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## SCIENTIFIC ARTICLE

# Effects of elevated artificial pneumoperitoneum pressure on invasive blood pressure and levels of blood gases

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### Abstract

**Background and objective:** to evaluate the clinical, hemodynamic, gas analysis and metabolic repercussions of high transient pressures of pneumoperitoneum for a short period of time to ensure greater security for introduction of the first trocar.

**Methods:** sixty-seven patients undergoing laparoscopic procedures were studied and randomly distributed in P12 group:  $n = 30$  (intraperitoneal pressure [IPP] 12 mmHg) and P20 group:  $n = 37$  (IPP of 20 mmHg). Mean arterial pressure (MAP) was evaluated by catheterization of the radial artery; and through gas analysis, pH, partial pressure of oxygen ( $\text{PaO}_2$ ), partial pressure of  $\text{CO}_2$  ( $\text{PaCO}_2$ ), bicarbonate ( $\text{HCO}_3$ ) and alkalinity (BE) were evaluated. These parameters were measured in both groups at time zero before pneumoperitoneum (TP0); at time 1 (TP1) when IPP reaches 12 mmHg in both groups; at time 2 (TP2) after five min with IPP = 12 mmHg in P12 and after 5 min with IPP = 20 mmHg at P20; and at time 3 (TP3) after 10 min with IPP = 12 mmHg in P12 and with return of IPP from 20 to 12 mmHg, starting 10 min after TP1 in P20. Different values from those considered normal for all parameters assessed, or the appearance of atypical organic phenomena, were considered as clinical changes.

**Results:** there were statistically significant differences in P20 group in MAP, pH,  $\text{HCO}_3$  and BE, but within normal limits. No clinical and pathological changes were observed.

**Conclusions:** high and transient intra-abdominal pressure causes changes in MAP, pH,  $\text{HCO}_3$  and BE, but without any clinical impact on the patient.

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## Introduction

Minimally invasive methods used to access organs and structures of the abdominal cavity cause a reduction of metabolic

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response to trauma and other benefits for patients. This applies particularly to laparoscopy.<sup>1-3</sup> However, being relatively recent, the laparoscopic surgical techniques still show controversy. One of them is the best way of creating the pneumoperitoneum. Although no consensus exists regarding the best method for accessing the peritoneal cavity with respect to the establishment of pneumoperitoneum, the puncture with Veress needle is the technique most often used.<sup>4,5</sup> The complications occurring during the introduction of the first catheter are still being discussed.

Much of the complications in laparoscopy procedures (in about 50% of them) occur at the beginning of the procedure, during the introduction of the Veress needle and the first trocar. For that reason, laparoscopy is a peculiar surgical procedure, in which the surgical approach is more dangerous than the surgery itself.<sup>6</sup> In a recent review of the literature concerning injuries caused by the use of a Veress needle and the first trocar in 357,257 patients, a prevalence of 0.04% of gastrointestinal lesions and 0.02% of vascular lesions was found.<sup>7</sup> These iatrogenic events are relatively rare, but the consequences are exceptionally grave. In such circumstances, bleeding, peritonitis, multiple organ failure, death and medico-legal implications may occur.

Thus, it is essential to seek technical options safer than the most commonly used method, which consists of the Veress needle puncture in the midline of the abdomen, in the vicinity of the umbilicus; abdominal insufflation to obtain intraperitoneal pressure of 10 and 12 mmHg; and the blind introduction of the first trocar in the same location used for needle insertion.<sup>4,5</sup>

A literature review revealed that the most serious injuries occur when the Veress needle is inserted into the midline of the abdomen at the level of the umbilicus.<sup>7</sup> The insertion of the Veress needle in the left hypochondriac region, however, is safe and effective<sup>8</sup> and the likelihood of serious injury is lower, because this place does not involve vital structures, such as the retroperitoneal vessels.<sup>7</sup>

However, the insertion of the first trocar should be done in the midline at the level of the umbilicus, and not in the left hypochondrium, as recommended for the Veress needle.<sup>8</sup> This recommendation is based on the fact that the trocar is the place where the laparoscopic cannula will be introduced.<sup>4,5</sup> When the laparoscope is introduced in the midline at the umbilicus, we get better clarity, better images of organs and intra-abdominal structures, and a broader vision for the introduction of the other trocars.

