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ALVEOLAR RECRUITMENT MANEUVERS IN CARDIAC ICU PATIENTS: A LITERATURE REVIEW

MANOBRAS DE RECRUTAMENTO ALVEOLAR EM PACIENTES DE UTI CARDÍACA: UMA REVISÃO DE LITERATURA

MANIOBRAS DE RECLUTAMIENTO ALVEOLAR EN PACIENTES DE CUIDADOS INTENSIVOS CARDÍACOS: UNA REVISIÓN DE LA LITERATURA

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ABSTRACT
Heart diseases represent a worrying condition in ICU patients, and heart failure (HF) is one of the most common and aggravating heart diseases, as it compromises respiratory function. HF causes the accumulation of fluids in the lungs, generating pulmonary edema and, consequently, atelectasis, which collapses the alveoli. This collapse reduces gas exchange, aggravating hypoxemia and making it difficult for the patient to recover. Due to the importance of the theme, the study aims to identify how alveolar recruitment maneuvers can help in the treatment of patients in cardiology ICUs. A search for scientific articles was carried out in the PubMed, SciELO, Getinge, Artmed and ScienceDirect databases. Articles published in full, in English and Portuguese, that addressed cardiology ICU patients on mechanical ventilation after cardiac surgery, patients affected by ARDS, and ICU patients in whom alveolar recruitment maneuvers were adopted as a therapeutic measure were included in the search. Studies that did not use alveolar recruitment maneuvers as an intervention method were excluded. Alveolar recruitment maneuvers, associated with pulmonary protective ventilation strategies, can establish a good hemodynamic condition, reducing lung lesions and significantly increasing oxygenation levels.

Keywords: Heart disease. ICU. Alveolar recruitment.

RESUMO
As cardiopatias representam uma condição preocupante em pacientes internados em UTI, sendo a insuficiência cardíaca (IC) uma das cardiopatias mais comuns e agravantes, por comprometer a função respiratória. A IC causa o acúmulo de líquidos nos pulmões, gerando edema pulmonar e, consequentemente, atelectasia, que colapsa os alvéolos. Esse colapso reduz as trocas gasosas, agravando a hipoxemia e dificultando a

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recuperação do paciente. Devido à importância do tema, o estudo tem como objetivo identificar como as manobras de recrutamento alveolar podem auxiliar no tratamento de pacientes internados em UTI cardiológica. Foi realizada uma busca por artigos científicos nas bases de dados PubMed, SciELO, Getinge, Artmed e ScienceDirect. Foram incluídos na busca artigos publicados na íntegra, em inglês e português, que abordassem pacientes internados em UTI cardiológica em ventilação mecânica após cirurgia cardíaca, pacientes acometidos por SDRA e pacientes internados em UTI nos quais as manobras de recrutamento alveolar foram adotadas como medida terapêutica. Foram excluídos estudos que não utilizaram as manobras de recrutamento alveolar como método de intervenção. Manobras de recrutamento alveolar, associadas a estratégias de ventilação protetora pulmonar, podem estabelecer uma boa condição hemodinâmica, reduzindo lesões pulmonares e aumentando significativamente os níveis de oxigenação.

Palavras-chave: Doença cardíaca. UTI. Recrutamento alveolar.

RESUMEN

Las enfermedades cardíacas representan una condición preocupante en los pacientes de la UCI, y la insuficiencia cardíaca (IC) es una de las enfermedades cardíacas más comunes y agravantes, ya que compromete la función respiratoria. La IC causa la acumulación de líquidos en los pulmones, generando edema pulmonar y, consecuentemente, atelectasia, que colapsa los alvéolos. Este colapso reduce el intercambio de gases, agravando la hipoxemia y dificultando la recuperación del paciente. Debido a la importancia del tema, el estudio tiene como objetivo identificar cómo las maniobras de reclutamiento alveolar pueden ayudar en el tratamiento de pacientes en UCI de cardiología. Se realizó una búsqueda de artículos científicos en las bases de datos PubMed, SciELO, Getinge, Artmed y ScienceDirect. Se incluyeron en la búsqueda artículos publicados íntegramente, en inglés y portugués, que abordaron pacientes de UCI de cardiología en ventilación mecánica después de cirugía cardíaca, pacientes afectados por SDRA y pacientes de UCI en quienes se adoptaron maniobras de reclutamiento alveolar como medida terapéutica. Se excluyeron los estudios que no utilizaron maniobras de reclutamiento alveolar como método de intervención. Las maniobras de reclutamiento alveolar, asociadas a estrategias de ventilación pulmonar protectora, pueden establecer una buena condición hemodinámica, reduciendo las lesiones pulmonares y aumentando significativamente los niveles de oxigenación.

