Video Article

Deep Neuromuscular Blockade Leads to a Larger Intraabdominal Volume During Laparoscopy

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URL: http://www.jove.com/video/50045
DOI: doi:10.3791/50045

Keywords: Medicine, Issue 76, Anatomy, Physiology, Neurobiology, Surgery, gynecology, laparoscopy, deep neuromuscular blockade, reversal, rocuronium, sugammadex, laparoscopic surgery, clinical techniques, surgical techniques

Date Published: 6/25/2013

Citation: Lindekaer, A.L., Halvor Springborg, H., Istre, O. Deep Neuromuscular Blockade Leads to a Larger Intraabdominal Volume During Laparoscopy. *J. Vis. Exp.* (76), e50045, doi:10.3791/50045 (2013).

Abstract

Shoulder pain is a commonly reported symptom following laparoscopic procedures such as myomectomy or hysterectomy, and recent studies have shown that lowering the insufflation pressure during surgery may reduce the risk of post-operative pain. In this pilot study, a method is presented for measuring the intra-abdominal space available to the surgeon during laproscopy, in order to examine whether the relaxation produced by deep neuromuscular blockade can increase the working surgical space sufficiently to permit a reduction in the CO_2 insufflation pressure. Using the laproscopic grasper, the distance from the promontory to the skin is measured at two different insufflation pressures: 8 mm Hg and 12 mm Hg. After the initial measurements, a neuromuscular blocking agent (rocuronium) is administered to the patient and the intra-abdominal volume is measured again. Pilot data collected from 15 patients shows that the intra-abdominal space at 8 mm Hg with blockade is comparable to the intra-abdominal space measured at 12 mm Hg without blockade. The impact of neuromuscular blockade was not correlated with patient height, weight, BMI, and age. Thus, using neuromuscular blockade to maintain a steady volume while reducing insufflation pressure may produce improved patient outcomes.

Video Link

The video component of this article can be found at http://www.jove.com/video/50045/

Introduction

Neuromuscular blocking agents are commonly used to facilitate tracheal intubation, and, during anesthesia, to facilitate surgery. The use of pharmacological agents to achieve deep relaxation throughout the laparoscopic procedure allows the surgeons either to proceed at the same level of CO_2 insufflation while benefitting from better surgical conditions, or lowering the insufflating pressure to lower the risk of surgical complications. Several studies have shown the positive effect of lowering the working pressure [5,6,7]. One symptom that is often seen after laparoscopic hysterectomies is shoulder pain, which is often stated as a major problem and the most important issue when speaking to the patient at follow up.[8]

Laproscopic myomectomy or hysterectomy is usually recommended when more conservative methods fail to control the symptoms caused by uterine fibroids. At our institution, these procedures are performed at an insufflating CO_2 pressure of 12 mm Hg. There are two highly experienced gynecologists performing all the gynecologic cases. All our cases are anaesthetized with propofol and remifentanil, and intubation is often facilitated with a low dose of rocuronium (15 mg).

From our daily clinical work we have identified shoulder pain as one of the most disturbing side effects after laparoscopic hysterectomies, which is supported by the literature [8]. Studies have shown that reducing the intraabdominal pressure can also reduce shoulder pain. In an effort to reduce the CO_2 insufflation pressure, one of our prior concerns was if the surgical field and visibility during the procedure would be compromised. Trying to determine the overview during the procedure, we set up a method to compare the intraabdominal working space. However, it can be very difficult to monitor the exact intra-abdominal volume within a patient during surgery. In a Belgian study, the volume-pressure relationship has been described, but the study authors concluded that there are major inter individual variations [9]. In order to get a more reliable statement of the intraabdominal space, we use the distance from the promontory to the skin as the metric.

