Heated, Humidified CO₂ Gas Is Unsatisfactory for Awake Laparoscopy

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ABSTRACT

Background: The necessity for general anesthesia represents an impediment to using a laparoscopic approach for some procedures that are otherwise performed with the patient under local anesthesia using a conventional open technique. Heating and humidifying the insufflation gas reportedly reduces perioperative pain associated with a CO₂ pneumoperitoneum, thus enabling awake laparoscopy.

Methods: Two cases are reported herein of laparoscopy performed with the patient under local anesthesia using heated, humidified CO₂ gas for the pneumoperitoneum.

Results: Both patients experienced pain with insufflation of heated, humidified CO₂ gas of sufficient magnitude that the procedure could not be performed. The CO₂ gas was washed out and replaced with helium gas insufflation with complete resolution of pain. The laparoscopic procedures were accomplished without further discomfort with local anesthesia and using a helium gas pneumoperitoneum.

Conclusions: Heated, humidified CO₂ gas insufflation does not reduce pain sufficiently to permit satisfactory performance of laparoscopy with local anesthesia, especially when full volume insufflation is required. Cold, dry helium gas produces no pain. The theory that cold, dry insufflation gas is a source of peritoneal pain during laparoscopy needs to be reassessed.

Key Words: Laparoscopy, Insufslow device, Carbon dioxide, Helium.

INTRODUCTION

Ordinarily, CO₂ gas cannot be used during laparoscopy with local anesthesia to create the pneumoperitoneum because it produces immediate pain upon insufflation. The CO₂ becomes carbonic acid at the level of the peritoneal membrane and produces noxious stimulation. Alternative insufflation gases like nitrous oxide and helium have been used with success to perform laparoscopy with local and regional anesthesia for peritoneal dialysis access surgery, appendectomy, and cholecystectomy. Neither of these gases produces pain during insufflation. Nitrous oxide has an acceptable solubility; however, although not flammable, it does not suppress combustion in the event that a hole is present in the bowel with leakage of methane or hydrogen gas. However, previous fears about the use of nitrous oxide generated by 2 odd reports subsequently have been shown to be unjustified. Helium is neither flammable nor supports combustion; however, the low solubility is of theoretical concern should accidental gas embolism occur. Both gases are metabolically inert, which is an advantage in high-risk patients with problems eliminating CO₂, poor tolerance for metabolic acidosis, or cardiac arrhythmias.

Configuring the gas tank and laparoscopic insufflator for nitrous oxide and helium can be inconvenient in that both require gas-specific plumbing connections. For practical purposes, this requires dedication of a laparoscopic equipment tower specifically for the alternative gas. Some newer insufflation devices on the market have CO₂ sensors that prevent the use of alternative gases. For this reason, a method of conditioning CO₂ gas that enables the performance of laparoscopy with local anesthesia is of great interest. In part, pain from CO₂ insufflation was ascribed to the cold, dry properties of the gas as it leaves the tank. Heating and humidifying the CO₂ reportedly diminishes the noxious stimulation produced by a cold, dry gas and permits laparoscopy with local anesthesia with good patient tolerance.

METHODS

Source gases provided to laparoscopic insufflators are near 0% relative humidity (RH) and presumed to be at...
ambient operating room temperature (21°C to 22°C). In the present report, insufflated CO₂ gas was heated (35°C) and humidified (95% RH) by using an Insuflow device (Lexion Medical, St. Paul, MN).

CASE REPORT ONE

A 67-year-old female with end-stage renal disease (ESRD) was admitted to the outpatient surgery department for laparoscopic implantation of a peritoneal dialysis catheter. The procedure was performed with the patient under local infiltration anesthesia with lidocaine-HCl 1% and bupivacaine-HCl 0.5% mixed in equal volumes with intravenous sedation consisting of midazolam-HCl 1 mg, fentanyl citrate 50 μg, and propofol 20 mg. The patient was completely awake and coherent during the entire procedure. After placement of the Veress needle, heated, humidified CO₂ gas was insufflated at a rate of up to 2.2 liters/minute with the Insuflow device. Insufflator pressure limit was set at 10 mm Hg. Immediately, the patient began to complain of diffuse abdominal pain. The pain increased in magnitude as insufflation proceeded. With 1.3 liters of gas insufflated, the Veress needle was replaced with a 5-mm port. Because of the continuing complaints of pain, the CO₂ was allowed to escape through the port stopcock. The pain quickly resolved. After the product representative assisted in assuring that the Insuflow device was functioning properly, an attempt was made to reinsufflate the patient. Again, the patient immediately experienced diffuse abdominal pain. Insufflation was stopped, and the pneumoperitoneum was released with resolution of pain over several minutes. The laparoscopic tower equipped with a helium insufflation system was brought into the operating room. A standard gas hose was used to connect the helium-configured insufflator to the laparoscopic port. The patient denied any complaints of pain with insufflation of 4 liters of helium. The insufflator pressure limit was 10 mm Hg. The surgical procedure was completed laparoscopically using a helium pneumoperitoneum without further complaints of discomfort.

