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The Practice Of Mechanical Ventilation In The Operating Room of The Mohammed V Military training Hospital of Rabat

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Abstract
Introduction:
Patients undergoing surgery often require general anesthesia and artificial ventilation to ensure proper breathing. Lung protective strategies, including low tidal volumes and PEEP, are crucial to avoid lung injury. With over 230 million patients needing mechanical ventilation annually, improving these practices is essential due to their impact on postoperative complications and outcomes. This study aims to review and enhance our ventilation practices by comparing them with existing guidelines.
Materials and methods:
We conducted a six-month observational study at Military Hospital Med 5 in Rabat, focusing on patients who underwent mechanical ventilation with general anesthesia. We collected data on patient demographics, comorbidities, procedural details, and ventilation parameters. Adjustments to ventilation settings were also documented. The study's single-center design and observational nature limit its generalizability and ability to establish causality.
Results :
Out of 857 patients, 62% required general anesthesia with artificial ventilation. The median age of these patients was 54 years, with a mix of ASA classifications. Visceral surgeries were performed on 22% of the ventilated patients. Ventilator settings were primarily adjusted by physicians (91%). Tidal volume varied widely, with 9% set at 6 ml/kg, 66% between 6 and 8 ml/kg, and 25% exceeding 8 ml/kg. Positive end-expiratory pressure (PEEP) was not set in 69% of cases. Recruitment maneuvers were used in 28% of patients only, and ventilation settings were adjusted during 67% of surgeries.
Conclusion:
protective ventilation strategies, including low tidal volumes, moderate PEEP, and recruitment maneuvers, are effective for managing respiratory function and reducing complications during surgery. Key recommendations are to use tidal volumes of 6-8 ml/kg, keep plateau pressures below 16 cmH2O, and maintain PEEP around 5 cmH2O. Reducing driving pressure also helps minimize complications. Further research is needed to refine these practices.
Keywords: *Mechanical ventilation, protective ventilation, tidal volume, positive end expiratory pressure, recruitment maneuvers*

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I. Introduction:

Patients undergoing surgical procedures often require general anesthesia, as most of the induction and maintenance drugs vastly influence respiratory function. Artificial ventilation management then becomes essential to maintain gas exchange and preserve respiratory function throughout the surgical procedure[1].

Lung protective ventilation, typically involving low tidal volumes of ≤8 ml/kg predicted body weight (PBW), PEEP ≥5 mbar, and recruitment maneuvers are fundamental elements[1].

Annually, over 230 million surgical intervention patients require mechanical ventilation[2]. Over the past decades, a significant increase in knowledge regarding mechanical ventilation for critically ill patients with lung injuries has altered clinicians' approach towards respiratory function support. Given that mechanical ventilation might exacerbate or even cause lung injury, physicians have devised a series of strategies coined as "protective ventilation"[2].

Postoperative pulmonary complications significantly influence postoperative morbidity, mortality, hospital stay length, and healthcare-associated social costs. Studies suggest that intraoperative protective ventilation may potentially enhance postoperative pulmonary complications[2]. The term "postoperative pulmonary complications" encompasses various clinical issues, including pneumothorax, atelectasis, pleural effusion, bronchospasm, pneumonia, weaning failure, prolonged mechanical ventilation, respiratory failure, and the need for reintubation. These complications affect up to 40% of patients, correlating with increased hospital stays and mortality[1].

The objective of our study is to assess the practice of mechanical ventilation in our operating theater, comparing it with existing literature to optimize our management.

II. Materials And Methods:

We conducted a rigorous prospective observational study at the operating theatre of the Military Hospital Med 5 in Rabat, spanning a comprehensive six-month period from January to June 2016.

Inclusion and Exclusion Criteria:

Our study encompassed all patients who underwent mechanical ventilation while receiving general anesthesia within the specified timeframe. Patients operated under local or locoregional anesthesia, as well as those managed under general anesthesia without tracheal intubation, were excluded from our analysis to maintain homogeneity within our study.

Data Collection:

Patient demographics, including age, gender, and any relevant comorbidities, were meticulously recorded. Procedural details, such as the type of surgery performed and the duration of mechanical ventilation, were documented. Additionally, we captured mechanical ventilation parameters, including tidal volume, respiratory rate, peak inspiratory pressure, and positive end-expiratory pressure.

