The Effect of Positioning on Oxygenation after Coronary Artery Bypass Graft

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Abstract: Introduction: Prolonged bed rest is common in critically ill patients, and therapeutic positioning is important to prevent further complications and to improve patient outcomes. **Methods:** This clinical trial study was carried out in Imam Khomeini Hospital, ICU of open heart surgery center, Ahvaz, Iran. Ethical approval for the study was gained from the Ethical Committee of Ahvaz Jundishapur of Medical Sciences (Ethics code: 358).After Informed consent, 60 coronary artery bypass graft patient enrolled in the study. **Result:** Both the PaO_2 and hemoglobin saturation (O_2Sat) were significantly higher in the left lateral position (PaO_2=96.4±28.93mmhg, O_2Sat=95.7±3.32%) than in supine (PaO_2=84.5±32.1mmhg, O_2Sat=92.9±5.38%) and right lateral position (PaO_2=91.7±30.42mmhg, O_2Sat=94.6±3.93%) and semi sitting position (PaO_2=83.3±29.23mmhg, O_2Sat=92.9±5.24%). Repeated measures of ANOVA showed a significant difference in hemoglobin saturation (O_2Sat) and PaO_2 with posture (p=0.00). PaO_2 and hemoglobin saturation (O_2Sat) were significantly higher in the left lateral than the other positions. In comparison two by two positions was not found significant difference in hemoglobin saturation (O_2Sat) for supine and semi sitting (p=0.95).But between other positions were significant difference in hemoglobin saturation (O_2Sat) (p=0.00). Also in comparison two by two positions in PaO_2 was not found significant difference for supine and semi setting (p=0.7) and supine and right lateral (p=0.057). But between other positions were significant difference in PaO_2 ($p<0.05$). **Conclusion:** lateral position improves arterial oxygenation in the coronary artery bypass patients, whereas left lateral position was the most effective position in this patients.

[Tayyebe Mahvar, Mansoor Soltanzadeh, Fahimeh Sabeti, Neda Akbari- Nassaji, Shahriar Mali, Ahmad Ebadi, Mehdi Dehghani Firoozabadi, Mohammad ali Sheikhi. **The effect of positioning on oxygenation after coronary artery bypass graft**. *Life Sci J* 2012;9(3):1426-1431] (ISSN:1097-8135). http://www.lifesciencesite.com. 208

Key Words: position, oxygenation, coronary artery bypass graft

1. Introduction

Prolonged bed rest is common in critically ill patients, and therapeutic positioning is important to prevent further complications and to improve patient outcomes (7).

Positioning of intensive care patients may be applied to enhance arterial blood oxygenation, promote drainage of respiratory secretions, prevent gastro-esophageal reflux, nosocomial pneumonia and pressure ulcers and/or promote patient comfort (9). Open heart surgery is associated a number of pulmonary or cardiac complications. For example, low in gas exchange, including mainly hypoxia, is one of the commonest problems of patients after open surgery operation in critical care unit (12).

Coronary artery surgery patients are admitted to an intensive care unit (ICU) after surgery .At least the first 12 to 24 hours these patients have to be critically ill and at high risk for complications of immobility like pulmonary complications and pressure ulcers. The current standard of care is to reposition patients every 2 hours. Unfortunately, the majority of critically ill patients do not receive this standard care because a negative influence on the reliability of hemodynamic measurements, and negative effect on oxygenation and on hemodynamic parameter is assumed (7, 11).

Rotation therapy may be effective in altering the distribution of ventilation and perfusion (9, 10). Post studies showed controversial results, In Chan´s study (1992) no statistically significant

differences in arterial oxygen were found among supine, right and left lateral position (3).

A beneficial effect of lateral recumbent positions was initially reported in patients suffering from cardiac disease and right lateral position was also recently confirmed to improve hemodynamic in patients suffering from heart failure (19).

In Geogé studies (2002) no differ significantly between supine and lateral position in oxygenation measurements in the immediate postoperative period in single-lung transplant recipients (11).

In Banasik´s study, lateral position of post operative cardiac surgery patients appears to cause no detrimental effects on indirect / non invasive blood pressure or heart rate measurements (1).

Lateral decubitus position general discomfort and worses lung function in chronic heart failure (21).

In elderly, mean PaO_2 in sitting position is higher than in supine position (6).

In newest studies report other results, such as: in a study (2007) right lateral posture improves arterial oxygenation in the valvular heart disease patient (21). Also in S. Tongyoo´s study (2006) the PaO_2 increased while in the right lateral position in patients whit predominant left pulmonary infiltration (26).either Peter´s study indicated lateral position had no beneficial effect on gas exchange in ventilated intensive care patients (21).

