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Research Article

Comparison the Effect of Changing from the Supine to Lateral Position and Vice Versa on Plethysmographic Variability Index and Hemodynamic Values Assessed by Ultrasonic Cardiac Output Monitors in Patients Who Undergo Thoracotomy

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ABSTRACT

Background: The change in patients' positions has a bold effect on the ventilation and hemodynamic parameters during surgery. In this study, we evaluated the changes in hemodynamic and ventilator values resulting from conversions in the position of patients under the thoracotomy from supine to lateral position and vice versa, to determine the most favourable position with the best hemodynamic stability and ventilation conditions.

Methods: In this pre and that post interventional clinical trial, 50 patients scheduled for thoracotomy were included. Following general anesthesia induction and 5 minutes later, hemodynamic data before thoracotomy and after the surgical intervention was measured, the patient was placed in the supine position and all hemodynamic data were recorded. Then, the position of the patient was slightly changed to the lateral recumbent position. Then, at the end of the surgery, the position was changed to supine.

Results: Regarding the change in study indices (including HR, SBP, DBP, MAP, SVV, CO, and PVI), changes in supine to lateral status led to only a decrease in systolic blood pressure, diastolic blood pressure, and mean blood pressure and other indicators did not show a statistically significant change. Similarly, the change in the above indices by changing the lateral to the supine state was only an increase in systolic blood pressure, diastolic blood pressure, mean blood pressure, and other data remained unchanged.

Conclusion: Changing the position of patients during surgical thoracotomy from supine to lateral position or vice versa is associated only with significant changes in patient's blood pressure and has no significant effect on other ventilatory and cardiovascular parameters.

Hemodynamic changes during general anesthesia in major surgeries are one of the main concerns requiring essential management. The hemodynamics in surgical settings is controlled and monitored during operation with various parameters. One of these parameters that need to be the subject of much research is the Plethysmographic Variability Index (PVI). This index measures the minimum and maximum of the

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Physiologic index over a given period and calculates the percentage difference between the two periods of time to determine variations in pulse oximetry plethysmographic (POP) waveform amplitude (delta POP) [1-2]. Another device that has been used to control the hemodynamics of patients during general anesthesia in major surgeries is Doppler Ultrasound Monitoring (USCOM). This index tracts cardiac output using an ultrasound probe that inserts into the chest in the suprasternal region. This monitor shows the real-time velocity of blood flow in the aorta and gives the instantaneous values of hemodynamic parameters proportional to the heart rate [3-6]. The patient's position during anesthesia can affect the patient's hemodynamics, and changes in the patient’s posture may lead to changes in the hemodynamic indices. In different studies, improvement in cardiac function in lateral positions during laparoscopic surgery, spinal surgery in the lumbar zone, and admission to ICU after major surgery have been reported [7-9]. However, some studies did not find a significant difference in cardiac function among different positions [10-12]. According to Ryan et al study, there was no significant difference in beat-to-beat heart rate variability (HRV) between right lateral decubitus, left lateral decubitus, and supine states [13]. Also, in a study by Casati et al who examined pulmonary function during surgery in different situations, it was observed that in lateral and prone conditions, the physiologic dead-space (Vdphys) and Vdphys/Vt ratio were significantly higher than in supine position [14]. Also, the values of arterial to end-tidal carbon dioxide gradient or P(a-Et) CO_2 (an indicator of ventilation and pulmonary perfusion) were significantly higher in lateral and prone states than in supine status.

So far, to the best of our knowledge, in search of the famous databases, we could not find any manuscript that the effect of a patient's positioning during thoracotomy on the hemodynamic status using PVI and USCOM indices. In this study, we intend to examine the effect of changing supine position to left lateral position and left lateral position to supine position on static and dynamic hemodynamic parameters in patients with thoracotomy.

