7-16-2018

Recruitment Maneuvers and Positive End Expiratory Pressure for Obese Patients Undergoing Laparoscopic Procedures

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RECRUITMENT MANEUVERS AND POSITIVE END EXPIRATORY PRESSURE FOR OBESE PATIENTS UNDERGOING LAPAROSCOPIC PROCEDURES

by

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Bachelor of Science in Nursing, University of North Dakota, 2013

An Independent Study

Submitted to the Graduate Faculty

of the

University of North Dakota

in partial fulfillment of the requirements

for the degree of

Master of Science

Grand Forks, North Dakota

December

2018

PERMISSION

Title	Recruitment Maneuvers and Positive End Expiratory Pressure for Obese Patients Undergoing Laparoscopic Procedures
Department	Nursing
Degree	Master of Science

Signature ______________________________

Date _______________________________

ABSTRACT

Title: Recruitment Maneuvers and Positive End Expiratory Pressure for Obese Patients Undergoing Laparoscopic Procedures

Background: Obese patients undergoing laparoscopic procedures are at an increased risk for experiencing perioperative respiratory complications, and anesthetic management can prove to be difficult due to the challenge of ventilation associated with both obesity and pneumoperitoneum used in laparoscopic procedures. There are multiple strategies to reduce perioperative respiratory complications, and one of these strategies is the use of intraoperative recruitment maneuvers (RM), with the addition of positive end expiratory pressure (PEEP). The goal of the RM is to recruit collapsed alveoli and PEEP will prevent re-collapse.

Purpose: The purpose of this independent project is to complete a review of the literature to determine a strategy for improving oxygen saturation during the intraoperative phase for this specific patient population.

Process: The Cumulative Index of Nursing and Allied Health Literature (CINAHL) and Medical Literature Analysis and Retrieval System Online (MEDLINE) using PubMed were accessed through the University of North Dakota Health Sciences Library. These two databases provided the best opportunity to find relevant and credible material, most of which performed in the past five years, on the subject being researched. The articles were then ranked via the Hierarchy of Evidence for Intervention Studies and included in the literature review if appropriate.

Results: Overall, the literature suggests the use of RMs with and PEEP had statistically significant increase of oxygen saturation in obese patients undergoing laparoscopic procedures, compared to other ventilation strategies. Minimal complications were noted during this

intervention. It does appear however, that the benefits gained by this intervention only last while the patient's trachea is intubated.

Implications: There is sufficient, high quality evidence that supports the use of RMs with addition of PEEP to improve oxygen saturation in obese patients undergoing laparoscopic procedures. Although future studies could be performed to find whether prophylactic use of this intervention is warranted in this population, and the method at which to perform this intervention, anesthesia professionals should consider using this cost-effective intervention.

Keywords: Recruitment maneuver, artificial respirations, alveolar recruitment maneuver, obesity, intraoperative, abdominal surgery, laparoscopy

RECRUITMENT MANEUVERS AND POSITIVE END EXPIRATORY PRESSURE FOR OBESE PATIENTS UNDERGOING LAPAROSCOPIC PROCEDURES

Introduction

Recruitment maneuvers (RM) with the addition of positive end expiratory pressure (PEEP) can be useful tools in the operating room (OR) when problems are encountered with oxygenating a patient. Such encounters may be experienced when providing anesthesia to obese patients undergoing laparoscopic procedures. In this specific patient population, it is important to have a plan in place if refractory oxygen desaturation occurs after providing FiO2 at 100% and optimizing patient position. RM and PEEP prove to be a viable option to improve oxygenation during the intraoperative phase.

The purpose of this independent project is to provide a case report in which RMs and PEEP were used to effectively improve oxygenation in a bariatric patient undergoing a laparoscopic procedure. This case can prove to a pertinent example of when RMs and PEEP can be used and provide the framework for future anesthetic care for patients in this specific population.