Practitioner Responsibilities and Adjustments:

We diligently identified the practitioner responsible for managing mechanical ventilation adjustments throughout the surgical procedure. Any modifications made to ventilation settings, such as adjustments to tidal volume or respiratory rate, were meticulously documented alongside the rationale for these changes.

Statistical Analysis:

Descriptive statistics were used to summarize patient demographics and procedural characteristics. Continuous variables were presented as mean ± standard deviation or median (interquartile range), depending on their distribution. Categorical variables were expressed as frequencies and percentages.

Limitations:

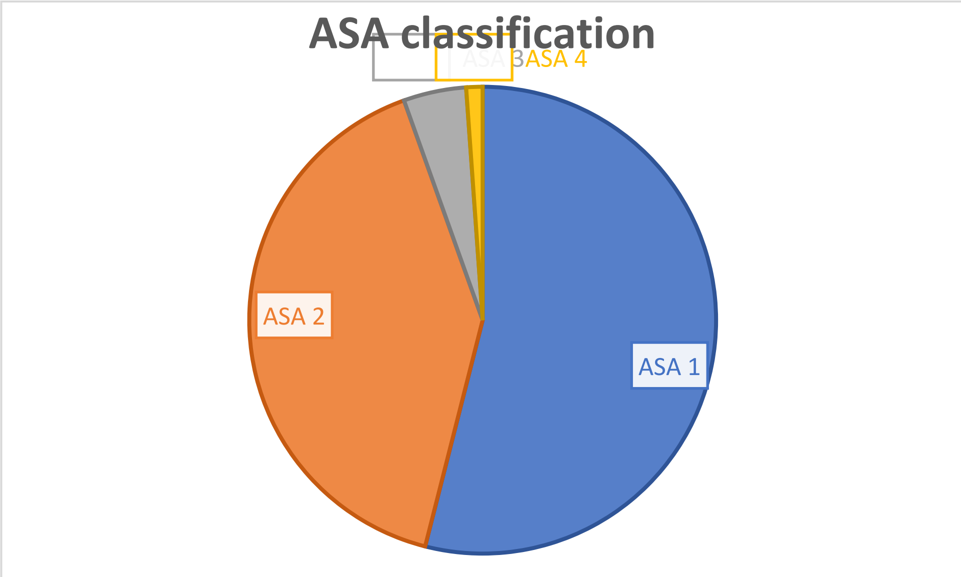
While every effort was made to ensure the accuracy and reliability of our data, our study had several limitations. The single-center design may limit the generalizability of our findings to other healthcare settings. Additionally, the observational nature of our study precluded us from establishing causality between mechanical ventilation parameters and patient outcomes.

III. Results:

A total of 857 eligible patients were included in our study, among whom 62% underwent general anesthesia with artificial ventilation.

Demographics:

The median age of patients in the ventilated group was 54 years with a standard deviation of ±13 years. Among these patients, there were 345 men and 185 women. Patients were further categorized according to the American Society of Anesthesiologists (ASA) classification: 286 were classified as ASA1, 215 as ASA2, 23 as ASA3, and 6 as ASA4.



Surgical Procedures:

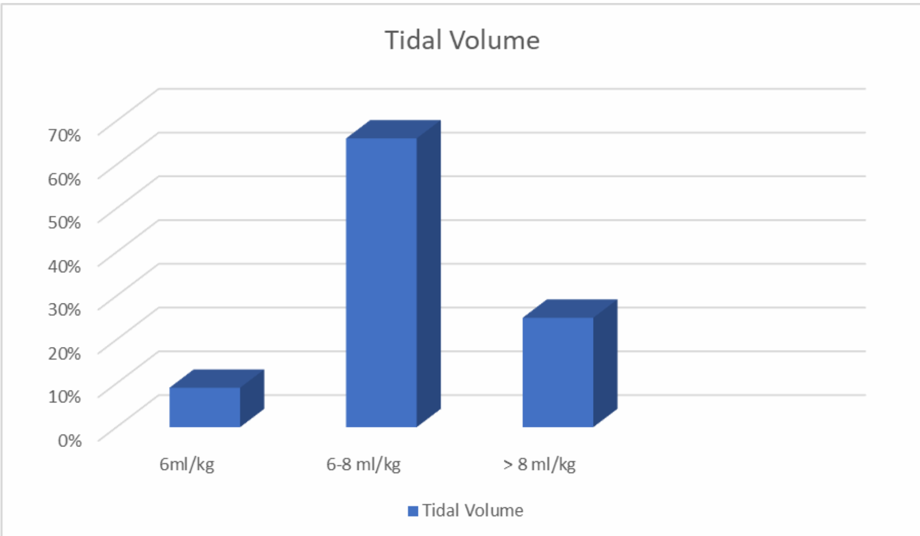
Regarding surgical procedures, 22% of ventilated patients underwent visceral surgeries, while smaller percentages were recorded for other types of surgeries.

