

# An observational study: Effects of tenting of the abdominal wall on peak airway pressure in robotic radical prostatectomy surgery

## ABSTRACT

**Background:** Robotic radical prostatectomy (RRP) is associated with various anesthetic challenges due to pneumoperitoneum and deep Trendelenburg position. Tenting of the abdominal wall done in RRP surgery causes decrease in peak airway pressure leading to better ventilation. Herein, we aimed to describe the effects of tenting of the abdominal wall on peak airway pressure in RRP surgery performed in deep Trendelenburg position.

**Methods:** One hundred patients admitted for RRP in Kokilaben Dhirubhai Ambani Hospital of American Society of Anesthesiologists 1 and 2 physical status were included in the study. After undergoing preanesthesia work-up, patients received general anesthesia. Peak airway pressures were recorded after induction of general anesthesia, after insufflation of CO<sub>2</sub>, after giving Trendelenburg position, and after tenting of the abdominal wall with robotic arms.

**Results:** Mean peak airway pressure recording after induction in supine position was 19.5 ± 2.3 cm of H<sub>2</sub>O, after insufflation of CO<sub>2</sub> in supine position was 26.3 ± 2.6 cm of H<sub>2</sub>O, after giving steep head low was 34.1 ± 3.4 cm of H<sub>2</sub>O, and after tenting of the abdominal wall with robotic arms was 29.5 ± 2.5 cm of H<sub>2</sub>O. *P* value is highly statistically significant (*P* = 0.001).

**Conclusion:** Tenting of the abdominal wall during RRP is beneficial as it decreases peak airway pressure and helps in better ventilation and thus reduces the ill effects of raised peak airway pressure and intra-abdominal pressures.

**Key words:** Gasless laparoscopic surgery; pneumoperitoneum; robotic radical prostatectomy; tenting

## Introduction

Laparoscopic prostatectomy was first performed by Bhandari *et al.* in 1997 using a transperitoneal approach.<sup>[1]</sup> An extraperitoneal approach was subsequently described by Raboy *et al.* With the first few clinical cases of extraperitoneal laparoscopic radical prostatectomy using a robotic system was developed and was also reported by Pruthi *et al.* in 2003.<sup>[2,3]</sup> The introduction of the da Vinci Surgical System has transformed the field of robotic surgery and solved some of the limitations of traditional laparoscopic surgeries.


Although many features of RRP are like those of conventional laparoscopic urological procedures (such as laparoscopic prostatectomy), the procedure is associated with some drawbacks, which include limited access to intravenous route and airway of the patient with relatively long operating time, deep Trendelenburg position, and high intra-abdominal pressure (IAP).

Currently, most of the knowledge about robotic urological surgery has been derived from the gynecological procedures

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performed in a less-deep Trendelenburg position and under lower IAP conditions. Laparoscopic cholecystectomy surgeries that were performed under lower IAP, with a relatively shorter surgical duration, and in the head-up position, can have different effects on patients' respiratory and hemodynamic parameters and the risk of embolism is also different.<sup>14</sup> Herein, we aimed to describe the effects of tenting of the abdominal wall on peak airway pressure in RRP surgeries performed in deep Trendelenburg position.

## Methods

### Study design

One hundred patients undergoing RRP in Kokilaben Dhirubhai Ambani Hospital of the American Society of Anesthesiologists 1 and 2 physical status were included in the study. As this study was an observational study, no written informed consent was taken.

All patients had routine blood investigations done which included complete blood count, renal function test, liver function test, coagulation profile, fasting blood sugar, HIV, HBsAg, and HCV reactivity, chest X-ray, electrocardiogram, and 2D echo (where necessary). On the day of surgery, patients were instructed to take their regular medication for systemic diseases if any and tablet pantoprazole 40 mg with sips of water. In the operating room, all patients were monitored with continuous electrocardiogram, pulse oximetry, EtCO<sub>2</sub>, Noninvasive blood pressure, and bispectral index (BIS) monitoring.

