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Effect Of Body Position On Peak Expiratory Flow Rate And Physiological Responses In Post Operative Cardiac Surgery Patients

Bhavna Sharma,[1*] Aayushi[2], Dr. Keerthi Rao[3], Ruchi Kukkar[4], Vipin Sharma[5], M Thangaraj[5]

[1*]*Assistant Professor, Chandigarh University, Punjab*
[2]*Assistant Professor, Chandigarh University, Punjab*
[3]*Professor, Chandigarh University, Punjab*
[4]*Assistant Professor, Chandigarh University, Punjab*
[5]*Assistant Professor, Sharda University, Greater Noida (U.P)*
[6]*Principle, ITS College of Physiotherapy, Ghaziabad (U.P)*

Abstract
Objectives: *To study the Effect of Body Positions on Peak Expiratory Flow Rate and Physiological Responses in Post Operative Cardiac Surgery Patients*
Settings: *ICU CTVS Department, Pushpanjali Crosslay Hospital (presently Max Hospital, Vaishali)*
Methods: *Cross over study design was used. 40 subjects were randomly selected from both male and female groups based on the inclusion and exclusion criteria of the study. Subjects will receive different Body Positions (Supine, Three-Quarter Sitting, Long Sitting and Sitting with Back Rest Vertical) randomly for 20min. With a gap of 5min interval between each position and PEFR and Physiological Responses were noted.*
Result: *Demographic data was analyzed by comparing means of descriptive. The mean of age is 58.97 ± 8.51 in all Body Positions (Supine, Three-Quarter Sitting, Long Sitting and Sitting with Back Rest Vertical). Peak Expiratory Flow and Physiological Responses was monitored and showed significant improvement in Sitting with Back Rest Vertical position followed by Long sitting and Three Quarter Sitting position than in Supine position P-value comes out to be significant for PEFR and Physiological Responses.*
However there were no significant improvement in Heart Rate and Respiratory Rate in different Sitting positions as compared to Mean Blood Pressure and Oxygen Saturation.
Conclusion: *Body Positions has a significant effect on PEFR and Physiological Responses in Post Operative Cardiac Surgery patients. However the Heart Rate and Respiratory Rate does not show any significant change with the Body Positions.*

Key words: *PEFR, Cardiac Surgery, Physiological Responses, Body Positions*

INTRODUCTION

Cardiovascular disease is the leading cause of mortality in most developed and developing countries. Cardiac surgery has become a standard treatment for some patients with heart diseases[1,2] and CABG is a common and successful procedure for coronary revascularization[3].

The incidence of post-operative respiratory complications after thoracotomy ranges from 10% to 40%[4]. As well as significantly contributing to morbidity and peri-operative mortality, they increase length of hospital stay and hospital costs[5,6]. The incidence rate also depends on the surgical site, presence of risk factors and the criteria used to define post pulmonary complications[7]. A reduction between 60% and 71% in vital capacity is attributed to post-operative diaphragmatic dysfunction, that parameter returning to preoperative values between 7 and 10 days after the operation. Patients who can't raise its values of maximal respiratory pressures in the postoperative period have a higher risk of developing respiratory compliance.[4]

Manipulation of thoracic surgery decreases the lung volumes and capacities, which leads to shallow and rapid breathing, which again leads to pulmonary complications with altered ventilation-perfusion or pulmonary shunts that results in hypoxemia. These respiratory changes reach their peak within first 48 post-operative hours.[8]

Dysfunction of the respiratory muscles, due to surgery may lead to a reduction in vital capacity and tidal volume, total lung capacity and thus, insufficient cough. This may can cause atelectasis in the basal lung segments and a decrease in functional residual capacity, which in turn affects the gas exchange properties of the lung by increasing the ventilation/perfusion(v/q) mismatch. Potential patient related risk factors that may contribute to the risk of postoperative pulmonary complications includes smoking, poor general health status, older age, obesity, chronic obstructive pulmonary disease, and asthma.[9]

Interestingly, little work has been done to evaluate the physiological response of rotational therapy. Body position has been shown to affect the lung volumes and muscle biomechanics often during respiratory infection, when good secretion clearance is the most important, changes in volumes and biomechanics may combine to lead to weak and ineffective expiratory maneuvers. High expiratory flow rates and expiratory pressures are required for the production of strong and effective expiratory maneuvers. Higher lung volumes have been linked with better expiratory muscle length-tension relationships and improved expiratory pressures and flow rates[9-14].