Protocol

1. Case Presentation

1. The patient is set up for a visit at the gynecological clinic, often due to the occurrence of bleeding disorders. A physical examination is performed.
    1. If deemed appropriate, the patient is scheduled for a hysterectomy. The paperwork is prepared, and the patient is given the premedication for the day of surgery.
    2. Patients 60 years and older must first submit blood samples and monitored by electrocardiography (or ECG) prior to the procedure.
2. On the day of surgery, the patient is not allowed to consume anything by mouth for six hours prior to admittance.
    1. An exception is made for sweet clear drinks without pulp, which are allowed until two hours prior to admittance.
    2. The patient takes the premedication (t.Paracetemol 1 g + t.Etodolac 300 mg + t.Dexamethason 8 mg) with the last drink.
3. The patient is admitted app. one hour prior to the scheduled time of surgery.
    1. The ward nurse first prepares the patient for surgery.
    2. The anesthesiologist examines the patient and prepares the papers for anesthesia.
4. When the operation room is prepared and the team is ready, the gynecologist transports the patient to the operating room.
    1. The patient lies down on the operating table and is covered with a surgical blanket.
    2. An i.v. line is placed in the left hand and 1,000 ml of saline is started. Monitoring equipment is attached.
    3. Anesthesia is induced with propofol and remifentanil until Loss Of Consciousness (LOC) occurs, and maintained using TOF.
    4. For facilitating intubation, a small dose of rocuronium (15 mg) is administered.
    5. Direct laryngoscopy is performed. If it is difficult to visualize the vocal cord, the McGrath videolaryngoscop is used. Intubation is subsequently performed.
5. Insufflation of the abdomen is started at 12 mm Hg CO_2.
    1. The ports are placed.
    2. The procedure is started.
    3. The surgeons are told when Train Of Four (TOF) ratio is > 90%, corresponding to the neuromuscular blockade is weaned off.
    4. At the neck of the grasper the distance from the promontory to the surface of the skin at the umbilicus is marked.
    5. The grasper is placed on the surgical table. With measuring tape, the distance between the end of the grasper and the neck of the grasper (at surgeon's finger) is marked, and then calculated distance is measured in centimeters.
6. The insufflations pressure of CO_2 is lowered to 8 mm Hg.
    1. At the neck of the grasper the distance from the promontory to the surface of the skin at the umbilicus is marked.
    2. The grasper is placed at the table. With measuring tape the marked distance is interpreted to centimeters.
7. CO_2 insufflation pressure is adjusted to 12 mm Hg.
    1. Deep neuromuscular blockade is applied to a Post Tetanic Count (PTC) < 2.
    2. At the neck of the grasper the distance from the promontory to the surface of the skin at the umbilicus is marked.
    3. The grasper is placed at the table. With measuring tape the marked distance is measured to centimeters.
8. CO_2 insufflation pressure is lowered to 8 mm Hg.
    1. At the neck of the grasper the distance from the promontory to the surface of the skin at the umbilicus is marked.
    2. At the neck of the grasper the distance from the promontory to the surface of the skin at the umbilicus is marked.
9. The procedure is finished.
    1. Infusions of propofol and remifentanil are terminated.
    2. The patient is woken up and moved to his or her bed.
    3. The patient is transferred to the Recovery Room.

Representative Results

This pilot study of 15 patients was performed to assess the impact of deep neuromuscular blockade during laparoscopic surgery.

The method illustrated here was used to obtain measurements of intra-abdominal space in patients undergoing laparoscopic hysterectomy (**Figure 1**). In each patient, measurements of intra-abdominal space were taken under the following conditions: 12 mm Hg pressure without deep neuromuscular blockade, 12 mm Hg with blockade, 8 mm Hg without blockade, and 8 mm Hg with blockade.

At both 12 mm Hg and 8 mm Hg, neuromuscular blockade significantly increased the intra-abdominal space (**Figure 2**; Wilcoxon Signed Ranks test, $p < 0.001$, $W = 1$ and 0 respectively). Indeed, the working intra-abdominal distance measured at 8 mm Hg with deep neuromuscular blockade was comparable to 12 mm Hg without blockade ($p > 0.2$, $W = 54.5$).

There were no correlations detected between patient demographic data and the differences in intra-abdominal space with/without neuromuscular blockade (**Figure 3**; R2 < 0.1 for all demographic criteria reported). Thus, differences in patient age, BMI, height, or weight cannot account for the volume differences observed in this study.