All patients received injection glycopyrrolate (0.2 mg) and injection midazolam (1 mg) intravenously 10 min before induction. General anesthesia was induced with fentanyl (1.5–2 mcg/kg), propofol (2–2.5 mg/kg) with sevoflurane (1%–2%) and O<sub>2</sub>. Atracurium (0.8–1 mg/kg) was used for endotracheal intubation. After induction of anesthesia, patients were maintained with sevoflurane/desflurane with O<sub>2</sub>+Air. Minimum alveolar concentration value adjusted to maintain BIS value of 40–60. Infusion of atracurium (5 mg/ml) at rate of 5 ml/h and fentanyl (10 mcg/ml) at rate of 3–5 ml/h. All the patients were monitored for anesthesia depth with BIS monitoring to maintain BIS value between 40 and 60.

Peak airway pressure was recorded in each patient after induction, after insufflation of CO<sub>2</sub>, after giving head-low position, and after tenting of the abdominal wall with robotic arms.

The robotic arms were attached to the abdominal robotic ports, which is commonly referred as "Docking." Docking is performed in steep head-low position which is the final

position. At this point of time, the IAP was maintained at 15 mm of mercury and peak airway pressure was measured. Once docking procedure was completed, the abdominal wall was lifted in a manner like "lap lift" as in gasless laparoscopic surgery [Figure 1] which we refer to as "tenting of the abdominal wall."

This was done for all the abdominal ports. Then, peak airway pressure was recorded at this time.

All the patients were extubated at the end of surgery.

### Statistical analysis

Statistical analysis was done using repeated measures ANOVA test.

## Results

One hundred patients of RRP were included in the study. [Table 1 and Graph 1] shows peak airway pressure recording after induction, after insufflation of CO<sub>2</sub>, after giving head-low position, and after tenting with robotic arms. Mean peak airway pressure recording after induction in supine position was 19.5 ± 2.3 cm of H<sub>2</sub>O, after insufflation of CO<sub>2</sub> in supine



Figure 1: Tenting during gasless laparoscopic surgery (image obtained from Google search engine)

Table 1: Comparison of peak airway pressures in various positions of patients during surgery

Peak airway pressure	Mean ± SD	P*
After induction in supine position	19.5 ± 2.3	<0.0001 (very highly significant)
After CO <sub>2</sub> insufflation in supine position	26.3 ± 2.6	
In head-low position	34.1 ± 3.4	
After tenting with robotic arms	29.5 ± 2.5	

Repeated measures ANOVA.  $F=1634.4$ ,  $df=3$ . \*Peak airway pressure after induction was 19.5 ± 2.3 cm of H<sub>2</sub>O, after insufflation of CO<sub>2</sub> was 26.3 ± 2.6, after head low was 34.1 ± 3.4, and after tenting was 29.5 ± 2.5, †Unit for airway pressure is cm of H<sub>2</sub>O. SD: Standard deviation

position was  $26.3 \pm 2.6$  cm of  $H_2O$ , after giving steep head low was  $34.1 \pm 3.4$  cm of  $H_2O$ , and after tenting of the abdominal wall with robotic arms was  $29.5 \pm 2.5$  cm of  $H_2O$ . Table 1 shows  $P$  value is highly significant ( $P = 0.001$ ).

## Discussion

In the present study, we aimed to describe effects of tenting of the abdominal wall and its effects on peak airway pressure in patients undergoing RRP in Trendelenburg position.

Insufflation of the abdomen with  $CO_2$  is not benign. Increased IAP after  $CO_2$  insufflation affects venous return (VR), systemic vascular resistance, and myocardial function. Initially, owing to autotransfusion of pooled blood from the splanchnic circulation, there is an increase in the circulating blood volume, resulting in an increase in VR and cardiac output. However, further increase in the IAP result in the compression of the inferior vena cava, reduction in VR, and subsequent decrease in cardiac output. Lung volume decreases, mean arterial pressure increases whereas cardiac index decreases, and absorption of  $CO_2$  causes hypercarbia and a concomitant decrease in blood pH.<sup>[5,6]</sup> Any of these can lead to cardiopulmonary complications.