However, to date the effects of body position on PEFR (peak expiratory flow rate) have not been directly investigated. By understanding, how PEFR (peak expiratory flow rate) are affected by body positions, physiotherapists can better advise their patients on positional changes that may help in maximizing the better outcome.

Therefore, this study aims to distinguish, which body positions lead to generation of better PEFR and improved Physiological responses.

MATERIALS AND METHODS

This study was conducted on 40 patients between the age group of 35 – 75 years. Ethical clearance has been obtained from the institutional review board. The study protocol was explained to the subjects and written informed consent was obtained.

Subjects undergone cardiac surgery post- operative day 1 with heamodynamically stable were included in the study. The subjects were given 20min of body positioning (Supine, Three Quarter Sitting, Sitting with Back Rest Vertical and Long Sitting) with a gap of 5min interval between each position.

TEST PROTOCOL

Subject's demographic data was recorded. Following the explanation about the procedure was given to the patient. The procedure was monitored by the researcher and adequate explanation and motivation was given to the subjects.

INSRUMENTATION

- Cipla Peak Expiratory Flow Meter.
- Philips Intelli Monitor in ICU

INSTRUCTIONS GIVEN TO THE SUBJECTS BEFORE PERFORMING PEFR

They were instructed to place the mouthpiece in situ and to form a tight seal with their lips. For peak expiratory tests, they were instructed to take two tidal breaths followed by one deep breath and forced expiration with maximal force. Total three deep maximum breath were noted out of three best one is included in the data. All instructions were given by the same researcher throughout the procedure.

POSITIONS USED

1) Supine: subject was positioned lying on his/her back on a padded plinth. The hips were flexed at 45 degrees angle with soles of feet in contact with the plinth. This resulted in about 90 degrees of flexion at the knees. A pillow was placed under the head.

2) Three quarter sitting: subject was positioned on a padded plinth, the top part of which was positioned at 45 degree angle. Subjects sat with their hips at the bend in the plinth and upper body resting back on the segment of the plinth that was angled. This means that the upper body formed an angle of approximately 135 degrees with the legs.

3) Long sitting: the subject sat up straight on a padded plinth with legs straightened in front. The upper body formed 90 degree angle to the legs without pillow support.

4) Sitting with back rest vertical: the subject sat up straight on a padded plinth with legs straightened in front. The upper body formed 90 degree angle to the legs with pillow support behind the lumbar spine to increase the comfort of the patient.

PROCEDURE

The aim and procedure of the study were explained to the patients and the duly signed consent forms were obtained, after explaining their rights as research subjects. Subjects were included based upon the inclusion and exclusion criteria of the study.The study was conducted on 1st post operative day of cardiac surgery of 40 subjects both male and female. Body positions (supine,three-quarter sitting, long sitting and sitting in bed with back rest) was given, when the patient got conscious and oriented. Subjects were receive different body positions (supine, three-quarter sitting, long sitting and sitting in bed with back rest vertical) randomly for 20min with a gap of 5min interval between each position and the subjects were assessed by PEFR (Peak Expiratory flow Rate) and Physiological responses (Heart Rate, mean arterial blood pressure, respiratory rate and oxygen saturation) at the end of 20min of each body position.

DATA ANALYSIS

The data was analysed using statistical software namely SPSS 15.0 version and Microsoft word and exel has been used to generate graphs, tables etc. The dependent variables were analysed by using repeated measures analysis of variance (ANOVA) and Post Hoc analysis. The tests were applied at 95% confidential interval and P – value set at 0.05. The result were taken to be significant if P – value ≤ 0.05.