Palabras clave: Cardiopatía. UCI. Reclutamiento alveolar.

INTRODUCTION

Heart failure (HF) is one of the main causes of hospitalization in the country. Given this, it is important to understand how it works because if it is not treated correctly, it can evolve into comorbidities resulting from it.

In 2007, HF was responsible for 2.6% of hospitalizations and 6% of deaths recorded by the Unified Health System (SUS) in Brazil, consuming 3% of the total resources used to attend to all hospitalizations performed by the system ((3) et al., 2009).

Among the main comorbidities related to HF is pulmonary edema (PE), which occurs when the heart finds it difficult to pump blood, increasing blood pressure and resulting in accumulation of fluid in the lungs, specifically in the interstitial spaces and alveoli, which hinders gas exchange. Due to the accumulation of fluid, the pressure inside the alveoli increases and prevents them from expanding properly, so surface tension increases, and can lead to alveolar collapse, defined as atelectasis.

Therefore, this study proposes to verify how alveolar recruitment maneuvers can help, and what are their benefits for cardiac patients.

METHODS

This study is characterized as a literature review, with the objective of investigating the application of alveolar recruitment maneuvers in the treatment of patients in cardiology Intensive Care Units (ICU). For data collection, a systematic search of scientific articles was carried out in the PubMed, SciELO, Getinge, Artmed and ScienceDirect databases. The search was limited to articles published in full, in English and Portuguese, that addressed patients on mechanical ventilation after cardiac surgery, those with acute respiratory distress syndrome (ARDS), and ICU patients who used alveolar recruitment maneuvers as a therapeutic measure. Studies that did not involve alveolar recruitment maneuvers as a therapeutic intervention were excluded.

Alveolar recruitment maneuvers, when applied in conjunction with protective pulmonary ventilation strategies, demonstrate the potential to improve the hemodynamic condition of patients, minimizing lung damage and promoting a significant improvement in oxygenation levels.

DEVELOPMENT

ATELECTASIS AND HEART FAILURE

Mechanical Ventilation (MV) has evolved significantly in recent decades, following technological advances and the understanding of respiratory physiology. In order to reduce the length of hospital stay, improve hemodynamic condition, and reduce respiratory effort, more sophisticated ventilators have emerged, allowing fine adjustments in pressures, volumes, and ventilatory modes, enabling a personalized approach for each patient. In this context, the application of alveolar recruitment maneuvers (ARM) emerges as a proposal, with the objective of opening collapsed alveolar units and improving oxygenation in patients with atelectasis.

Since hematosis is impaired due to the collapse of the alveoli, atelectasis can generate hypoxemia, due to the decrease in the ventilation/perfusion ratio (V/Q), which aggravates heart failure, in addition, the areas of atelectasis create an environment conducive to the accumulation of secretions, since ventilation in the affected regions is insufficient to mobilize them, This accumulation favors the proliferation of pathogens, which also increases the risk of pneumonia.

Collapsed lung regions are associated with increased respiratory infections and hypoxemia due to increased pulmonary shunt. In addition, atelectasis can progress to severe respiratory complications, such as acute respiratory distress syndrome (ARDS), which is associated with high mortality.

Due to the alveolar collapse caused by atelectasis, there is an increase in intrathoracic pressure, overloading the right ventricle of the heart and affecting venous return, thus resulting in congestive heart failure (CHF).

Alveolar reexpansion is necessary to rescue collapsed alveolar areas, improve the V/Q ratio and oxygenation, and consequently reverse the hypoxemic condition, thus also reducing the risk of infections and worsening, providing reduction and weaning from extracorporeal ventilatory support, and later extubation.