Methods

This interventional before-after study was performed on patients aged 16 to 70 years who were scheduled for thoracotomy. Following obtaining local ethics committee approval and patient's informed consent, patients were included in the study. Patients with any history of cardiac arrhythmia, moderate to severe left and right ventricular dysfunction, cardiac shunts, and moderate to severe aortic valve disease, were not included in the study. Any surgical complication, failure to position the patient properly, and patient refusal were considered exclusion criteria. Before surgery, patient demographic data (age, sex, BMI) and various medical lab tests and the cause of their surgery were recorded. On the operating bed, standard monitoring including noninvasive blood pressure, ECG, and pulse oximetry were used and a 3 mL/kg lactated ringer was infused for the patients. Anesthesia was induced with propofol (1-3 mg/kg) and sufentanil (0.5-1.0 μg/kg) and tracheal intubation was facilitated by cisatracurium (0.15-0.2 mg/kg). After anesthetic induction, an 8-centimeter catheter 5F (Arrow International Inc.) was introduced into the right or left radial artery and a blood pressure transducer (Medex Medical Ltd., Rossendale, Lancashire) was embedded on the mid-axillary line and held constant during operation. These sensors were set to zero before the operation started. A pulse oximeter probe (Masimo Radical 7 monitor) was placed on the right-hand index finger. Anesthesia was maintained with continuous infusion of propofol (5-8 mg/kg/h) and sufentanil (0.7-1.0 μg/kg/h), keeping the bispectral index (BIS) between 40 and 50. The two-lung ventilation of the patient during anesthesia was performed at a tidal volume of 8ml/kg tidal volume, with Etco2 maintained between 35to 40. After general anesthesia and before surgical incision, in two supine and lateral decubitus positions and again in two similar positions at the end of surgery and before discontinuing anesthesia drugs and patient awakening, all static and dynamic hemodynamic indices including mean arterial blood pressure, heart rate, PVI, cardiac output, stroke volume, and systemic vascular resistance, stroke volume was measured and recorded. Dynamic hemodynamic parameters were recorded using the USCOM probe (Ultrasonic Cardiac Output Monitors) positioned in the suprasternal notch and PVi was measured using Masimo SET. The optimal quality of the signal was when the perfusion (PI) displayed on the monitor was more than 1.0 (as recommended by monitor manufacturers). PVI is a measure of the dynamic variation in PI that occurs during a complete respiratory cycle and is calculated by the formula: $PVI = [(PImax - PImin)/PImax]\times100$. Using USCOM, heart rate, cardiac output, stroke volume, systemic vascular resistance, maximum acceleration, and flow time were calculated and recorded.

All data were presented as an average ± standard deviation. First of all, the normality of the data was tested. The Pearson test was used to evaluate the linear relationships between the two variables. Data were analyzed using SPSS 22.0 software. The P values below 0.05 were considered statistically significant to compare the changes in the characteristics following the change in position.

Results

There was no study protocol violation and all the 50 patients met the criteria of the study and their data was analyzed. Demographic data were presented in (Table1). The mean age of patients was 37.33 ± 13.89 years whit the range of 23 to 76 years. Forty-two percent of patients were males and 58% were females (Table1). There were no significant differences in age in groups (39 ± 15 in females and 41± 17 in males). The mean BMI of patients was 25.62 ± 5.6 kg/m2 (Table 1). Again, there were no significant differences in BMI in genders, so it was23±4 in females and 27±6in males (Table 1). According to the data presented in Table 2, by altering the position of patients from the supine to lateral, there is a significant difference between systolic blood after modification of positions. (119.70 ± 20.81versus 115.06 ± 19.55, P<0.5, Table 2). As well as diastolic blood pressure shows significant differences (65.45 ± 15.09 versus71.6 ± 2.67, P<0.5, Table 2) following to change to lateral position. Also, this significant change was shown in mean blood pressure (93.93 ± 17.13 versus 86.75 ± 18.39 P<0.5, Table 2). There were no significant differences in other hemodynamic and respiratory factors (Table 2). Following the return of the position of patients from lateral to supine, the against changes were observed. Systolic blood pressure rose from 107.78 ± 12.81 to 115.06 ± 19.55 and it was significant (P<0.5, Table 3). There was a significant difference in diastolic blood pressure (62.77 ± 12.41 to 71.69 ± 12.98, P<0.5, Table 3). As well mean arterial pressure showed a significant difference (77.86 ± 10.75 versus 86.29 ± 15.45, P<0.5, Table 3).

