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Original Contribution

Effect of depth of neuromuscular blockade on the abdominal space during pneumoperitoneum establishment in laparoscopic surgery☆,☆☆

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Abstract

Study Objective: To evaluate the effect of neuromuscular blockade (NMB) upon the abdominal space during pneumoperitoneum establishment in laparoscopic surgery, comparing moderate NMB and deep NMB.

Design: Prospective, randomized, crossover clinical trial.

Setting: Operating room.

Patients: Seventy-six American Society of Anesthesiologists 1 to 2 patients scheduled for elective laparoscopic surgery.

Interventions: Two independent evaluations were performed at the establishment of pneumoperitoneum for a preset intraabdominal pressures (IAPs) of 8 and 12 mm Hg, both during moderate NMB (train-of-four count, 1-3) and deep NMB (posttetanic count, <5). Rocuronium was used to induce NMB, and sugammadex was used for reversal.

Measurements: We evaluated (i) the volume of CO_2 introduced in 41 patients and (ii) the skin-sacral promontory distance in 35 patients, at pneumoperitoneum establishment.

Results: Compared to moderate NMB, deep NMB increased, in a significant manner, both the intraabdominal volume of CO_2 insufflated (mean [SD], 2.24 [1.10] vs 2.81 [1.13] L at 8 mm Hg IAP, $P < .001$, and 3.52 [1.31] vs 4.09 [1.31] L at 12 mm Hg IAP, $P < .001$) and the skin-sacral promontory distance (11.78

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[1.52] vs 12.16 [1.51] cm at 8 mm Hg IAP, $P = .002$, and 13.34 [1.87] vs 13.80 [1.81] cm at 12 mm Hg IAP, $P < .001$). Increase in intraabdominal volume after inducing deep NMB was observed in 88% and 81.7% of patients at 8 and 12 mm Hg pneumoperitoneum, with a volume increase of mean of 36.8% (95% confidence interval [CI], 22.8-50.8) and 25% (95% CI, 13.7-36.4), respectively ($P = .003$). Increase in distance was observed in 61% and 82% of patients at 8 and 12 mm Hg pneumoperitoneum, with a mean distance increase of 3.3% (95% CI, 1.3-5.4) and 3.6% (95% CI, 1.9-5.2), respectively ($P = .840$).

Conclusions: Deep NMB, in comparison to moderate NMB, increased in a significant manner the abdominal space at pneumoperitoneum establishment. However, the effective increase in the abdominal cavity dimensions could be low, the increase showed a great interindividual variability, and it was not observed in every patient. Clinical significance of this increase on surgical conditions is yet to be demonstrated.

1. Introduction

The abdominal space created after pneumoperitoneum establishment during laparoscopic surgery defines the surgeon's working space and, together with proper patient position, determines surgical exposure and organ visibility and contributes to a safe and an efficient surgery. This working space is determined by nonmodifiable factors, as those related with the patient (obesity, previous abdominal surgery, and previous pregnancies), and by potentially modifiable factors, like those related with anesthesia and the preset pneumoperitoneum.

Among the factors related with the anesthetic procedure, neuromuscular blockade (NMB) has been thoroughly studied. It is well known that deep NMB (defined as train-of-four [TOF] count 0, and the presence of posttetanic count [PTC] stimuli response), as compared to absence of NMB, can increase both intraabdominal volume [1] and the dimensions of the abdominal cavity (expressed as skin-sacral promontory distance) [2,3] at pneumoperitoneum establishment. On the other hand, NMB decreases the intraabdominal pressure (IAP) in patients with increased IAP due to acute abdominal pathology [4], and a reduction on IAP requirements during laparoscopic cholecystectomy with deep NMB, compared with no block, has been reported [5]. However, to date, the effect that different NMB depth levels have on the abdominal space during pneumoperitoneum establishment has not been yet described. In clinical practice, especially in laparoscopic surgery, it is uncommon to work without NMB but to maintain certain degree of NMB, which can vary from deep to moderate NMB (TOF count 1-3) and even superficial or residual NMB (TOF count 4) at the end of the surgical procedure. It is not well known whether this variation in the depth of NMB can influence the working space conditions in the abdominal cavity throughout the surgical procedure or its possible clinical relevance [6,7].

We hypothesized that depth of NMB could influence the working space during laparoscopic surgery. The aim of the study was to characterize the effect of NMB upon the abdominal space during pneumoperitoneum establishment while comparing moderate and deep NMB. To evaluate this effect, we measured the following: (i) the volume of CO_2 introduced and (ii) the intraabdominal space, obtained from the skin-sacral promontory distance, both at 8 and 12 mm Hg pneumoperitoneum for the 2 levels of NMB.

2. Materials and methods

This prospective, single-center, and crossover clinical trial was approved by the Institutional Clinical Research and Ethics Committee of Hospital Arnau de Vilanova of Valencia, and written informed consent was obtained from the participants.

Seventy-six adult patients (18-65 years old), American Society of Anesthesiologists (ASA) physical status class 1 to 2 scheduled for elective laparoscopic surgery (laparoscopic cholecystectomy or gynecological laparoscopy) were included in the study during an 8-month period of 2014. Exclusion criteria were as follows: ASA greater than 2, age younger than 18 years to older than 65 years, body mass index (BMI) less than 18.5 to greater than 30 kg/m^2, allergy to any drug included in the anesthetic protocol, renal insufficiency (glomerular filtration rate, <40 mL/min), impaired liver function (hepatic cirrhosis, cholestatic jaundice), neuromuscular disease, pregnancy, breastfeeding, predicted difficult airway, or patients receiving medications known to interact with neuromuscular blocking agents.

In the operating room, dexamethasone 4 mg iv, midazolam 1 mg iv, and fentanyl 75 μg iv were injected, and propofol 2 mg/kg was used as the induction agent. Propofol, adjusted under guidance of bispectral index, and remifentanil (0.1-0.5 μg/kg per minute) were used for anesthesia maintenance. Ventilation was adjusted to maintain normocapnia, and skin temperature over the adductor pollicis brevis muscle was maintained at greater than 32°C. Sugammadex was used for reversal of rocuronium-induced NMB, adjusting the dosage to the level of NMB at the time of reversal.

To characterize the effect of NMB upon the abdominal space, we performed 2 measurements at the establishment of the pneumoperitoneum at 8 and 12 mm Hg: (i) the volume of CO_2 introduced (evaluation 1) and (ii) the intraabdominal space, obtained from the skin-sacral promontory distance (evaluation 2). Acceleromiography was used for NMB monitoring (TOF-WATCH-S Organon-Teknika, Oss, the Netherlands) according to the good clinical research practice in