood pressure and heart rate during the SUC alone and MHTC + SUC ($p \leq 0.001$). These variables returned to baseline values five minutes after the interventions. No hemodynamic difference was found between the procedures ($p=0.611$, $p=0.328$ and $p=0.220$ for SBP, DBP and HR, respectively) (Figure 3).

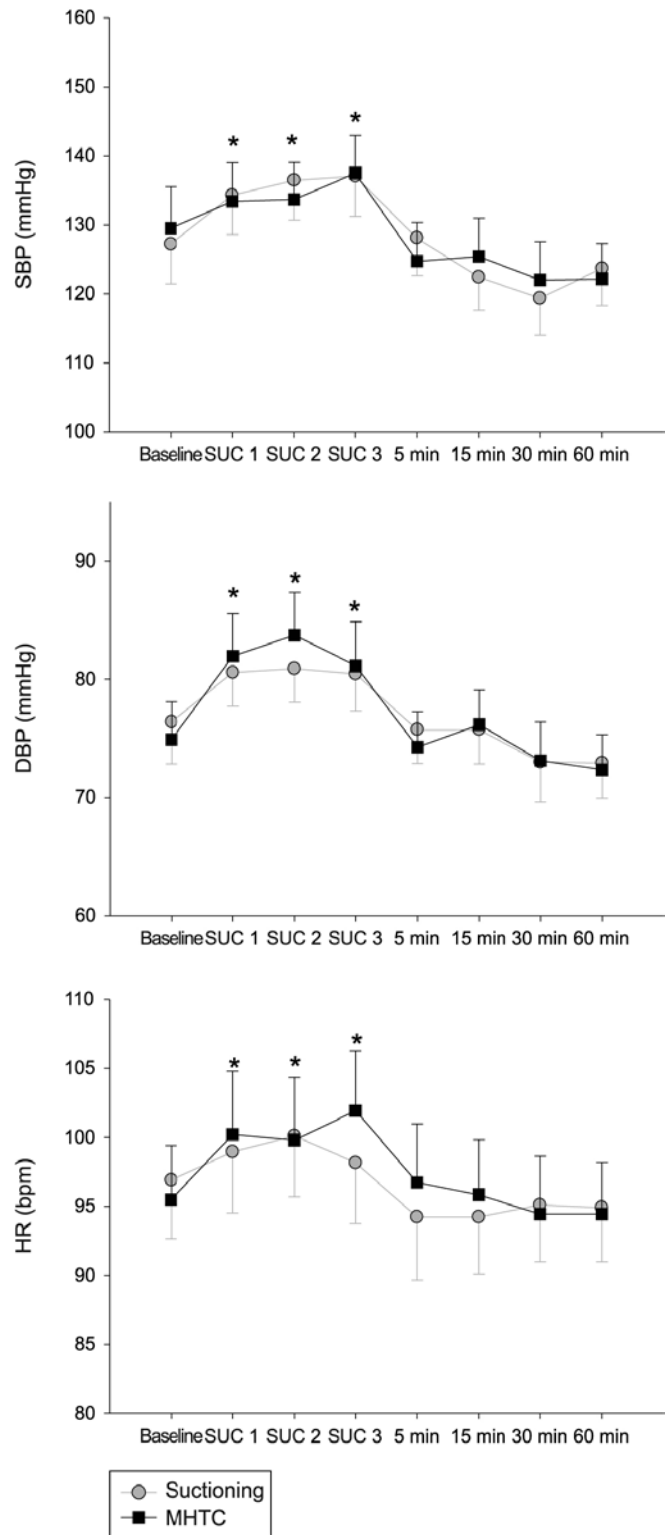
During the study period, the mean SpO₂ was 99%, except for the times after the second and third suction during the MHTC + SUC procedure when it was 98% ($p=0.028$ and $p=0.048$, respectively). During and after both interventions, the lowest recorded SpO₂ value was 88%, and the highest was 100%.

Regarding the clearance of bronchial secretions, no significant difference was observed between the techniques ($p=0.308$). The mean wet weight of the collected secretions was 6.60 ± 2.12 grams and 5.95 ± 1.84 grams for the SUC alone and MHTC + SUC techniques, respectively.



V_T – tidal volume; P_{PLAT} – plateau pressure; C_{ST} – static compliance; MHTC – manual hyperinflation with thoracic compression; min – minutes. Data expressed as mean \pm standard error.

Figure 2 – The profile of the respiratory mechanics during both study phases.



SBP – systolic blood pressure; DBP – diastolic blood pressure; HR – heart rate; MHTC – manual hyperinflation with thoracic compression; SUC – suctioning; min – minutes. Data expressed as mean \pm standard error. * $p < 0.05$ versus baseline evaluation.

Figure 3 – Hemodynamic changes during both study phases.

DISCUSSION

The most important findings in this study can be summarized as follows: 1) the MHTC maneuver combined with tracheal suctioning caused a hemodynamic response that was similar to that observed with suctioning alone and 2) the MHTC procedure as applied in this trial failed to add any benefit regarding oxygenation optimization, respiratory mechanics or clearance of bronchial secretions.