RESULT

40 subjects participated in the study with the mean age of (59.97 ± 8.51) Comparison of (M ± SD) of PEFR between the Body Positions-
Comparison of Peak expiratory flow rate (PEFR) between the body positions showed that there was a significant improvement in peak expiratory flow rate values after 20min of each body position in supine v/s three quarter sitting position (p = 0.03), supine v/s long sitting (p = 0.0001), supine v/s sitting with back rest vertical (p = 0.001) and three quarter sitting v/s long sitting (p = 0.028) where as there is no significant change in three quarter sitting v/s sitting with back rest elevated (p = 0.067) and long sitting v/s sitting with back rest vertical (p = 1.00).

Posit ion	Supine(M±SD)	Three quarter sitting (M ±SD)	Long sitting(M ±SD)	Sitting with back rest vertical(M ±SD)	P - valu e
PEF R	93.75±19.70	109.25±43.28	117.75±41.29	119.75±46.50	0.0001

Table 5.3 : Comparison of PEFR between the Body Positions

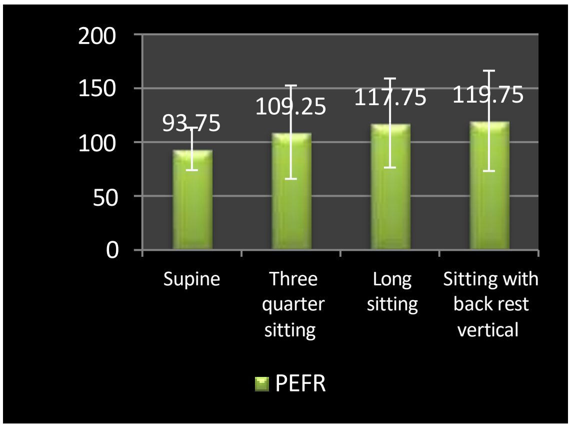

Figure 5.3: Comparison of PEFR between the Body Positions

Heart Rate (HR) and Respiratory Rate(RR)
Comparison of HR and RR between the Body Position :
Heart Rate :
Comparison of (M ± SD) of HRbetween the Body Positions :
Comparison of heart rate between the positions showed that there is a significant improvement in heart rate after 20min of each body position in supine v/s three quarter sitting position (p = 0.043) and supine v/s long sitting (p = 0.0001) where as there is no significant improvement in supine v/s sitting with back rest vertical position (p = 0.017), three quarter sitting v/s long sitting (p = 0.008), three quarter sitting v/s sitting with back rest vertical (p= 1.000) and long sitting v/s sitting with back rest vertical position (p = 0.029).
Respiratory Rate :
Comparison of (M ± SD) of RRbetween the Body Positions :
Comparison of respiratory rate between the positions showed significant improvement after 20min of each body position in supine v/s three quarter sitting position (p = 0.01) where as there is no significant improvement in supine v/s three quarter sitting position (p = 0.53),supine v/s long sitting position (p = 1.00), three quarter sitting v/s long sitting position (p = 1.00), three quarter sitting v/s sitting with back rest vertical (p = 0.87) and and long sitting v/s sitting with back rest vertical position (p = 0.11).

Posi tion	Supin e (M ± SD)	Three quarter sitting(M±SD)	Long sitting(M±SD)	Sitting with back rest vertical(M±SD)	P - val ue
HR	89.55±9.03	84.55±6.95	81.50±5.33	83.92±6.89	0.0001
RR	20.05±2.65	18.87±3.61	19.70±2.98	17.85±3.52	0.0001