Whitman's study (2009) statistically significant differences were found in PaO_2 and Sat O_2 averages in supine and semi sitting positions in postoperative open heart surgery patients (29).

Studies showed (1995 & 88) showed that lateral position (30 ◌̊) had negative effect on cardiac index in this position (5, 6).

Considering the different results of oxygenation in various positions, the question is whether different body positions are superior to each for more gas exchange and preventing hypoxia. This study aimed to determine the effect of supine, semi sitting, and right and left lateral positions on oxygenation of hospitalized patients in ICU of open heart surgery center in Ahvaz Imam Khomeini Hospital.

2. Methods

This clinical trial study was carried out in Imam Khomeini Hospital, ICU of open heart surgery center, Ahvaz, Iran. Ethical approval for the study was gained from the Ethical Committee of Ahvaz Jundishapur of Medical Sciences (Ethics code: 358).

After Informed consent, 60 coronary artery bypass graft patient enrolled in the study. Inclusion and exclusion criteria were showed in Table 1.

Patient characteristic data include: age, sex, marietal status, level of education and job were collected by interview prior the study.

Table 1: Inclusion and exclusion criteria

Inclusion Criteria
• **Age 40 - 60 year** • **Hemodynamic stability:** **a) Heart Rate :60-130 beat / min** **b) No compromising arrhythmia** **c) No respiratory arrest** **d) Respiratory rate ≥12** **e) Intubated and unconscious patients** **f) Patients undergoing mechanical ventilation** • **Fi O_2=50%** • **Have intra-arterial line** • **Hemoglobin >10 g/dl**
Exclusion Criteria
• **Evidence of chest and spinal trauma** • **Pump time>120 minute** • **Reception of extra liquid**

All patients were premeditated with 2cc Sofentanil 15 minute before admitted to ICU. They received oxygen 100% supplementation before procedure. During the intervention, ventilator settings remained constant:

FiO_2=50%, F=12, Peep=5, Peressur support=15, Mood= SIMV.

At first, all patients were lying in supine position and after 30 minute the arterial blood sample baseline were collected via inserted arterial catheter. Then the patients were lying in the different position such as: semi sitting, right and left lateral respectively for 30 minutes and at the end of period, the amount of 1cc a trial blood gas samples were drawn and analyzed immediately (analyzed in premier 3000(American) series machines-Radiometer). Comparison of PaO_2 and hemoglobin saturation (O_2Sat) values in different positions performed using Bonferroni test.

To determine whether posture brought about significant changes in arterial oxygenation, repeated measures of analysis of variance (***ANOVA***) was used.

3. Results

Both the PaO_2 and hemoglobin saturation (O_2Sat) were significantly higher in the left lateral position(PaO_2=96.4±28.93mmhg, SaO_2=95.7±3.32%) than in supine (PaO_2=84.5±32.1mmhg, O_2Sat=92.9±5.38%) and right lateral position

(PaO_2=91.7±30.42mmhg, O_2Sat=94.6±3.93%) and semi sitting position (PaO_2=83.3±29.23mmhg, O_2Sat=92.9±5.24%). Repeated measures of ANOVA showed a significant difference in hemoglobin saturation (O_2Sat) and PaO_2 with posture (p=0.00). PaO_2 and hemoglobin saturation (O_2Sat) were significantly higher in the left lateral than the other positions.

In comparison two by two positions was not found significant difference in hemoglobin saturation (O_2Sat) for supine and semi sitting (p=0.95).But between other positions were significant difference in hemoglobin saturation (O_2Sat) (p=0.00). Also in comparison two by two positions in PaO_2 was not found significant difference for supine and semi setting (p=0.7) and supine and right lateral (p=0.057). But between other positions were significant difference in PaO_2 (p<0.05).

A statistically significant difference on PaO_2 and hemoglobin saturation (O_2Sat) was found in different positions. PaO_2 and hemoglobin saturation were significantly higher in the left lateral position: ***(PaO_2=96.4±28.93mmhg, SaO_2=95.7±3.32%)***

Than in supine:
(PaO_2=84.5±32.1mmhg, O_2Sat=92.9±5.38%)

And right lateral position:
(PaO_2=91.7±30.42mmhg, O_2Sat=94.6±3.93%)

And semi sitting was position:
(PaO_2=83.3±29.23mmhg, O_2Sat=92.9±5.24%)

There was significant differences in Pao2 and hemoglobin saturation(O_2Sat) between left and right lateral position(P<0/00) ,semi sitting and right lateral(P<0/00),supine and left lateral (P<0/00),supine and right lateral(P<0/00) .no significant differences was found in supine and semi sitting(P<0/95).

