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Effect of patient position on intra-thoracic pressure during general anesthesia

Emadi S. A.[1] *MD*, Nasiri E.[*] *MSc*, Kariman Majd M. H.[1] *MD*, Babatabar H. D.[2] *MSc*, Tadrisi S. D.[2] *MSc*

[*]*Paramedicine Faculty, Mazandaran University of Medical Sciences, Sari, Iran;*
[1]*Paramedicine Faculty, Mazandaran University of Medical Sciences, Sari, Iran;*
[2]*Nursing Faculty, Baqiyatallah University of Medical Sciences, Tehran, Iran*

Abstract

Aims. Change in position during general anesthesia may accompany hemodynamic and mechanical complications. In this study effect of change in position on intra-thoracic pressure during general anesthesia has been studied.

Methods. In this cross-sectional descriptive study, 115 adult patients were evaluated. Peak and plateau intra-thoracic pressures were measured with spirometer in supine position and then peak and plateau intra-thoracic pressure during one to 60 minutes of anesthesia were measured and recorded in Trendelenburg , left hemi lateral , right hemi lateral or prone positions in 10 minute intervals.

Results. The highest peak and plateau intra-thoracic pressures were registered in supine position and before changing position (33.7±5.5 and 20.5±5.1) that showed no significant change during general anesthesia ($p > 0.05$). Highest intra-thoracic pressure after changing position was recorded in right hemi lateral group, and least change of pressure was seen in group who were changed to prone position.

Conclusion. Changing patients' position during general anesthesia and complete muscle relaxation from supine position to prone, right hemi lateral, left hemi lateral or Trendelenburg positions don't cause significant clinical change in intra-thoracic pressure.

Keywords: General Anesthesia, Change in Position, Intra-thoracic Pressure

Introduction

Changing patients' position during general anesthesia may accompany some hemodynamic and mechanical complications. There are several reports that imply some complications such as changes in arterial blood gasses due to changes in body posture during general anesthesia in infants and children [1, 2]. Studies that show the effects of changes in position on respiratory parameters, report different results so that Rauh et al. declare based on their study results that respiratory compliance parameters and airway pressure do not change due to change of patient position [3]. On the other hand, Salih et al. showed that change in position during general anesthesia causes mechanical respiratory changes [4].

Since many surgery operations accomplish in different body positions during general anesthesia, airway pressure and intra-thoracic pressure measurement and preventing from its changes can be essential. Lack of consistency in this factor leads to ventilation disturbances and changes in eye pressure and intra cranial pressure, and also may cause some problems for heart failure patients and cause great hemodynamic changes in them [5,6]. Due to the lack of researches for determining the amount of intra-thoracic pressure in adults above fifteen years old, present study was performed in order to investigate the amount of intra-thoracic pressure due to change in anesthetized patient position in supine, lateral, prone and Trendelenburg positions.

Methods

In this cross-sectional descriptive study, study units were all adult patients who entered operating room for general, spine, orthopedic surgery, neurosurgery and kidney surgery, and were anesthetized and were under complete muscle relaxation and cardiovascular and respiratory monitoring. After muscle relaxation, periodic positive pressure with 10ml volume per kg and 12 respirations per min with exhale to inhale ratio of 1 to 2 was done by ventilator for respiratory support during general anesthesia.

115 patients in 5 groups of supine (20 patients), prone (38 patients), right lateral (12 patients), left lateral (13 patients) and Trendelenburg (32 patients) were selected using available and continuous sampling technique (i.e. each patient who referred for different surgeries was selected). With regard to preoperative evaluation, patients who had severe cardiovascular or respiratory diseases and airway obstruction did not enter the study.

Intra-thoracic Peak or maximum pressure and Plateau

* Correspondence; Email: rezanf2002@yahoo.com
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or minimum pressure rate, were measured and recorded for all five groups in supine position by Spirometer of anesthesia device (commercial model: Sula 808). These two pressures were measured and recorded, from the first minute after the change in position, with 10 min intervals. This process continued to the end of surgery and anesthesia. Results of the study were analyzed using repeated measurement tests within each group and ANOVA tests among different groups, and $p< 0.05$ was considered significant.

Results

44 male and 71 female patients participated in this study. 73 patients went under organs surgery, 34 patients general surgery and laparotomy, 6 patients thoracotomy and 2 patients under brain surgery.