Table 5.5: Comparison of HR and RR between the Body Positions

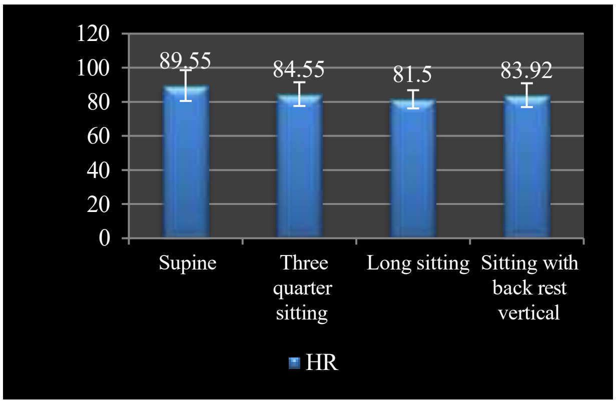

Figure 5.4 Comparison of HR between the Body Positions

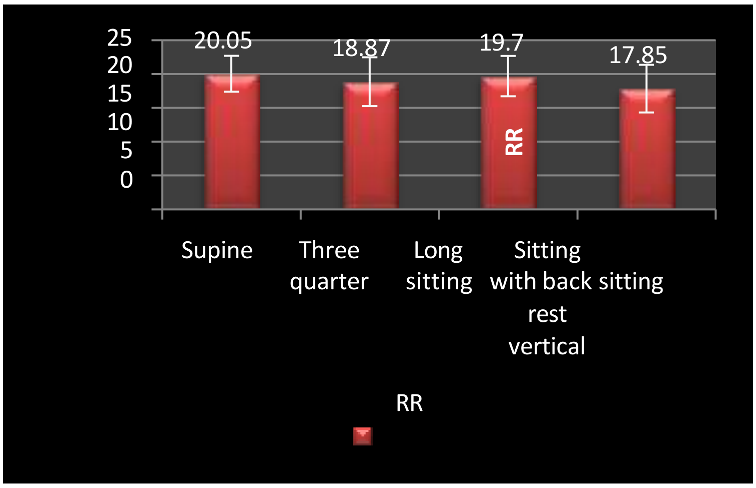

Figure 5.5: Comparison of RR between the Body Positions

Mean Blood Pressure (MBP)
Comparison of MBP between the body position:
Comparison of (M ± SD) of mbp between the body positions:
Comparison of mean blood pressure between the positions showed that there is significant improvement in MBP after giving 20min of each body position in supine v/s long sitting (p = 0.0001), three quarter sitting v/s long sitting (p = 0.020) and long sitting v/s sitting with back rest vertical (p = 0.002) whereas there is no significant improvement in supine v/s three quarter sitting position (p = 0.164), supine v/s sitting with back rest vertical (p= 1.000), three quarter sitting v/s sitting with back rest vertical (p = 0.475).

Position	Supine (M ± SD)	Three quarter sitting (M±SD)	Long sitting (M±S D)	Sitting with back rest vertical (M±SD)	p - value
MBP	96.90± 5.70	94.65± 3.46	92.25± 4.39	95.92± 3.72	0.0001

Table 5.7: Comparison of MBP between the Body Positions

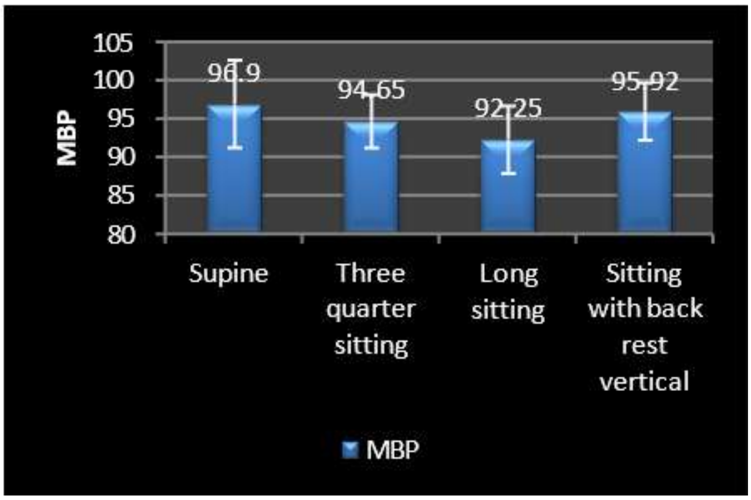

Figure 5.5: Comparison of MBP between the Body Positions

Oxygen saturation (SPO2)
Comparison of SPO2 between the body position :
Comparison of (M ± SD) of spo2 between the body positions :

Comparison of spo2 showed that there is significant improvement after giving 20min of each body position in supine v/s three quarter sitting position (p = 0.0001), supine v/s long sitting position (0.0001) and supine v/s sitting with back rest vertical position (p = 0.0001) where as there is no significant improvement in three quarter sitting v/s long sitting (p = 1.000), three quarter sitting v/s sitting with back rest vertical (p = 1.000) and long sitting v/s sitting with back rest vertical position (p = 0.390).