Cardiac patients, especially those who have undergone cardiac surgery, are highly susceptible to postoperative atelectasis, which can progress to pneumonia, acute respiratory distress syndrome (ARDS), or pulmonary infections. Thus, the alveolar recruitment maneuver proves to be an effective alternative in the reversal of atelectasis and hypoxemic areas.

ARM(s) are procedures that aim at a sustained or intermittent increase in transpulmonary pressure in order to promote the opening of as many alveoli as possible and thus improve the distribution of alveolar gas. Thus, this approach maximizes gas exchange and minimizes atelectrauma. It is also used to prevent alveolar collapse during mechanical ventilation performed at low tidal volumes. Its most important goal, however, is to protect the lungs from lung injury and MV-induced lung injury (MVIP). CABG can be indicated by means of oxygenation markers, the most commonly used being arterial oxygen pressure (PaO2), PaO2/fraction of inspired oxygen (FiO2), oxygenation index (OI), pulse oximetry (SpO2) and SpO2/FiO2 ratio ((10); KOLISKI; GIRALDI, 2009).

The PaO_2/FiO_2 ratio, also known as the Horowitz oxygenation index, is a fundamental parameter for evaluating the efficiency of pulmonary gas exchange and classifying the severity of respiratory failure. Its calculation is made by dividing the arterial oxygen pressure (PaO_2, in mmHg) by the fraction of oxygen inspired (FiO_2, expressed as decimal). Values below 300 mmHg indicate impaired oxygenation, and a ratio below 200 mmHg suggests severe lung injury, and values below 100 mmHg are compatible with critical respiratory failure. The higher the OI value, the worse the oxygenation and the greater the severity of the pulmonary dysfunction.

The quantification of the degree of lung injury is generally performed by lung injury markers, such as the Murray score, for acute lung injury (LIS), and by static and dynamic lung compliance. These markers, associated with computed tomography and bioelectrical impedance tomography, can confirm and clarify the effects of lung recruitment. ((10) et al., 2009).

The literature points to conventional sustained inflation as a widely used technique in clinical practice, characterized by an abrupt increase in airway pressure to 40 cmH2O that can last for up to 40 s. ((13) et al., 2009; SILVA et al., 2011).

HEMODYNAMIC EFFECTS OF BARMS

This maneuver has been shown to improve oxygenation and pulmonary mechanics ((13) ET AL., 2009; SILVA ET AL., 2011), and is associated with a reduction in pulmonary atelectasis ((7) ET AL., 2005).

PEEP plays a fundamental role in maintaining the effectiveness of the maneuver, preventing derecruitment and preventing ateletrauma. However, the application of the sustained inflation technique can result in adverse hemodynamic consequences and

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alveolar stress. Thus, it is necessary to associate these maneuvers with the appropriate PEEP.

In addition, stratification of patients according to severity can contribute positively to the impact of the application of ARMs on patient morbidity and mortality. The efficiency of maneuvers can be affected by different factors, including the nature and extent of lung injury, ability to increase inspiratory transpulmonary pressures, patient positioning, and cardiac preload.

Although there is still no consensus on the values used in BAR and PEEP, many of these studies, based on imaging methods, have shown the importance of ART in improving oxygenation. Even though the pathophysiology of ARDS is different, the strategy for the treatment of hypoxemia in these patients, which includes ARM, as well as specific studies in cardiac surgery using the same technique, endorsed and motivated the conduct of this present investigation.

Alveolar recruitment maneuvers were effective in correcting hypoxemia and increasing exhaled tidal volume in mechanically ventilated patients in the immediate postoperative period of cardiac surgery. These results indicate that higher pressures are required for the opening of collapsed alveolar units in the postoperative period, when compared to conventional PEEP values of around 5 cmH2O ((2) JUNIOR et al., 2007).