Before the change in patient position, the highest peak pressure of intra-thoracic, related to supine group and was 32.7+_ 5.7 mmHg that no changes occurred in the pressure to the end of surgery. Also, the highest intra-thoracic Plateau pressure was recorded in supine group that was 20.6+_5.1 mmHg and had no changes until the end of surgery and the difference was not significant ($p>0.05$). Recorded data of intra-thoracic pressure in different positions during general anesthesia is summarized in table1 and 2, and diagram 1 and 2 compares the data changing process. The maximum increase due to change in position is in lateral group.

Discussion

With regard to the fact that the highest Peak and Plateau intra-thoracic pressures has been recorded before the stage of position change in supine group (32.7+_5.7 and 20.6+_5.1) and didn't have significant change until the end of surgery ($p>0.05$), this high pressure may be due to the characteristics and type of surgery that muscles are in complete relaxation status. In this situation, anatomic conditions, circulation dependence and high resistance of spine and therefore lack of chest expansion or dilation have caused resistance increase in a way that even at starting point, airway autonomy had been in highest level and considering muscle relaxation, no significant changes have occurred in this pressure during the surgery.

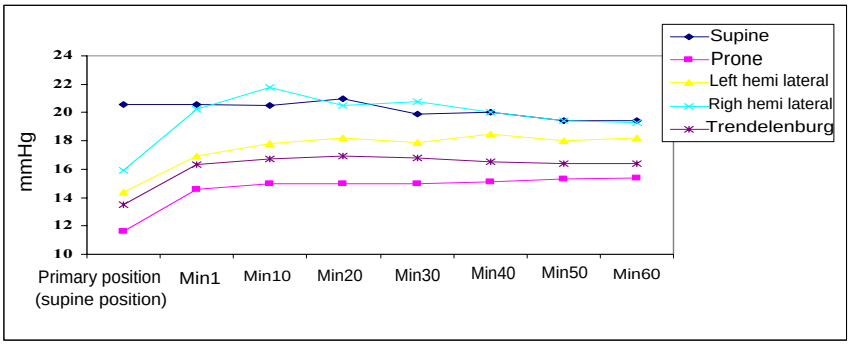
Table 1- Mean of Peak intra-thoracic pressure in different positions of patients during general anesthesia
(All numbers are in mm Hg. Superscript numbers show the number of each group members)

Body positions	Primary position (Supine)	Min1	Min10	Min20	Min 30	Min 40	Min 50	Min 60
Supine (control)	32.7±5.7	33.5±6	33.1±5.5	34±5.8	33.9±5.9	33.6±5.5	33.9±5.4	34.4±5.8
Prone	22.2±3.7	24.8±5	25.3±4.8	25.1±4.8	25.2±4.5	25.3±4.4	25.5±4.6	25.5±4.6
Left hemi lateral	26.5±4.9	29.5±6	30.5±5.8	31.2±5.5	31.2±5.4	31.3±5	31±4.5	30.5±4.2
Right hemi lateral	28±5.6	31.5±5.3	33.2±4.9	33.7±5.5	33.4±5.7	32.6±5.7	32.1±6.2	32.4±5
Trendelenburg	25.8±5.2	30.2±4.6	30.9±6.2	31.3±6.4	31.1±6.3	30.6±5.5	30.4±7.5	30.1±5.2

Table 2- Mean of Plateau intra-thoracic pressure in different positions of patients during general anesthesia
(All numbers are in mmHg. Superscript numbers show the number of each group members)

Body positions	Primary position (Supine)	Min1	Min10	Min20	Min 30	Min 40	Min 50	Min 60
Supine (control)	20.6±5.1	20.6±5.2	20.5±4.8	21±4.9	19.9±4.2	20±4	19.4±3.6	19.4±3.8
Prone	11.6±3.2	14.6±4.9	15±4.9	15±4.8	15±4.6	15.1±4.5	15.3±4.7	15.4±4.8
Left hemi lateral	14.4±3.3	16.9±4.9	17.8±4.1	18.2±4	17.9±3.8	18.5±4	18±4	18.2±3.9
Right hemi lateral	15.9±3.9	20.2±4.1	21.8±3.8	20.5±2.4	20.8±4	20±4.3	19.4±4.4	19.3±4.3
Trendelenburg	13.5±4.2	16.3±5.1	16.7±4.4	16.9±5	16.8±5.2	165±4.5	16.4±4.5	16.4±4.5