Positio n	Supine (M ± SD)	Three quarter sitting (M±S D)	Lon g Sitti ng(M±S D)	Sittin g with back rest vertic al(M±SD)	p - value
SPO2	91.70 ±2.30	95.02± 2.79	95.75 ±2.93	94.52± 2.72	0.0001

Table 5.9: Comparison of Spo2 between the Body Positions

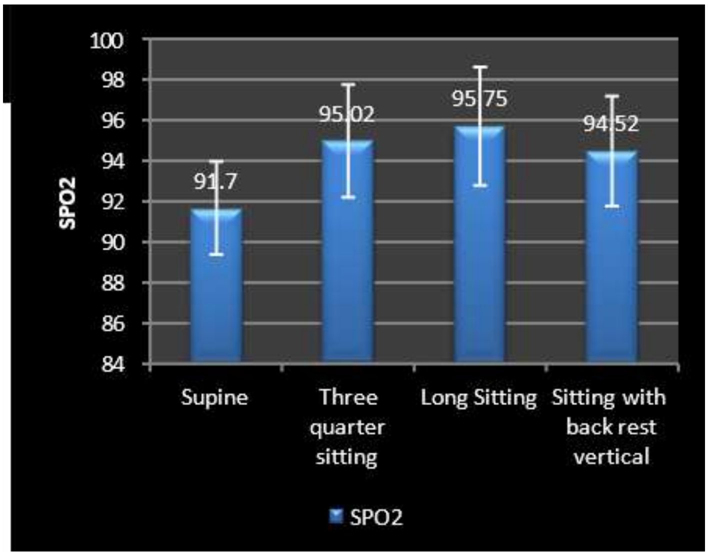

Figure 5.6: Comparison of Spo2 between the Body Positions

DISCUSSION

Results of this study showed that the Sitting with Back Rest Vertical position recorded the highest values of PEFR as compared to other positions (supine, three quarter sitting, long sitting). According to Pride N.B, the forceful expiratory maneuvers entirely depends on the total lung capacity[12].The elastic recoiling force increases with increase in lung volumes. In this study the subjects were asked to take deep inspiration, before the forced expiratory maneuvers. Due to this a large number of potential energy is stored in the chest wall structures. This increased descend of the diaphragm pushes the abdominal muscles slightly. This increases the force production of the abdominal muscles. The action of the expiratory muscles also increases in the upright postures[14].

The respiratory resistance also increases in supine lying when compared to sitting position (three quarter sitting, long sitting, sitting with back rest vertical). All these actions are combined together to produce the maximal forceful expiratory values in sitting with back rest vertical position followed by long sitting than three quarter sitting positions.

Compared to all other positions supine lying has got the lowest values because of the action of gravity. As compared to supine position diaphragmatic excursion is less in other positions due to mechanical compression. Though the pillows have been provided for the neck support , the pressure exerted by the gravity on the abdomen can't be neglected[10,14]. Due to these reasons supine lying has recorded the lowest values.

Further most of the previous research has focused on the inspiratory rather than expiratory muscles. Previous studies that involved large representative samples have established normal maximum expiratory pressures and PEFR values in sitting positions. Alterations in body positions may allow more effective secretion clearance, which may be especially useful for those patients demonstrating sub-optimal huffing and coughing1[3].