Table 1- Demographic data in groups

Variable	Female	Male
Sex	58%	42%
BMI in each sex	23±4	27±6
Age in each sex	39 ± 15	41± 17

*Data were presented as mean ± standard deviation
#Data was presented as percentage

Table 2- Hemodynamic changes by modifications the position of patients from the supine to the lateral position

Variable	Supine	Lateral	Variance	P value
Heart Rate	82.83 ± 13.52	79.41 ± 15.07	3.41 ± 1.20	0.434
Systolic Blood Pressure	119.70 ± 20.81	112.76 ± 21.25	5.72 ± 3.20	0.034
Diastolic Blood Pressure**	74.33 ± 12.57	65.45 ± 15.09	7.16 ± 2.67	< 0.001
Mean Arterial Pressure**	93.93 ± 17.13	86.75 ± 18.39	6.03 ± 2.73	0.007
Stroke Volume Variation	34.36 ± 21.69	42.36 ± 34.35	-8.00 ± 5.87	0.179
Cardiac Output	4.23 ± 1.23	4.95 ± 6.58	-0.71 ± 0.95	0.455
Pleth Variation Index	16.46 ± 6.08	14.83 ±5.85	1.63 ± 1.27	0.205

*Data were presented as mean ± Standard deviation
**There is a significant difference in data

Table 3- The values of the indexes by changing the state of the lateral to supine position

Variable	Lateral	Supine	Difference	P value
Heart Rate	87.51 ± 12.26	92.08 ± 13.50	3.41 ± 1.20	1.00
Systolic Blood Pressure**	107.78 ± 12.81	115.06 ± 19.55	5.72 ± 3.20	0.016
Diastolic Blood Pressure**	62.77 ± 12.41	71.69 ± 12.98	7.16 ± 2.67	< 0.001
Mean Arterial Pressure**	77.86 ± 10.75	86.29 ± 15.45	6.03 ± 2.73	0.001
Stroke Volume Variation	41.35 ± 31.73	34.60 ± 25.03	-8.00 ± 5.87	0.279
Cardiac Output	5.69 ± 7.88	4.21 ± 1.20	-0.71 ± 0.95	0.200
Pleth Variation Index	10.95 ± 3.49	12.82 ±7.65	1.63 ± 1.27	0.133

*Data were presented as mean ± Standard deviation
**There is a significant difference in data

Discussion

The result of the present study showed that in thoracic surgical patients, changing position from supine to lateral and vice versa can lead to a change in systolic, diastolic, and mean blood pressure but the amount of these changes has no significant effect on cardiac output and other dynamic parameters. In the lateral position patients experience a little bit fewer blood pressures, yet variation can't have an important effect on the patient situation. Cardiac output and its related variables such SVV and PVI, as well as respiratory variables, don't change. so in these procedures, in the healthy patients, this change in position can be without serious problem.

In the review of previous studies performed on this subject, we found some changes in the respiratory parameters and hemodynamic conditions following the change in the position of the patients. In the Nakao study, the change in the supine position to lateral led to an increase in cardiac output. There was also a significant difference in arterial oxygen saturation between the left and right side positioning. With the change from supine to the lateral position, the increase in systolic and left ventricular diastolic pressure was also evident [15]. These findings are not consistent with ours. In the study of Channabasappa et al., the heart rate was higher in supine status, and the mean blood pressure was also higher in supine status than in prone position. However, in our study, the changes in heart rate were not shown [16]. Yet, in another study, the finding was alike ours [17]. The reason for these differences could be the difference in study design, for example, pre-hydration variation or the difference in time of positioning; However, as previously mentioned, the results of our study shows that this position changing is a safe practice

Our study had some limitations. First and the most important, relatively small sample size was calculated based on systolic blood pressure outcome. If it would calculate based on SVV or another variable, maybe the power of the study increase and other results show and the results were different. Yet, we have some concerns about the right position of the OSCUM probe in some cases.

Further study with more power and probably a more accurate mean of cardiac output could be a good idea.

Conclusion

In conclusion, changing the position of patients during surgical thoracotomy from supine to lateral position or vice versa is associated with little changes in patient's blood pressure and can be performed as a safe practice.

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