Diagram 1- Comparison of fluctuations in mean of Peak intra-thoracic pressure in different positions during general anesthesia



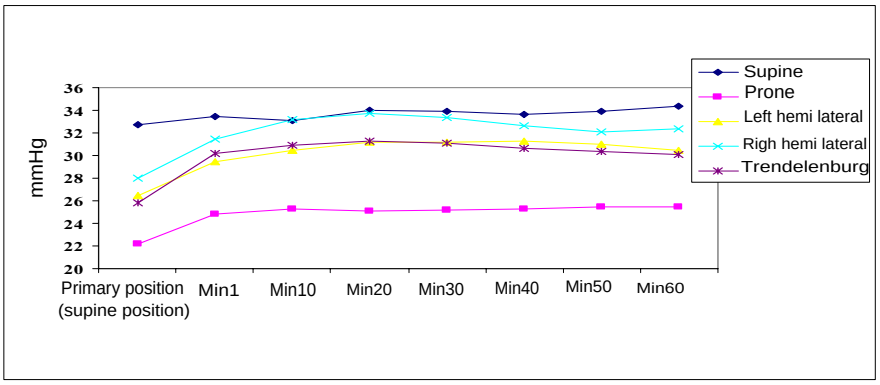


Diagram 2- Comparison of fluctuations in mean of Plateau intra-thoracic pressure in different positions during general anesthesia

These results are similar those of Paolo et al. study on fat anesthetized patients receiving muscle relaxation medicines [7], in which, it has been shown that pulmonary volume decreases and some changes occur in mechanical condition of lungs in supine position which are followed by resistance increase and pulmonary efficiency decrease and lead to moderate hypoxia.

Sample volume in that study was 10 patients (8 female and 2 male), and it was conducted particularly on fat patients whose BMI were higher than 30 kg/m2. Results of that study show that prone position improves pulmonary function and this result has consistency with present study, which showed, the lowest intra-thoracic pressure was in prone position among different positions of patients during anesthesia. Probably, the main cause of this result is that in prone position during anesthesia, using padding, condition is in a way that the lowest resistance exists against chest and lungs dilation.

In the present study, it has been shown that intra-thoracic pressure in left hemi lateral had been lower than right hemi lateral and supine positions. Nielsen et al. reported in their study that the amount of CO2 in left and right hemi lateral positions is better than supine position [8] and also oxygenation status in right hemi lateral and supine positions was better than left hemi lateral position. Accepted that by increase in airway resistance, oxygenation status may become undesirable, Nielsen results will have difference with present study. It seems that the main cause of this difference relates to sampling in different stages of anesthesia. In the present study, changes in patient position were recorded in anesthetized patients who had received muscle relaxants while in Nielsen et al. reports, changes in position were recorded at recovery stage and in anesthesia care unit in which patients had been out of muscle relaxation. In such situation, dependence of circulation and ventilation condition change. The cause of increase in airway pressure in right hemi lateral compared to left hemi lateral position in present study is likely the anatomic condition of lung lobes and pulmonary physiologic condition which are exposed to higher pressure and ventilated better in right hemi lateral position.

Although it seems that the pressure of abdominal viscera on diaphragm in prone position may increase intra-thoracic and airway pressure, but in the present study, peak and Plateau intra-thoracic pressure in prone position is lower than other positions during general anesthesia and muscle relaxation. Change in patient position from supine to prone, Trendelenburg, left lateral and right lateral, respectively, causes a brief increase in airway pressure during general anesthesia (maximum: 5 mmHg)and this increase is not clinically significant and is in natural range. Results show that the lowest pressure rate exists in prone position group. There was no significant difference in intra-thoracic pressure in different positions between men and women ($p=0.108$). Also, there was no significant difference in intra-thoracic pressure in different positions in different age groups ($p=0.277$). In this study, there was no significant difference between different positions based on weight ($p=0.295$). This study showed that there is significant difference in intra-thoracic pressure at different positions, among different type of surgical operations ($p<0.005$).

Conclusion

Change in the position of anesthetized patients who have received muscle relaxant, from supine to prone, Trendelenburg and right and left lateral positions, does not cause significant increase in intra-thoracic pressure. It seems that, regarding the studied patients who had been in ASAI and ASAII stages, changes in position that lead to slight pressure changes are not problematic, but for patients with higher risk

probability, these changes can give rise to some problems and further study is needed in this field.

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