Case Report

A 52 year old, 165 kg, 193 cm male presented to the OR for an emergent laparoscopic appendectomy after arriving at the emergency department (ED) complaining of severe abdominal pain in the right lower quadrant (RLQ) for approximately 16 hours. The patient's past medical history included obesity, obstructive sleep apnea, hypertension, gastric esophageal reflux, and an allergy to latex. He did not smoke and had occasional alcohol use. His surgical history included a toe amputation and Achilles tendon repair with no anesthetic complications. The patient's home medications included Lisinopril-hydrochlorothiazide, naproxen, omeprazole,

zolpidem, multiple vitamin, and probiotic. Lab results completed in the ED were all within normal limits. Findings of an abdomen/pelvis CT scan revealed appendicitis and periappendiceal fluid tracking along the distal ileum and along the sigmoid colon, suggesting possible rupture of the appendix.

Vital signs upon arriving to the ED were pulse of 129/min, respirations of 24/min, BP of 169/91 mm Hg, temperature of 37.4 °C, SpO_2 of 98% on room air, and sharp pain rating at 9/10 in the RLQ of the abdomen. Upon entering the operating room, vital signs included pulse of 141/min, respirations of 20/min, BP of 192/82 mm Hg, nasopharyngeal temperature of 38.8 °C, SpO_2 of 98% on room air and continued sharp pain rating 9/10 in the RLQ of the abdomen. Peripheral IV access was established in the ED with normal saline infusing and the patient had received two doses of fentanyl 50 mcg preoperatively.

Once the patient arrived in the OR, he was pre-medicated with midazolam 2 mg and fentanyl 50 mcg. Standard monitors including a non-invasive blood pressure cuff, oxygen saturation probe, and 5-lead ECG were applied. The patient was pre-oxygenated and de-nitrogenated with O_2 8 L/min via mask for approximately 2 minutes followed by rapid sequence induction with lidocaine 50 mg, fentanyl 100 mcg, propofol 200 mg, and succinylcholine 140 mg. Endotracheal intubation was performed without complications using a Glidescope (Verathon Inc., Bothell, WA) with a size 4 blade and an 8.0 endotracheal tube. Cricoid pressure was applied prior to induction and maintained until placement of the endotracheal tube was confirmed. Following induction and intubation, the patient quickly desaturated to approximately an SpO_2 of 70%. Manual ventilation was performed until the SpO_2 was above 90%. Two RMs were performed with a pressure of about 30 cm H_2O held for 10-15 seconds each. The patient was then placed on volume auto-control mode with a tidal volume of 650 ml, respiratory rate of

16/min, FiO_2 at 100%, and PEEP of 5 cm H_2O. General anesthesia was approximately maintained with desflurane 6.5% inspired concentration in O_2 1 L/min throughout the maintenance phase.

During the intraoperative period the patient received a total of cefazolin 2 g for antibiotic prophylaxis, rocuronium 90 mg to maintain adequate level of neuromuscular blockade, ondansetron 4 mg and decadron 8 mg for nausea prophylaxis, and normal saline 1500 ml to maintain fluid balance. Vital sings remained stable with HR of 80 to 90/min, SBP of 120 to 130 mm Hg, and SpO_2 above 90%. Two more RMs were performed for SpO_2 of 91% after placing patient in Trendelenburg position. The SpO_2 improved, and ventilator settings remained unchanged. At the end of the procedure, his neuromuscular blockade was antagonized after train of four 3/4 with glycopyrrolate 0.6 mg and neostigmine 4 mg. Estimated blood loss was approximately 25 ml. The patient was then extubated and oxygen 6 L/min was administered via simple mask. The patient was transported to the post anesthesia care unit (PACU). His vital signs were stable. He denied pain, nausea, or troubles breathing, and no other complications were noted. The total length of the intraoperative period was 105 minutes. From the PACU, the patient was admitted to the medical surgical unit and was later discharged home within 24 hours of the procedure with no complications.

Discussion

Laparoscopic procedures are commonly performed in the operating room, and many patients have a body mass index (BMI) greater than 30 kg/m^2. According to the Center for Disease Control, from 2011 to 2014, the prevalence of obesity in American adults was 36.5% (2015). Obese patients undergoing laparoscopic procedures are at an increased risk for experiencing perioperative respiratory complications, and anesthetic management can prove to

be difficult due to the challenge of ventilation associated with both obesity and pneumoperitoneum used in laparoscopic procedures. Each of these can independently reduce lung volumes, decrease lung compliance, and impair oxygenation. In a patient population where both obesity and pneumoperitoneum are encountered, the risk for respiratory complications is increased, which can lead to an increase in morbidity and mortality, along with an increase in length of hospital stay and healthcare costs (Stankiewicz-Rudnicki, W. Gaszynski, & T. Gaszynski, 2016).