Ventilation Management:

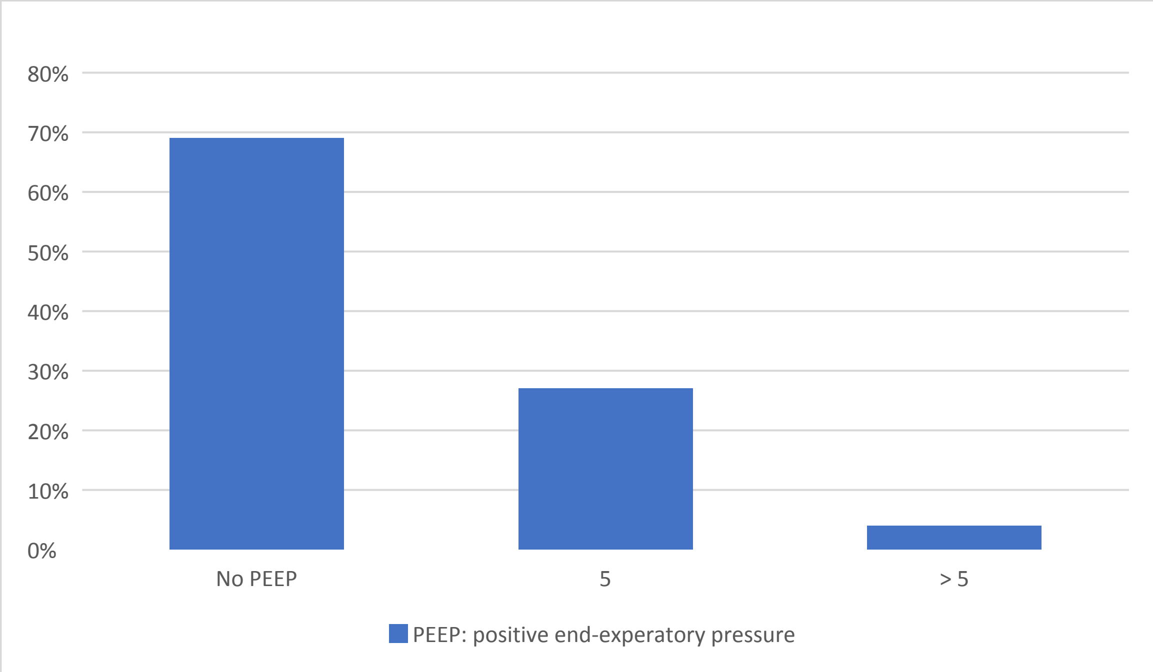
In our study, adjustments to ventilator settings were predominantly carried out by physicians, accounting for 91% of cases, while anesthetist nurses were responsible for the remaining 9%.

Ventilation Parameters:

Analysis of ventilation parameters revealed that tidal volume settings varied among ventilators. Specifically, tidal volume was set at 6ml/kg in only 9% of ventilators, between 6 and 8ml/kg in 66% of cases and exceeded 8ml/kg in 25% of ventilators.