DISCUSSION

However, the application of the sustained inflation technique can result in adverse hemodynamic consequences and alveolar stress. Since ARM implies high intra-alveolar pressurization, (2) Junior et al. (2007) highlight that there are inherent risks, such as alveoli rupture, resulting in pneumothorax, and hypotension, resulting from reduced venous return during its application. Therefore, sustained inflation, when performed without a protective ventilatory strategy, can contribute to ventilator-induced lung injury (MVIP), favoring the release of inflammatory mediators into the bloodstream.

APPLICATION PARAMETERS

The literature describes different protocols for performing MRAs, varying in relation to the pressure applied, duration, and monitoring of cardiorespiratory parameters. The choice of protocol should be individualized, considering the patient's clinical conditions.

Rothen et al. reported that 40 cmH_2O is required for a period of 7 to 15 seconds to recruit collapsed alveoli from healthy individuals after 20 minutes of general anesthesia. Tusman et al. recorded similar airway pressure values in improving oxygenation after anesthesia for general surgery.

There are few reports of the use of ART in cardiac surgical procedures. (6) et al. defined CABG as the application of four sustained insufflations with airway pressure of 45 cmH_2O for 10 seconds each, in the ventilator's CPAP modality. The interval between insufflations was 20 seconds, and the patients were ventilated in the volume-controlled mode with PEEP (0 or 12 cmH_2O).

(2) Junior et al. (2007) also observed that, in the postoperative period of cardiac surgery, ARM combined with the maintenance of PEEP results in an increase in exhaled lung volume and improved oxygenation after recruitment.

INDICATIONS AND CONTRAINDICATIONS

It is believed that this association in clinical practice determines an important reduction in morbidity and mortality, as well as prevention of ventilator-induced injuries. Its indication is related to acute lung injury, usually resulting from pneumonia or sepsis, which course with severe hypoxemia. Its main contraindications are hemodynamic instability, presence of pneumothorax, and intracranial hypertension.

In the present study, oxygenation increased simultaneously with an increase in exhaled tidal volume, demonstrating that the recruitment of collapsed alveoli contributed to the improvement of gas exchange. Claxton et al. studied a similar population and follow-up period, but with PEEP values of 15 cmH2O, allowing a peak inspiratory pressure of 40 cmH2O.

There was a significant improvement in oxygenation measured by the PaO2/FiO2 ratio in the recruitment group, 30 minutes and one hour later, when compared to the groups without PEEP and with PEEP of 5 cmH2O ((2) Junior et al. (2007).

CONCLUSION

Patients undergoing cardiac surgery are particularly prone to developing atelectasis, and its pathophysiology is multifactorial. In the present study, CABG increased arterial oxygenation in hypoxemic patients, as demonstrated by the increase in the PaO_2/FiO_2 ratio and peripheral oxygen saturation. This fact indicates that the alveolar recruitment pressure determined the opening of collapsed bronchoalveolar territories, promoting improvement in arterial oxygenation. This increase in oxygenation after ARM also suggests a better coupling between ventilation and pulmonary perfusion ((2) JUNIOR et al., 2007).

ARM promoted an improvement in gas exchange and pulmonary ventilation, sufficient to increase oxygenation and decrease dead space. However, since ARM implies a large intra-alveolar pressurization, there are inherent risks, such as alveoli rupture, causing pneumothorax, and hypotension due to reduced venous return during its application ((2) JUNIOR et al., 2007).

ARM is also associated with respiratory and cardiovascular side effects, which can be minimized by recently proposed strategies: prolonged or incremental elevation of PEEP; pressure-controlled ventilation with fixed PEEP and increased driving pressure; pressure-controlled ventilation applied with increasing PEEP and constant driving pressure; and long, slow increase in pressure.

Thus, in order to produce beneficial effects of the maneuver on oxygenation and alveolar collapse, it is necessary to establish an associated protective ventilatory strategy, thus reducing biotraumas, barotraumas, atalectraumas, morbidity and mortality.

FINAL CONSIDERATIONS

MRAs have significant therapeutic potential for patients with pulmonary complications in cardiology ICUs. However, its application requires careful evaluation and close monitoring, especially in patients with cardiac dysfunction. Future studies are needed to establish safer and more effective protocols, aiming to maximize benefits and minimize risks.

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