The supine position and general anesthesia decrease functional residual capacity (FRC). Pneumoperitoneum and the Trendelenburg position cause cephalad shift of the diaphragm, further decreasing FRC, possibly to values less than closing volume; this causes airway collapse, atelectasis, ventilation-perfusion (V/Q) mismatch, potential hypoxemia, and hypercarbia. There is an increase in airway resistance and reduction in compliance which potentiates the risk of barotrauma with positive pressure ventilation. Intracranial pressure is increased by the rise in IAP, which may result in a decrease in the cerebral perfusion pressure, especially if there is a reduction in cardiac output. In addition, unintentional injury to vessels can lead to massive hemorrhage or  $CO_2$  embolism requiring rapid resuscitation.<sup>[5-7]</sup> Routine capnography should be used in all laparoscopic cases as it allows the adequacy of mechanical ventilation to be assessed.

Tenting of the abdominal wall is performed after abdominal port insertion procedure is completed. After robotic arm docking, abdominal wall is lifted with the help of robotic arms with the aim of tenting which result in a decrease in IAP, ultimately leading to decrease in peak airway pressure [Figures 2-4].

Gasless laparoscopic surgery is performed to reduce the effect of pneumoperitoneum. In gasless laparoscopy, abdominal wall is lifted with a subcutaneously inserted



Figure 2: Before tenting of abdominal wall (original picture taken in the operation theater with mobile phone camera)



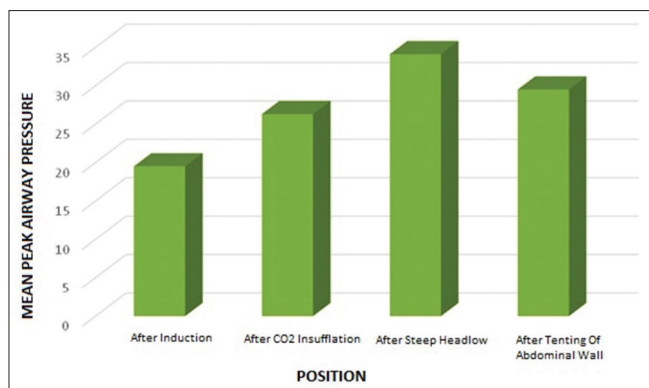
Figure 3: After tenting of abdominal wall (original picture taken in the operation theater with mobile phone camera)



Figure 4: Photograph after docking and tenting of abdominal wall (original picture taken in the operation theater with mobile phone camera)

abdominal wall-lifting system to create a space for surgeon to work without creating pneumoperitoneum.<sup>[8]</sup> Tenting of





**Graph 1: Peak airway pressure in various positions of the patient during surgery × mean peak airway pressure after induction was 19.5 ± 2.3 cm of H<sub>2</sub>O, after insufflation of CO<sub>2</sub> was 26.3 ± 2.6, after steep head low was 34.1 ± 3.4, and after tenting of the abdominal wall was 29.5 ± 2.5. †unit for mean peak airway pressure is cm of H<sub>2</sub>O**

the abdominal wall in our study mimics the same as in gasless laparoscopic surgery giving more space intra-abdominally and reducing the peak airway pressure.

In this study, mean peak airway pressure recording after induction was 19.5 ± 2.3 cm of H<sub>2</sub>O, after insufflations of CO<sub>2</sub> was 26.3 ± 2.6 cm of H<sub>2</sub>O, after giving steep head low was 34.1 ± 3.4 cm of H<sub>2</sub>O, and after tenting with robotic arms was 29.5 ± 2.5 cm of H<sub>2</sub>O ( $P = <0.0001$  highly significant).

Tenting of the abdominal wall done in RRP surgery causes a decrease in peak airway pressure leading to better ventilation as proven in the statistics.

Tenting of the abdominal wall leads to increase in working space for surgeon with reduced need to increase abdominal pressure, ultimately reducing peak airway pressure. Although tenting does not eliminate all adverse effects of pneumoperitoneum and high abdominal pressure, tenting is helpful to improve ventilation of the patient and reducing complications of high peak airway pressure such as barotrauma, pneumothorax, and ventilator-induced lung

injury. Thereby helping in reducing morbidity associated with peak airway pressure.

## Conclusion

Robotic Prostatectomy is associated with various anesthetic challenges due to pneumoperitoneum and deep Trendelenburg position. Tenting of the abdominal wall done during robotic prostatectomy is beneficial by decreasing peak airway pressure and helps in better ventilation and in return reduces the ill effects of raised peak airway and abdominal pressures.

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Nil.

## Conflicts of interest

There are no conflicts of interest.

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