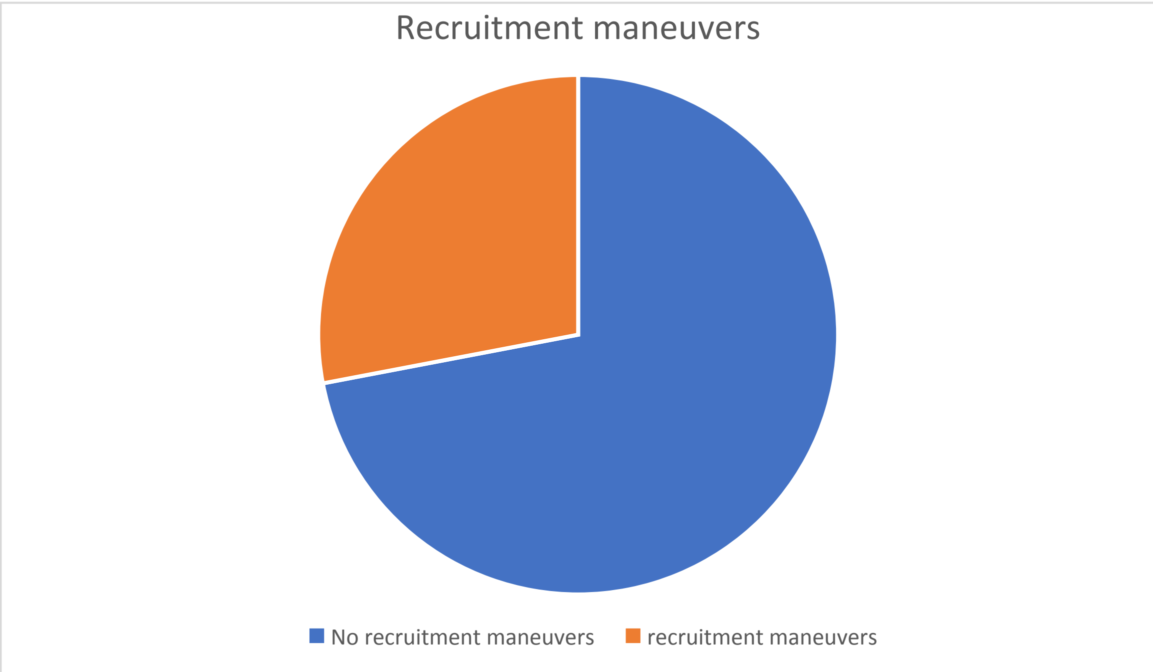


Notably, 69% of ventilators did not have positive end-expiratory pressure (PEEP) settings configured, while 27% were set at PEEP 5, and only 4% were set at levels greater than 5.



Clinical Interventions:

Recruitment maneuvers, aimed at optimizing lung recruitment and improving oxygenation, were performed in only 28% of ventilated patients. Adjustments to ventilation parameters were made during 67% of surgeries, indicating the dynamic nature of ventilation management during procedures.



IV. Discussion:

The alteration of oxygenation due to hypoxemia, restrictive syndrome, or atelectasis is almost constant in anesthetized and intubated patients, whether ventilation is spontaneous or controlled. The type of anesthesia, surgery, patient position, and comorbidities such as obesity, chronic obstructive pulmonary disease (COPD) or age, influence these changes in perioperative respiratory function. Intubated and ventilated patients are therefore at risk of postoperative pulmonary complications, especially when surgery is performed in emergency situations. However, perioperative modifications in respiratory function can be controlled through appropriate perioperative management. Thus, the concept of protective ventilation has been introduced in recent years.

It involves the application of positive end-expiratory pressure (PEEP), with a moderate tidal volume and regular recruitment maneuvers. These measures are believed to limit perioperative and postoperative respiratory complications.

The Role of VT, PEEP, and Recruitment Maneuvers:

The definitive role of protective ventilation within the operating room (OR) remains undecided. Most randomized controlled trials have not examined individual ventilation settings but focused on intervention bundles. These bundles often encompass lower VT per predicted body weight, higher PEEP, and recruitment maneuvers. These studies primarily focus on laparoscopic[3,4,5,6,7] or open major abdominal surgery[2]. However, the results are not consistent. While smaller studies have found strategies combining lower VT, higher PEEP, and recruitment maneuvers improved intraoperative gas exchange[3,7] and respiratory mechanics[2,4,8], postoperative outcomes were only improved in certain studies, with no differences found in others[4,8] or postoperative patients not investigated[3,7]. Despite this, a comprehensive retrospective study on 29,343 patients found that from 2008 to 2011, there was an increased utilization of lower intraoperative tidal volumes, with low TV (6-8 ml/kg PBW) and minimal PEEP associated with higher risk of 30-day mortality[9]. This study's retrospective design, however, does limit the interpretation of these results.