During and after the maneuvers, MHTC + SUC and SUC alone, a similar hemodynamic response was seen, which was characterized by increased HR, SBP and DBP. These values returned to baseline values five minutes after the end of the procedures. Because the hemodynamic response observed during and after both maneuvers showed similar patterns, it can be concluded that the observed changes were due to the suctioning procedure and that the MHTC maneuver was shown to be hemodynamically safe without no long-term impact on cardiovascular parameters.

A drop in pressure during the MH maneuver has already been described in the literature. This drop is thought to be the result of reduced venous return due to increased thoracic pressure associated to no HR changes.⁽¹⁸⁾ As in this study, the mean P_{IP} value during MHTC was 27.8 cmH₂O; thus, the impact on venous return was probably irrelevant.

Different cardiovascular changes, e.g., hypotension and hypertension, bradycardia and tachycardia, have been extensively described in the literature as complications of the suctioning technique.^(17,19) According to Segar et al., an increase in BP is apparently a consequence of the stimulation of the sympathetic receptors of the main airways, which results in increased sympathetic activity, peripheral vasoconstriction and, consequently, increased pressure.⁽²⁰⁾ However, the changes observed in this trial may be better ascribed to adrenergic release and sympathetic vasoconstrictive response caused by the stress of the procedure, as suggested by Paraz and Lipman.⁽²¹⁾ Regardless of the physiological mechanism responsible for the increased blood pressure and heart rate, the mean SBP did not increase above 140 mmHg, the DBP did not increase above 85 mmHg and the HR remained below 105 bpm, showing that the suctioning technique was safely performed.

Variables related to respiratory mechanics and the weights of the suctioned secretions were not significantly different between the procedures in this study, suggesting that the MHTC maneuver, as

performed in this trial and for the studied population, was not effective.

Most of the trials on bronchial hygiene maneuvers in IMV patients have evaluated the effects of MH alone, i.e., not combined with TC, and show conflicting results. Choi et al. compared MH followed by suctioning versus suctioning alone in 15 ventilator-associated pneumonia patients and found improved compliance and reduced resistance, which persisted for at least 30 minutes after the MH.⁽¹⁵⁾ Hodgson et al., in a multicenter trial that included 18 patients, found improved compliance and increased clearance of secretion (wet weight) after adding MH to the physiotherapeutic treatment with no cardiovascular or oxygenation repercussion.⁽⁶⁾ However, in another trial, the use of MH alone in combination with lateral decubitus positioning and later tracheal suctioning in patients with pulmonary injury failed to significantly change compliance and oxygenation values after 60 minutes.⁽²²⁾ Of the few trials associating MH and TC, Rosa et al. observed reduced respiratory system resistance with no dynamic compliance changes after the maneuver in 12 IMV patients when compared to suctioning alone. This reduction was maintained for two hours after the maneuver; such a reduction was not seen with tracheal suctioning alone.⁽²³⁾ However, in that study, it was not clear if the MH was used in association with TC or if the techniques were sequentially applied. The lack of literature consensus is likely a consequence of the use of distinct techniques, different populations and small samples, rendering a comparison of results difficult.⁽⁶⁾

The failure to identify improvement in compliance or in the amount of suctioned secretions after MHTC in this study was likely due to the achieved V_T , which was below the recommended, and because the generated expiratory/inspiratory flows ratio was sub-optimal. Some authors have reported that during MH, a V_T 50% above the mechanical ventilator V_T should be used.⁽²⁴⁾ However, more recently, when documenting the ventilation pattern during MH, Maxwell and Ellis found that the V_T was close to 100% above the ventilator's V_T , with a mean P_{IP} of 36 cmH₂O.⁽¹¹⁾ The authors support the idea that V_T and P_{IP} during MH should be high enough to promote appropriate alveolar recruitment.

Additionally, since the 1980s, the literature in this area has increasingly shown that expiratory peak flow must be approximately 10% above the inspiratory peak flow to displace secretions from the periphery toward the central airways.⁽⁷⁻⁹⁾ In addition, it has been observed

that the broader the difference in absolute peaks (expiratory > inspiratory) above a given threshold, the larger the secretion displacement toward the trachea.⁽⁹⁾ Although the V_T generated during the maneuvers was not monitored, the mean P_{IP} achieved during the maneuvers was 27.8 cmH₂O. Considering the resistance imposed by the ventilatory prosthesis, the pressure effectively distending the pulmonary parenchyma and generating V_T was lower than this value. When V_T is low, the thoracic expansion and recruitment of collapsed units are also lower, resulting in a lower expiratory peak flow generated, thus rendering the technique ineffective. Administration of a low V_T was likely a consequence of performing the MH with a single hand, while the other hand compressed the chest. However, MH with both hands associated with TC demands three concomitant professionals: one for MH, another for TC and a third for suctioning; this is currently unfeasible in clinical practice. Another issue to be considered is the type of resuscitator used in this trial (self-inflating) with a low internal volume (1,200 mL), which is different from flow-inflating resuscitators, which are able to provide higher V_T .⁽¹⁰⁾ However, different from other countries, e.g., Australia, in Brazil, the use of flow-inflating resuscitators is not common in the adult ICU, rather they are used in anesthesiology.⁽⁶⁾

Despite these considerations, our results agree with the observations by Rodrigues, who evaluated the effects of three bronchial hygiene techniques in IMV post cardiovascular surgery patients in two different phases.⁽²⁵⁾ During the first phase, patients categorized as not having pulmonary secretions were included, and the second phase included patients categorized as hyper-secreting. For both phases, the author found no significant differences with regard to respiratory mechanics, clearance of secretions and hemodynamic variables between the MHTC maneuver and suctioning alone.