The establishment of a regime of very high pressure by an artificial pneumoperitoneum, during a period just sufficient for the introduction of the first trocar, taken blindly in the closed method, may contribute to the protection of the intra-abdominal structures against injury, but without any organic repercussion in the form of clinical complications.<sup>9,10</sup> No vascular injury was reported in a study that investigated 3041 patients undergoing blind insertion of the first trocar in the midline with an intra-abdominal pressure below 25–30 mmHg.<sup>11</sup>

One study investigated the protective effect of elevated intraperitoneal pressure on intra-abdominal structures facing the aggression shown by the blind introduction of the first trocar into the peritoneal cavity.<sup>12</sup> The authors correlated the distance between the anterior abdominal wall and intra-abdominal viscera with different intraperitoneal

pressures and volumes, and also the observed distances with the required force for insertion of the first trocar into the abdominal cavity. These authors also could observe that high intraperitoneal pressures cause an important increase in these distances and in the volume of gas bubbles and provide a better slippage of the trocar into the cavity. It was also shown that, with the use of high intraperitoneal pressure, the abdominal wall becomes tenser and reduces its elastic deformation caused by a force applied to the trocar.<sup>12</sup>

Despite the absence of clear clinical signs of complications, the artificial pneumoperitoneum with very high pressures over a prolonged period of time can cause hemodynamic and structural changes in the host, directly related to the magnitude of the tensional levels and detectable by monitoring hemodynamic and gas analysis parameters. Thus, under high intraperitoneal pressures, decreases in cardiac output and venous return, increases of mean arterial pressure and systemic vascular resistance and changes in renal perfusion and glomerular filtration were demonstrated, besides ischemic lesion and reperfusion of intra-abdominal organs.<sup>13-19</sup> Because of these deleterious effects of high intraperitoneal pressures during laparoscopic procedures, most authors recommend maintaining the pressure at a level of 12 mmHg (never more than 15 mmHg, considered as a high pressure).<sup>5,20-26</sup>

Despite the above considerations, hemodynamic, metabolic and structural changes may occur with elevated intra-abdominal pressures for a prolonged period of time. The literature does not provide important information about gas analysis and metabolic changes in patients undergoing high transient intraperitoneal pressure. This means that laparoscopic surgeons may not have taken into account a safe strategy for the introduction of the first trocar.

The aim of this study is to improve the safety of the introduction of the first trocar and evaluate the clinical, hemodynamic, gas analysis and metabolic effects of high transient pneumoperitoneum pressures for short periods of time.

## Materials and methods

For this prospective, randomized clinical trial, authorization was obtained from the Federal University of São Paulo (UNIFESP) Research Ethics Committee under number 1.219/07, and from the University of Taubaté (Unitau) Research Ethics Committee, under number 007/2.007. All patients signed an informed consent. The study was conducted at Hospital Municipal Dr. José de Carvalho Florence (HMJCF) in São José dos Campos (SP).

Between October 2007 and May 2008, 67 patients scheduled for elective laparoscopic surgery, between 20 and 79 years old, classified into ASA I or ASA II according to their physical condition, with no history of abdominal surgery on organs located at the abdominal supramesocolic level, without previously diagnosed peritonitis and with body mass index (BMI) less than 35, were studied.

Upon obtaining odd and even numbers on the upper face of a dice rolling, patients were randomly assigned to P12 group:  $n = 30$  (intraperitoneal pressure of 12 mmHg) and P20 group:  $n = 37$  (intraperitoneal pressure of 20 mmHg). P12 group consisted of 25 women and five men, between

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