Recruitment Maneuvers Techniques:

Recruitment maneuvers can be performed in several ways. The most commonplace is the "bag squeezing" technique, where the ventilator is manually adjusted with the adjustable pressure limiting (APL) valve set to 30 or 40 cmH2O. However, this method has potential limitations due to difficulty in maintaining constant pressure and potential lung de-recruitment when switching back from manual to mechanical ventilation. More advanced machines depend on ventilatory settings, avoiding manual ventilation. In this case, a more reproducible and effective strategy could be increasing PEEP during VCV without modifying VT until a plateau pressure of 30 or 40 cmH2O is achieved, followed by a decrease in PEEP in a decremental PEEP trial or cycling maneuver[10]. Nonetheless, the maximum limit of PEEP in some new anesthesia machines is 20 cmH2O, making it difficult to reach the desired plateau pressure for some patients. In morbidly obese patients, the conventional recruitment pressure of 30 to 40 cmH2O might be inadequate for full lung recruitment: pressures up to 60 cmH2O might be required[8].

Effectiveness of Protective Mechanical Ventilation in the Operating Room:

Numerous randomized clinical trials with different primary outcome measures conducted over the past 15 years have shown an association between protective ventilation and low systemic and local inflammatory levels[11,12]. As investigative studies continue, current evidence suggests that mechanical ventilation during general anesthesia should comprise low tidal volumes (6-8 ml/kg of predicted body weight), a maintained plateau pressure of less than 16 cmH2O, low PEEP levels (equal to or less than 5 cmH2O), ensuring a driving pressure of 13 cmH2O or less.[12]

Exclusive use of low tidal volumes does not necessarily translate into a decreased incidence of PPCs. The key elements of a protective ventilation strategy revolve around alveolar recruitment and PEEP. Recruitment Maneuvers (RMs) prove useful for initial alveolar recruitment, whereas PEEP serves to avert alveolar collapse and atelectasis. However, it's crucial that PEEP levels remain low enough to eschew hemodynamic changes[12].

In a comprehensive retrospective analysis of a large dataset containing 69,265 patients, Ladha et al. Noted a decreased incidence of respiratory complications in patients who received protective ventilation with PEEP values >5 cmH2O and tidal volumes <10 ml/kg. This approach aimed to achieve a plateau pressure less than 30 cmH2O, a threshold identified as safe for acute respiratory distress syndrome, but not necessarily for healthy lungs in anesthesia scenarios. Significantly, multivariate analysis displayed an association between low PEEP pressure and moderate PEEP values and a better outcome. Conversely, no effects were noted from tidal volume, and the role of high tidal volume is communicated through an increase in plateau pressure, which is closely related to pulmonary compliance. Interestingly, it was observed that the incidence of PPCs escalated when the plateau pressure exceeded 16 cmH2O—indicating that the pulmonary damage threshold in healthy lungs during general anesthesia could be lower than anticipated. This discovery gave rise to the concept of 'driving pressure', defined as the difference between plateau pressure and PEEP levels. Building on this, Serpa Neto et al. Demonstrated that reductions in driving pressure were significantly correlated with a decreased incidence of postoperative pulmonary complications[13].

Considering the current evidence, mechanical ventilation during general anesthesia should comprise the following components:

1) Low tidal volume values (6-8 ml/kg of predicted body weight)
2) Plateau pressure maintained under 16 cmH2O

3) Low PEEP levels (equal to or less than 5 cmH2O), ensuring a driving pressure of 13 cmH2O or less
4) Consideration of PEEP values between 5 and 10 cmH2O for patients presenting with a BMI exceeding 35 kg/m2, those undergoing laparoscopic surgery in the Trendelenburg position, and surgical procedures with a duration surpassing 4 hours.

V. Conclusion:

Our review highlights the critical role of protective ventilation in managing perioperative respiratory function and mitigating postoperative pulmonary complications. While low tidal volumes, moderate positive end-expiratory pressure (PEEP), and recruitment maneuvers are foundational elements of protective ventilation, their impact on outcomes remains debated. The evidence supports using low tidal volumes (6-8 ml/kg) and maintaining plateau pressures below 16 cmH2O to reduce complications. PEEP should be optimized, with levels typically ≤5 cmH2O, though values between 5 and 10 cmH2O may be beneficial for specific patient groups, such as those with high BMI or undergoing prolonged surgeries. The concept of driving pressure also emerges as a valuable metric, correlating reductions in driving pressure with decreased incidence of pulmonary complications. Future research should continue to refine these strategies and evaluate their effectiveness across different surgical contexts.

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