There are multiple strategies to reduce perioperative respiratory complications, and one of these strategies is the use of intraoperative RMs, also known as vital capacity maneuvers or sigh breaths, with the addition of PEEP. A RM is performed after a secure airway has been established and usually involves providing positive airway pressure around 40 cm H_2O for around 40 seconds. Both the pressure and the time can be altered, and these maneuvers can be performed multiple times during the intraoperative period. The goal of the RM is to recruit collapsed alveoli, caused by the excess cephalad pressure on the diaphragm from both the carbon dioxide inflation of the abdominal cavity used to create the pneumoperitoneum, and also the excess weight and abdominal contents found in obese patients in a supine or Trendelenburg position. RMs also improve oxygenation and ventilation. After this, positive pressure is applied at or around a PEEP of 10 cm H_2O in order to reduce the re-collapse of the recruited alveoli (Futier et al., 2010).

PICO Question

The following PICO question was utilized: Among patients with a BMI greater than 30 kg/m^2 undergoing laparoscopic surgery, does the use of RMs and PEEP improve perioperative oxygenation and ventilation? This PICO question was selected because I have experienced first-

hand the benefit of using RMs and PEEP during procedures to improve oxygenation. One of the most common times oxygenation issues were encountered was during anesthetic care of obese patients undergoing laparoscopic procedures.

In this question, the population of interest is obese patients with a BMI greater than 30 kg/m^2 undergoing laparoscopic surgery. The intervention is performing one or more RMs with the addition of PEEP if the patient is experiencing oxygenation complications after induction and intubation, during the intraoperative phase, or prior to extubation. The control group would be those patients in which this intervention was not used. Finally, the outcome being studied would be whether or not there was an improvement in oxygenation during the intraoperative phase of care.

Literature Search

Two different databases were chosen for the literature search. These included the use of the Cumulative Index of Nursing and Allied Health Literature (CINAHL) and accessing Medical Literature Analysis and Retrieval System Online (MEDLINE) using PubMed through the University of North Dakota Health Sciences Library. These two databases provided the best opportunity to find relevant and credible material on the subject chosen for this particular PICO question.

CINAHL

The technique used to search CINAHL was as follows. For the main search topic, “recruitment maneuver” was typed in without selecting a search field. “Obesity” was also selected, after including the conjunction AND, without adding a search field. This brought up 12 articles. The titles of these articles were reviewed and six articles that could be relevant to the research topic were kept for more complete evaluation. Next, another search using the term

"obesity" AND "intraoperative" AND "abdominal surgery" was completed. This search resulted in eight articles, one of which was relevant to the research topic.

PubMed

The technique used to search PubMed was as follows. After accessing PubMed, the Medical Subject Headings (MeSH) option was selected and a search for "artificial respirations" AND "obesity" AND "laparoscopy" was conducted. This search resulted in 46 articles. After reading the article titles, 10 articles that possibly were relevant to the literature review topic were selected. One of the articles in the search titled "Intraoperative Recruitment Maneuver Reverses Detrimental Pneumoperitoneum-induced Respiratory Effects in Healthy Weight and Obese Patients Undergoing Laparoscopy" appeared to be one of the most relevant articles found, so the "similar articles" link was then selected, which produced 119 articles. Many of these articles however, were irrelevant to my research question or were already found under the previous search.

In addition, PubMed was searched using the term "alveolar recruitment maneuver" which resulted in 130 articles. The results were then narrowed by applying the filter of publication dates within the past 5 years and those studies only involving humans. This left 26 articles, and reading the titles, three of these appeared to be relevant to the research topic.

Final Articles

After reading the 19 articles found using CINAHL and PubMed, 12 relevant articles were included that could be used for the research topic that qualified after ranking them using the Hierarchy of Evidence for Intervention Studies. Some of the articles found did not apply directly to my PICO question, therefore, were not chosen. Of the articles chosen, some did not fit the

topic entirely, but did apply to some of the areas of interest. Therefore, these studies were included in the literature review.

Level I Evidence

Overall, the literature review proved to be successful in finding multiple studies directly related to my PICO question. Using the Hierarchy of Evidence for Intervention Studies, the found evidence was evaluated. Four systematic review/meta-analysis, classified as Level I evidence, found evidence supporting the use of various RM methods followed by the application of PEEP.