CASE REPORT TWO

A 39-year-old male with ESRD was admitted through the outpatient department for laparoscopic placement of a peritoneal dialysis catheter and repair of an umbilical hernia. The patient received intravenous sedation with midazolam-HCl 2 mg and fentanyl citrate 100 μg during local anesthetic infiltration of lidocaine-HCl 1% and bupivacaine-HCl 0.5% mixed in equal volumes. Peritoneal access was initially obtained by entering the hernia sac through an infraumbilical incision. A 5-mm port device was secured in the hernia defect with a purse-string suture. Heated, humidified CO₂ gas was insufflated through the port at a rate of up to 1 liter/minute. The insufflator pressure limit was set at 4 mm Hg. The patient immediately complained of burning pain that involved the entire abdomen after insufflation of only 200 mL. Insufflation was stopped, and the gas was allowed to escape from the port with resolution of the pain over several minutes. After the product representative confirmed proper function of the Insuflow device, an attempt to reinsufflate the patient with heated, humidified CO₂ was accompanied by the same painful response. The helium gas insufflator was connected, and a pneumoperitoneum of 2.7 liters was rapidly created without pain. Pressure limit for helium insufflation was set at 10 mm Hg. The laparoscopic procedure was completed without further complaints of pain.

DISCUSSION

Controversy exists regarding the benefits of heated, humidified CO₂ gas insufflation in patients undergoing laparoscopic procedures under general anesthesia. Previous studies relied upon outcome measures that included after-the-event use of visual analog pain scales, analgesic consumption amounts, time until subjective perception of return to well being, or time it took to return to work. It is very difficult to control the myriad of confounding variables that potentially taint these measured outcomes. As a result, some studies have shown that heated CO₂ gas reduced postoperative pain compared with cold, dry gas, while others have found either no difference in pain or the pain was actually made worse by gas heating. Equally conflicting reports exist regarding postoperative pain reduction or lack thereof when the insufflated CO₂ gas was both heated and humidified.

The 2 cases in the present report offered a unique opportunity to evaluate the effects of heated, humidified CO₂ gas insufflation on awake patients through real time verbal feedback and to immediately compare the results to an alternative insufflation gas.
analysis; however, heated and humidified CO$_2$ did not completely eliminate pain in his series of patients undergoing laparoscopic gynecological procedures. Although both studies showed improved pain tolerance with local anesthesia with heated, humidified CO$_2$ compared with cold, dry CO$_2$, no statistically significant difference was found between groups.

Heated, humidified CO$_2$ gas appears unsatisfactory for awake laparoscopy, especially when full volume insufflation is required. Outside of a limited number of gynecological procedures, few laparoscopic procedures can be adequately accomplished with a 700 mL pneumoperitoneum. In addition, aggressive sedation to control insufflation pain potentially turns the procedure into “open-air” general anesthesia and generates concerns for patient safety. Furthermore, excessive sedation produces an abdominal respiratory pattern that impedes the performance of the procedure.

**CONCLUSION**

The theoretical significance of cold, dry insufflation gas as a source of peritoneal pain during laparoscopy needs to be reassessed. The 2 cases in the present report and the author’s previous experience with the use of cold, dry nitrous oxide and helium gas during laparoscopy with local and regional anesthesia without complaints of insufflation pain would seem to refute this theory.\textsuperscript{2,3,14} Although the observations about 2 cases using heated, humidified CO$_2$ cannot be considered conclusive, they emphasize the importance of further investigation into the cause of CO$_2$ gas-induced pain.

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