Apart from peak expiratory maneuvers, oxygen saturation were more in sitting with back rest vertical compared to other positions. In sitting positions all the respiratory muscles are placed in a mechanically advantageous position[13]. But in supine and other positions due to effect of gravity the length-tension of the diaphragm is altered. It has been mentioned earlier, that in the upright sitting the motor recruitment of the respiratory muscles is more when compared to recumbent position. All these together increases the strength of the respiratory muscles in sitting with back rest vertical position. The relationship of gas exchange to position in these subjects may also have been influenced by the small airway closure during tidal breathing[15]. Oxygen saturation was probably less in supine position than in other positions, and this may contribute to the improvement in gas exchange on changing from supine position to different sitting positions.

However, the lung is subjected to internal and external forces some of which respond to changes in gravity, so that their effect on the lung alters with changes in postures. On assuming the supine position this force is reversed, the base of the lung being compressed by the weight of the viscera. This dome shape of the diaphragm causes the greatest pressures to be exerted on the posterior aspect and this force is sufficient to compress the lung from a height of 30cm when erect to 20cm when horizontal. In the sitting position the force exerted by viscera depends on whether the subject is sitting upright.[10] The reductions in pulmonary functions detected in the supine position tends to confirm the suggestion that this posture, all too often observed in the hospital setting has a potentially detrimental effect on patients. Based on the demonstrated negative effect that the supine position has on the pulmonary function and in turn on the arterial blood gas composition, LeBlanc et al have cautioned that comparing arterial oxygen saturation obtained from supine position may not be valid because the normal standards are invariably taken from seated individuals. But some reviewes, explores age related physiological responses in the respiratory system and their consequences in respiratory mechanics, gas exchange and and respiratory adaptations to exertion[16,17].

The clinical implications of the studies comparing lung functions in the different sitting position could be a therapeutic adjunct for improving oxygenation compared with the supine position. These findings may also have particular importance for the immobilized individual who may spend a considerable amount of time in supine position[17].

The reductions in Mean Arterial Pressures and Heart Rate during upright position , postural change has less impact on heamodynamics and oxygen transport after, than before surgery[18]. Patients had anemia after surgery which reduces the oxygen carrying capacity of the blood and also reduced blood viscosity contributing to changes in pre load and after load[16]. As a result of the post operative increase in Heart Rate, Respiratory Rate and resting Mean Arterial Pressure increased to maintain the Oxygen Saturation. The increase in Heart Rate may be compensatory due to anemia, which may reflect altered loading conditions or may result from vagal tone suppression after cardiac surgery[19].

In this study Heart Rate improves by improving the different Body Position from supine to long sitting followed by three quarter sitting than in sitting with back rest vertical position, which again proves that sitting is better than lying down flat[10].

The small changes between the two position may balance each other out and account for the similar Respiratory Rate and Mean Arterial Pressure values seen in long sitting and Sitting with Back Rest Vertical position.

The result in Sitting with Back Rest Vertical and Long sitting were similar to those in Three Quarter Sitting and Supine Position. Again due to limited data available and lack of previous research, it was hard to accurately compare these positions. The comparison of respiratory rate in different positions showed lowest values in Supine position as compared to other positions and long sitting has got the highest values compared to Three Quarter Sitting and Sitting with Back Rest Vertical Position, which proves that Supine is a physiologically unstable position than other therapeutic positions[20]. However, the effect of body position on Respiratory Rate has not been directly investigated.

Similarly the comparison of Mean Blood Pressure between the Body Position has not shown significant effects but it is found that Long sitting and Three Quarter Sitting position is better than Sitting with Back Rest Vertical followed by Supine position which doesn't showed significant effect on Mean Blood Pressures.

By reviewing these factors which affect the regional distribution of ventilation in the lung, it is hoped that the physiotherapist will be further stimulated to rationalize the use of this technique in the management of the patients.

A similar replication of this study using more detailed measures, a large number of subjects and more positions should be carried out. Such a study will provide more reliable information about muscle activation and may find difference between similar positions. This would be important implications on improving the care and education of the cardiac surgery patients. Other groups who can benefit from the replication of this study includes, patients with upper abdominal surgery, following spinal cord lesion and cystic fibrosis.

CONCLUSION :

Thus the body positioning has an significant effect on expiratory maneuver and physiological parameter following post operative cardiac surgery patients. Changing a better position may be especially useful for those patients with weak expiration.

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