A systematic review performed by Hartland, Newell, and Damico (2015) reviewed six randomized controlled trials involving 186 adults undergoing general anesthesia and found that RMs allowed the anesthesia provider to **“**reduce the FiO_2 while maintaining a higher SpO_2, limiting the masking of shunts. Utilization of alveolar recruitment maneuvers may reduce postoperative pulmonary complications and improve patient outcomes” (p. 610). Like the previously stated study, a meta-analysis performed by Hu (2016), reviewed 13 randomized controlled trials observing multiple ventilation strategies for 519 obese patients undergoing laparoscopic bariatric surgeries. The analysis found that multiple strategies using RMs and PEEP demonstrated to be effective in improving intraoperative oxygenation, lung volume expansion, and atelectasis. Hu described the reason why the use of RMs and PEEP are more effective compared to using and RM or PEEP alone is that a:

> recruitment maneuver is only effective, however, when it is followed by adequate PEEP. Recruitment maneuver uses sustained pressure to open the closed or collapsed alveoli, and it thereby improves compliance, alveolar ventilation, and oxygenation and decreases

> elastance and airway resistance. The succeeding PEEP is used to maintain the recruited alveoli. (Hu, 2016, p. 42)

Similar results were found in a meta-analysis of thirteen randomized controlled trials with a total of 505 obese surgical patients. According to Aldenkortt, Lysakowski, Elia, Brochard, and Tramèr (2012), this study also found that using RMs and PEEP improved intraoperative oxygenation and compliance more than using PEEP alone or no intervention at all. Aldenkortt et al. (2012) states:

> RM plus PEEP compared with PEEP alone added both a statistically significant and clinically relevant effect on intraoperative oxygenation and increased respiratory system compliance, although it remained unclear how long these benefits were lasting and whether they extended into the postoperative period (p. 497).

A systematic review of multiple studies performed by Shah, Wong, J., Wong, D., & Chung (2016), observed ventilation strategies in 386 obese patients found mixed evidence but suggests that RMs and PEEP may be beneficial to obese patients undergoing general anesthesia during the intraoperative phase. Shah et al. (2016) states:

> There is no gold standard method for intraoperative ventilation in obese patients. Volume controlled ventilation (VCV) delivers a set tidal volume but may result in high airway pressures and barotrauma. Pressure controlled ventilation (PCV) allows limitation of high airway pressure but may result in variable tidal volumes depending upon lung resistance and compliance (p. 114).

This review also found various methods of applying RMs and different levels of PEEP to be used, all of which proved to be more beneficial to improving oxygenation when compared to the control groups.

As reviewed in the evidence, there are multiple methods to improving oxygenation during the intraoperative phase using RMs and PEEP. In the case discussed, two RMs were performed initially with a pressure of about 30 cm H_2O held for 10-15 seconds each. When the patients started desaturating again after being placed in Trendelenburg position, this was repeated. In retrospect, increasing the PEEP to 10 cm H_2O after the first two RMs would have possibly prevented the need for further RMs. However, an increase in oxygen saturation was noted without any complications.

Level II and IV Evidence

Five of the six randomized controlled trials, classified as Level II evidence, and one prospective study, classified as Level IV evidence, found similar results that the systematic review/meta-analysis found. In the article by Futier et al. (2013), a randomized controlled trial was performed with a sample size of 400 patients undergoing major laparoscopic or non-laparoscopic abdominal surgery. Lung protective strategies, including use of low tidal volumes of 6 to 8 ml/kg, PEEP of 6 to 8 cm H_2O, and RMs of 30 cm H_2O of pressure held for 30 seconds, repeated every 30 minutes, showed statistical significant improvement in clinical outcomes, and reduction of hospital length of stay and health care utilization compared to the control group. However, Futier et al. does suggest that “recruitment maneuvers, in which hemodynamic effects are potentially influenced by the applied level of alveolar pressure, should be used with caution in patients with hemodynamic instability” (2013, p. 436). A randomized controlled trial by Stankiewicz-Rudnicki, Gaszynski, and Gaszynski, (2016), was performed with a sample size of 49 obese patients undergoing laparoscopic where PEEP of 10 cm H_2O proceeded by two RMs of 40 cm H_2O of pressure held for 10 seconds. This intervention showed statistically significant improvement in lung compliance and oxygenation. However, this article