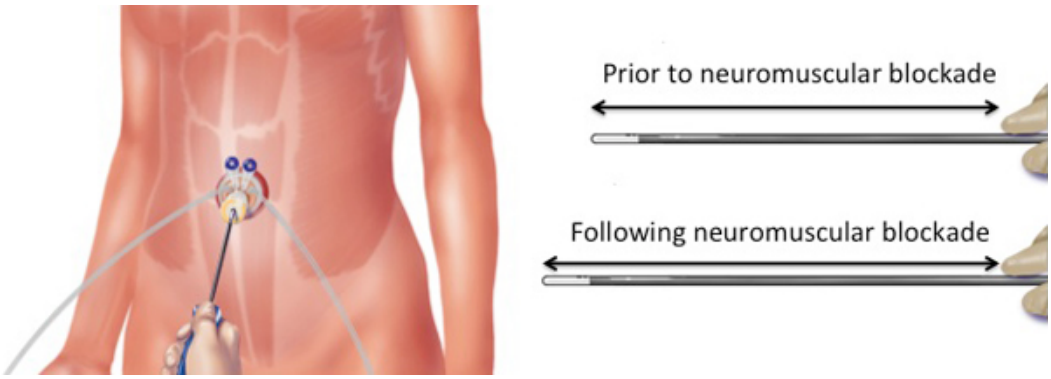

Figure 1. The working intra-abdominal space during laparoscopic surgery is measured, using the grasper, as the distance from the promontory to the surface of the skin at the umbilicus.

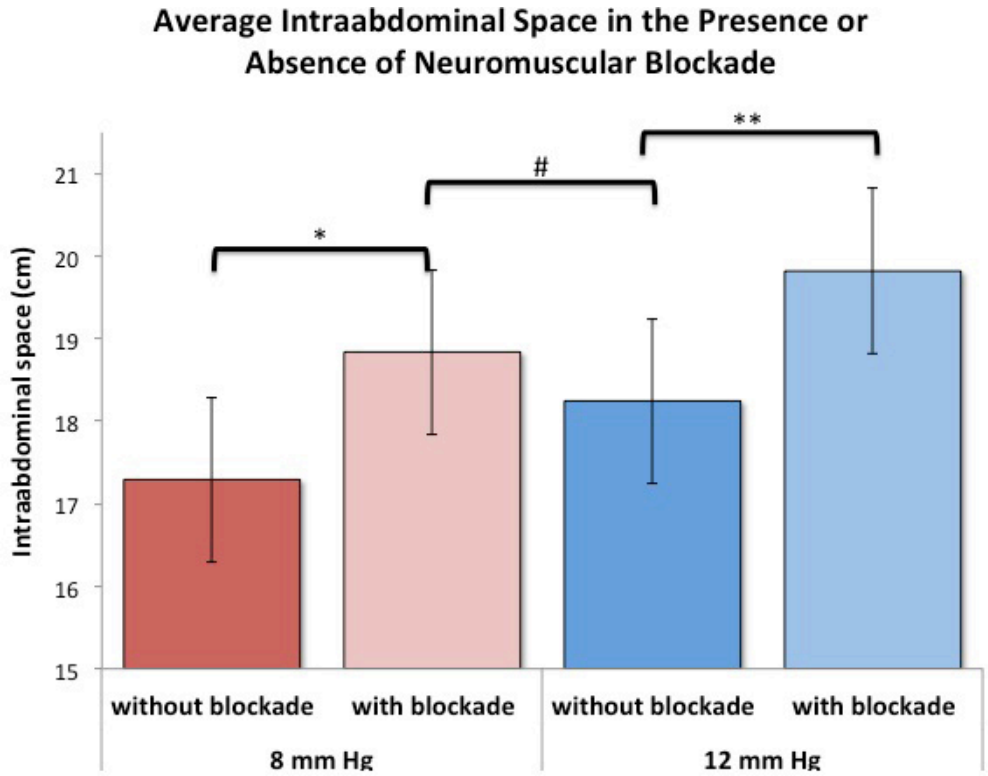

Figure 2. Measurements of intra-abdominal space at 12 mm Hg and at 8 mm Hg were taken for 15 patients. The measurements were repeated in the presence or absence of neuromuscular blockade for each patient. * $p < 0.001$, W=0; ** $p < 0.001$, W=1; # $p > 0.2$, W=54.5.