Another possibility to explain the lack of secretion clearance and differences in respiratory mechanics between the techniques is that both procedures were applied sequentially after a pre-determined four hour interval. The standardization of the time interval is relevant because the accurate bedside identification of the treatment indication, i.e., presence of pulmonary secretion, is not easy regardless of the procedure utilized. Even with rhonchi on pulmonary auscultation and a sawtooth pattern in the expiratory flow signal observed on the ventilator screen, the presence of tracheal secretions cannot be assured.⁽¹³⁾ Therefore, to

prevent equivocal indications, the time interval has been standardized. Other trials comparing different bronchial hygiene treatments in IMV patients have also established two,⁽²⁵⁾ four,⁽¹⁵⁾ or at least three hour intervals between the procedures.⁽⁶⁾ However, it is not possible to state that in four hours, even in patients under IMV for longer than 48 hours, that enough secretions would have been produced to indicate the treatment. Additionally, it should be highlighted that in clinical practice, the treatment should always be driven by the patient's need.⁽¹⁾

Regarding oxygenation, although a statistically significant difference was observed, the lowest mean SpO₂ seen during MHTC + SUC was 98%, and during SU alone, was 99%. Therefore, despite of being statistically significant, this difference was not clinically relevant. During both procedures, FiO₂ was increased one minute before the procedure and kept at 1.0. However, during MHTC, although the resuscitator was fed with 15 L/min oxygen, a reservoir was not used; thus, the FiO₂ provided was lower than 1.0, possibly explaining the lower SpO₂.

The limitations of this trial included the broad range of patients' underlying diseases, the impossibility of assuring that all patients were hyper-secreting or had retained secretions (despite the issues regarding definition of these concepts), the lack of monitoring V_T and the flows generated during MHTC, and not assessing respiratory system resistance, as the mechanical ventilators had no way to monitor inspiratory flow. However, regardless of these limitations, this study adds important information concerning the MHTC maneuver, which has been poorly evaluated in the literature and is frequently used during physiotherapeutic care.^(5,6,16)

New trials that monitor V_T , P_{IP} and the flows generated during the MHTC maneuver are necessary to provide a better understanding of the effects of this technique.

CONCLUSION

The MHTC maneuver had no clinically relevant impact on cardiovascular function when compared to SUC alone and was shown to be hemodynamically safe when performed by a single professional using one hand for MH and the other hand for TC. However, moderate P_{IP} values were generated, which were apparently unable to provide a benefit with regard to oxygenation optimization, respiratory mechanics and clearance of bronchial secretions.

RESUMO

Objetivos: Avaliar os efeitos da manobra hiperinsuflação manual com compressão torácica em termos de depuração de secreções, mecânica pulmonar, hemodinâmica e oxigenação em pacientes sob ventilação mecânica invasiva.

Métodos: Foi realizado estudo controlado do tipo cruzado, com vinte pacientes com mais de 48 horas em ventilação mecânica invasiva. Após 4 horas da última aspiração os pacientes foram submetidos aos procedimentos, aspiração ou hiperinsuflação manual com compressão torácica e aspiração, um após o outro, respeitando intervalo de quatro horas, em ordem estabelecida conforme randomização. As variáveis foram coletadas nos momentos pré, durante e após 5, 15, 30 e 60 minutos do término dos procedimentos. A secreção aspirada foi coletada e mensurada.

Resultados: Não foram encontradas alterações significativas para o volume corrente, pressão platô e complacência após os dois procedimentos durante o estudo ($p > 0,05$). As variáveis hemodinâmicas apresentaram comportamento dis-

tinto ao longo do tempo caracterizado por aumento das pressões e frequência durante a realização dos procedimentos, com retorno aos valores basais após 5 minutos das intervenções ($p \leq 0,001$). Não foi encontrada diferença no comportamento hemodinâmico entre os procedimentos ($p > 0,05$). A saturação de oxigênio durante todos os momentos do estudo foi 99%, com exceção de dois momentos durante a realização da HMCT+ASP que foi 98% ($p < 0,05$). Não houve diferença significativa entre as técnicas em relação ao peso das secreções aspiradas.

Conclusão: Os resultados sugerem que a hiperinsuflação manual com compressão torácica, conforme aplicada neste estudo, embora tenha se mostrado segura hemodinamicamente, não apresentou benefícios em relação à técnica de aspiração isolada em termos de otimização da oxigenação, mecânica respiratória e depuração de secreções.

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

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