states when comparing a PEEP of 0 and a PEEP of 10 preceded by a RM, "the positive end expiratory pressure of 10 cm H_2O preceded by recruitment maneuver with peak inspiratory pressures of 40 cm H_2O is insufficient to prevent atelectasis in the dependent lung regions as a result of anesthesia in obese patients" (Stankiewicz-Rudnicki, Gaszynski, & Gaszynski, 2016, p. 6). A prospective study with a sample size of 30 healthy weight patients and 30 obese patients by Futier et al. (2010), also found when the use of PEEP of 10 cm H_2O was applied, proceeded by a RM of 40 cm H_2O held for 40 seconds compared with ventilation with no PEEP, and ventilation with only PEEP, showed statistically significant improvement in end expiratory lung volumes, respiratory mechanics, and oxygenation during the pneumoperitoneum.

Many of the studies suggest advantages in using RMs and PEEP, however, it is unclear of when to perform a RM and how often to perform them. Almarakbi, Fawzi, and Alhashemi (2009), performed a randomized controlled trial with a sample size of 60 patients with a BMI greater than 30kg/m^2 undergoing a laparoscopic procedure. There were four groups in the study including patients who receive PEEP, patients who receive a RM, patients who receive both, and patients who receive both but the RMs are repeated every ten minutes. RMs involved pressure of 40 cm H_2O held for 15 seconds and PEEP was applied at cm H_2O. The group in which RMs were performed every ten minutes, followed by application of PEEP, had the most improvement in intraoperative oxygenation and compliance. This result is thought to be caused by reducing alveolar de-recruitment by the repeated RMs and the maintenance of these recruited alveoli by PEEP (Almarakbi, Fawzi, & Alhashemi, 2009).

Talab et al. (2009), performed a randomized controlled trial with a sample size of 66 patients with a BMI between 30 to 50 kg/m^2 undergoing laparoscopic bariatric procedures. This study had three different groups. The first received a RM after intubation and maintained for

about 8 seconds followed by PEEP of 0 cm H_2O. The second received a RM after intubation and maintained for about 8 seconds followed by PEEP of 5 cm H_2O. The third group received a RM after intubation and maintained for about 8 seconds followed by PEEP of 10 cm H_2O. All other variables remained constant throughout the case. Like the previous studies stated, results showed a statistically significant improvement in intraoperative oxygenation and reduction in atelectasis, PACU stay, and pulmonary complications. This study does discuss, however, the potential disadvantages including increased intrathoracic pressure which may reduce blood return to the heart and cardiac output, ultimately lowering blood pressure (Talab et al., 2009). Another randomized controlled trial performed by Whalen et al. (2006), discussed the advantages and possible disadvantages of RMs and PEEP. This study had a sample size of 20 obese patients with BMI > 40 kg/m^2 undergoing laparoscopic where PEEP of 12 cm H_2O was applied, proceeded by up to four RMs of up to 50 cm H_2O per breath. This showed statistically significant improvement in oxygenation throughout the intraoperative phase. However, this study also showed that these improvements only lasted while the patient's trachea was intubated, but "it is possible that techniques such as continuous positive airway pressure (CPAP) or bilevel positive pressure, applied by mask immediately after tracheal extubation, could help to maintain the alveolar expansion" (Whalen et al., 2006, p. 303).

Although some of the studies found potential hemodynamic changes after applying PEEP and performing an RM, a randomized controlled trial performed by Edmark et al. (2016), found differently. A sample size of 40 patients with a BMI greater than 35 kg/m^2 undergoing a laparoscopic procedure was split into two groups. The intervention group received PEEP of 10 cm H_2O and a RM after intubation and throughout the procedure while the control group received no PEEP. Results showed statistically significant improvements in oxygenation

compared to the control group, but no changes in hemodynamic status were noted between the groups.

Similar results were noted with the patient presented in this case report. An increase in oxygen saturation was noted after applying the RMs and PEEP. Minimal to no hemodynamic changes occurred, and the patient had no complications during the intra-operative or post-operative phases of his care.