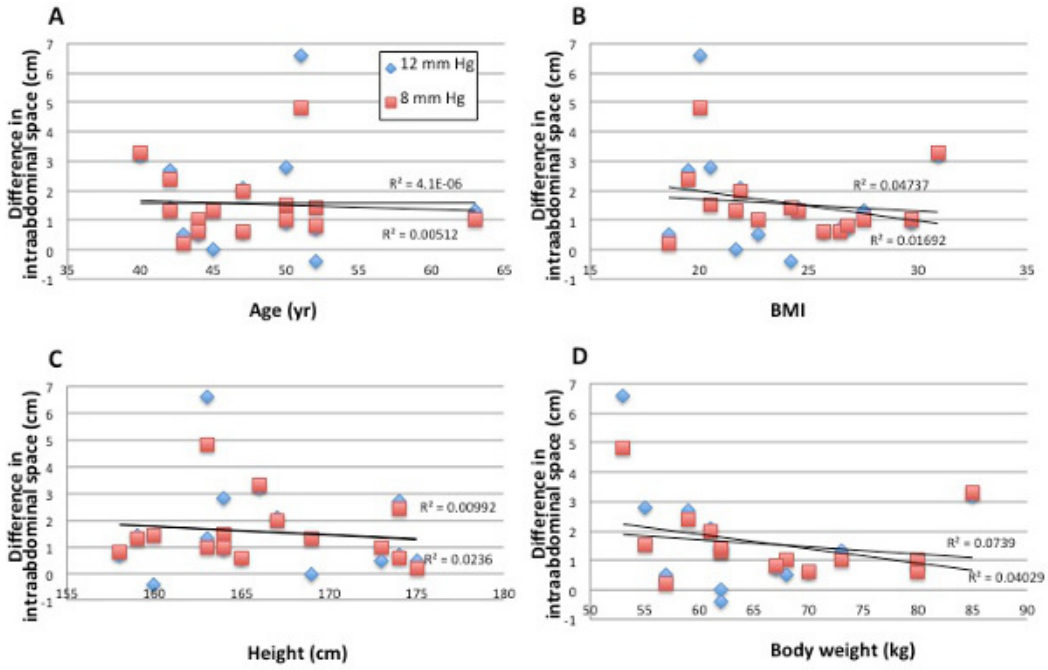

Figure 3. Correlation between patient data and intra-abdominal space. The difference in intra-abdominal space between the block and no-block conditions was compared with the demographic data on patient age **(A)**, BMI **(B)**, height **(C)**, and weight **(D)**. No significant correlations were detected (R2 values shown on each plot). Legend in **3A** applies to **A-D**. Click here to view larger figure.

Discussion

Directly calculating the working volume available for laproscopic surgery is difficult, but the relationship between insufflating CO_2 pressure and abdominal volume is easier to measure[9]. Here, we present a method to use the surgical grasper to estimate the space within the abdomen during insufflation, as an alternative to the method of recording the volume of insufflated CO_2. These measurements have demonstrated that it is possible to maintain a steady volume when lowering the insufflation pressure and inducing a deep neuromuscular blockade.

An obvious limitation is that this technique directly measures 2D distance rather than 3D volume. However, since the distance is measured with the same surgical tool used to perform the procedure, this particular linear distance measurement has direct relevance to the working space available to the surgeon.

Problems during and after laparoscopic surgery are commonly due to pneumoperitoneum induced by CO_2 insufflation, making lower insufflation pressures desirable[5-8,10]. At the same time, restricted working space can make laparoscopic dissection steps difficult and result in longer operating time, potentially increasing the risk of complications[12,13]. Accordingly, the use of neuromuscular blockade to enable greater working space with lower insufflation pressure can simultaneously address two of the major source of concern for laparoscopic procedures.

Residual neuromuscular blockade increases the risk of some postoperative complications, including prolonged time for emerging from anesthesia[4], residual paralysis[4], and respiratory[11] and pulmonary complications[2]. The development of blocking agents with improved specificity, reversibility, and faster kinetics may reduce or even eliminate many of these concerns[1]. Future studies will be conducted to show if decreasing the insufflation pressure will lead to a reduction in pain scores and fatigue after laproscopic myomectomy or hysterectomy, although past studies of other laproscopic procedures strongly suggest that this will be the case[8]. Detailed investigation of the impact of neuromuscular blockade on postoperative analgesia will also help to clarify whether neuromuscular blockade itself is impacting the efficacy of pain management and the course of postoperative recovery.

Disclosures

No conflicts of interest declared.

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