Most of the literature supports using RMs and PEEP to improve intraoperative compliance and oxygenation. However, there is research that suggests limited benefit with 24 hours postoperatively. One randomized controlled trial by Defresne et al. (2014) stated there was no significant difference between using RMs and PEEP to using PEEP alone in improving oxygenation. This study used a sample size of 50 obese patients with BMI > 35 kg/m^2 undergoing laparoscopic where PEEP of 10 cm H_2O was applied, proceeded by two RMs of 50 cm H_2O held for 40 seconds. When compared to the control group, the patients receiving RMs and PEEP had better compliance, but it was found that postoperative functional residual capacity remained similar to preoperative measurements in both groups, and there was not a statistically significant difference in postoperative oxygenation or atelectasis between the two groups being studied.

Practice Recommendations

Recommendations

After performing the literature search and reviewing the evidence, performing RMs with addition of PEEP on obese patients undergoing laparoscopic procedures who are experiencing problems with oxygenation is a reasonable, cost effective, and evidence-based approach to improving intraoperative oxygenation. Although researchers have not yet agreed upon a certain

method for implementing RMs with addition of PEEP, "the most commonly used methods were PEEP of 40 cm H_2O held for 15 seconds and PEEP of 40 cm H_2O held for 40 seconds" (Hu, 2016, p. 42). Therefore, the first practice recommendation would be to perform a RM by applying 40 cm H_2O held for 15 seconds on a bariatric patient undergoing a laparoscopic procedure who was experiencing oxygenation complications. The second recommendation would be to apply PEEP of 10 cm H_2O after using a RM to ensure the benefits of the RM are not lost.

Research shows that using this as an intervention has proved to be effective and successful for improving perioperative oxygenation. Although RMs and PEEP prove to be an effective intervention, future research needs to be performed to study whether prophylactic use is warranted in this population. Complications such as hemodynamic alterations, barotrauma, and specific patient conditions in which this intervention would be contraindicated, would need to be considered and discussed with the operative team. In addition, future research should focus on which method for implementing RMs with addition of PEEP is the most effective in improving oxygenation.

Audience

The audience who would need to be included in this practice recommendation would include anesthesia professionals including Certified Registered Nurse Anesthetists and Anesthesiologists. Critical Care physicians taking over care of ventilated, post-surgical patients could also be included. Surgeons would also need to be informed on the benefits of performing this intervention, and specific contraindications would need to be discussed. Although this intervention is already being performed by many anesthesia providers, it would be wise to have protocols and best practices to implement this intervention in this patient population who are

experiencing complications with oxygenation, as RMs with addition of PEEP proves to be beneficial and cost effective in treating oxygenation complications in the obese population undergoing laparoscopic procedures.

Conclusion

There is sufficient evidence of high quality that supports the use of RMs with addition of PEEP to treat problems with oxygenation during the perioperative phase of surgery for bariatric patients undergoing laparoscopic procedures. Anesthesia professionals should consider using these cost-effective interventions as the evidence has demonstrated they likely will improve intraoperative oxygenation in this patient population. This ultimately would likely lead to better patient outcomes and reduced hospital costs all with minimal risk of complications.

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Appendix A

Recruitment Maneuvers and Positive End Expiratory Pressure for Obese Patients Undergoing Laparoscopic Procedures

Nathan McGee, SRNA

UND NURSE ANESTHESIA
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Introduction

- One of the biggest responsibilities of anesthesia providers is to ensure our patients are properly oxygenated
- Many factors can alter oxygenation
- Both obesity and pneumoperitoneum used in laparoscopic procedures can create difficulty with oxygenation and ventilation
- When both factors are encountered, it is best to have a plan in place if troubles with oxygenation are encountered
- Recruitment maneuvers and PEEP prove to be an effective strategy to improve oxygenation in this population

Case Information

- Emergent Laparoscopic Appendectomy
- 52 years old
- 165 kg
- Male
- ASA 2
- Arrived to ED with extreme LLQ abdominal pain

Preoperative Evaluation

- Past Medical History: obesity, OSA, HTN, GERD, allergy to latex, no smoking, occasional alcohol use.
- Surgical History: toe amputation and Achilles tendon repair with no anesthetic complications.

Preoperative Evaluation

- HR: 129/min
- RR: 24/min
- BP: 169/91
- Temp: 37.4 °C
- SpO_2 : 98% on RA
- Pain rating: 9/10 in the RLQ of the abdomen
- All labs WDL
- Abdomen/pelvis CT scan: appendicitis with possible appendiceal rupture
- Airway evaluation: Mallampati III, TM Distance < 3cm

Anesthetic Course

- RSI using Glidescope
- Drugs:
  - midazolam 2 mg
  - fentanyl 50 mcg
  - lidocaine 50 mg
  - fentanyl 100 mcg
  - propofol 200 mg
  - succinylcholine 140 mg

Intraoperative Issues

- Following induction and intubation:
  - quickly desaturated to approximately an SpO_2 of 70%
  - 2 RMs were performed
    - pressure of about 30 cm H_2O held for 10-15 seconds each
  - manual ventilation was performed until the SpO_2 was above 90%
  - Ventilator was set to volume auto-control mode, Vt of 650 ml, RR of 16/min, FiO_2 at 100%, and PEEP of 5 cm H_2O

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Intraoperative Issues

- Trendelenburg position
  - Two more RMs were performed for SpO_2 of 91%
  - SpO_2 improved, and ventilator settings remained unchanged
- Vital signs remained stable throughout the remainder of the case

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PACU

- No anesthetic complications noted.
- Vital signs remained stable.
- Denied pain, nausea, or troubles breathing.
- Admitted to medical surgical unit and discharged home the next day.

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Discussion

Laparoscopic Procedures on Obese Patients

- According to the Center for Disease Control, from 2011 to 2014, the prevalence of obesity in American adults was 36.5% (2015).
- This specific population is at increased risk for:
  - Respiratory complications including reduced lung volumes, decreased lung compliance, and impaired oxygenation
  - Higher morbidity and mortality
  - Longer hospital stays
  - Higher healthcare costs

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Recruitment Maneuvers

- Also known as vital capacity maneuvers or sigh breaths.
- A RM is performed after a secure airway has been established and usually involves providing positive airway pressure around 40 cm H_2O for around 40 seconds.
- The RM recruits collapsed alveoli, caused by various factors.
- RM improves compliance, and alveolar ventilation / oxygenation
- RMs decrease elastance and airway resistance

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Positive End Expiratory Pressure

- PEEP is applied at around 10 cm H_2O.
- PEEP reduces the re-collapse of the recruited alveoli from the RM.

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5/11/18

Discussion Overview

- Evidence was evaluated using the Hierarchy of Evidence for Intervention Studies.
- Four systematic review/meta-analysis articles (Level I evidence)
  - RMs and PEEP improved oxygenation compared to multiple other ventilation strategies.
- Five of the six randomized controlled trials (Level II evidence), and one prospective study (Level IV evidence)
  - Found similar results to the systematic review/meta-analysis
- One RCT
  - No significant difference between using RMS and PEEP, to using PEEP alone in improving oxygenation.

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Best Ventilation Strategy

- Although the evidence was inconclusive on the specifics of how to apply a RM and PEEP, it overwhelmingly supported the use of RMs with the addition of PEEP in order to improve intraoperative oxygenation.
- Application of 30-40 cm H_2O held for 15-40 seconds should be used for a RM.
- PEEP of 10 cm H_2O should be applied throughout the intraoperative phase.

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Recommendations

- Using RMs with addition of PEEP to improving intraoperative oxygenation for this patient population is:
  - reasonable
  - cost effective
  - Supported by evidence of high quality
- Potential complications that would need to be considered and discussed with the operative team:
  - hemodynamic alterations
  - Barotrauma
  - specific patient conditions in which this intervention would be contraindicated

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Recommendations

- Future research focusing on:
  - which method for implementing RMs with addition of PEEP is the most effective in improving oxygenation
  - whether prophylactic use is warranted in this population
- Education on this intervention and discussion with:
  - Certified Registered Nurse Anesthetists
  - Anesthesiologists
  - Critical Care physicians taking over care of ventilated patients
  - Surgeons
  - Other members of the operative team

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Conclusion

- Sufficient, high quality evidence supporting the use of RMs with addition of PEEP to improve oxygenation.
- The use of this strategy proved to be effective in the case presented.
- This could ultimately lead to better patient outcomes and reduced hospital costs all with minimal risk of complications.

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References

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Thank You
Are There Any Questions?