Patient's characteristics data are shown in Table 2.Both the PaO_2 and hemoglobin saturation (O_2Sat) in different positions are shown in Table 3. Both the Pao2 and hemoglobin saturation (O_2Sat) were significantly higher in the left lateral position (PaO_2=96.4±28.93mmhg, SaO_2=95.7±3.32%) than in supine (PaO_2=84.5±32.1mmhg, O_2Sat=92.9±5.38%) and right lateral position (PaO_2=91.7±30.42mmhg, O_2Sat=94.6±3.93%) and semi sitting position (PaO_2=83.3±29.23mmhg, O_2Sat=92.9±5.24%).

The difference between supine and semi sitting positions was not significant (P<0.95).

Repeated measures of ANOVA showed a significant change in hemoglobin saturation (O_2Sat) with posture and hemoglobin saturation (O_2 Sat) were significantly higher in the left lateral than the other positions. In comparsion positions two by two showed that no significant effect was found for supine and semi sitting (P<0/95).But between other positions were significant different in hemoglobin saturation (O_2 Sat).

There was significant difference in O_2Sat mean between supine position and right lateral position(P<./001) , supine position and left lateral position(P<0/00) , semi sitting position and right lateral position(P<0/00) , semi sitting position and left lateral position(P<0/00) and left lateral position and right lateral position(P<0/001) .PaO_2 mean was in supine position(84.57±32.1) , semi sitting position (83.357±29.23) , right lateral position(91.758±30.42) left lateral position(96.465±28.93) Repeated measures of ANOVA showed a significant change in PaO_2 in all of the postures and PaO_2 were significantly higher in the left lateral (P<0/338) than the other position. There was no significant difference in PaO_2 between supine position whit semi sitting(P<0/713) and right lateral position(P<0/057) .

But the change in PaO_2 was significant between supine position and left lateral position (P<0/00) and this amount in left lateral position was higher. In comparison two by two was significant difference in semi sitting position whit right lateral position (P<0/00) and semi sitting position whit left lateral position (P<0/00) and this amount in lateral position was higher. Also the change in PaO_2 in left and right lateral position was significant and PaO_2 in left lateral position (P<0/033) was higher.

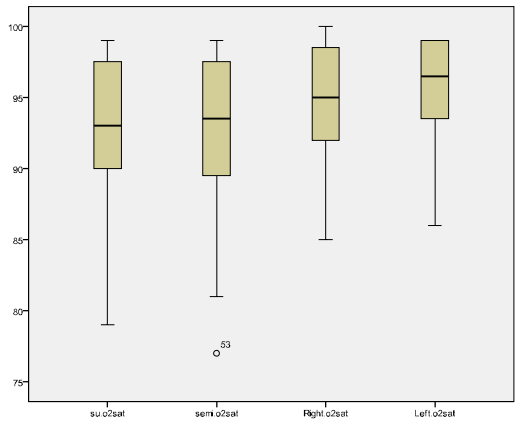

Fig 1: Comparison between the two conditions in mean O_2 saturation

4. Discussion

The effect of posture on regional lung function has long interested pulmonary physiologists (12).

Frequent change positions can provide improved ventilation in the lung area and alternating gravitational forces for drainage of mucus from sinus and lung cavities (16).

Gravity causes a vertical gradient in the distribution of pulmonary blood flow such that dependent parts of the lung receive maximal perfusion (12).

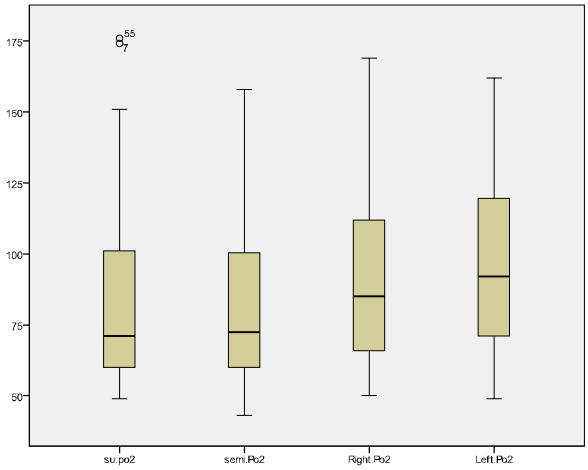

Figure 2: Comparison of PaO_2 in examining both the two conditions

Table2. Patient's characteristics data

Age (yr)	**54.48**
Sex (M: F) 40(66.7%)	20(33.3%)
Education(Elementary, high school , Academic)	39,16,5
Occupation (employee, jobless)	35,25
Marital status (bachelor, married)	3,57

Table3: Arterial oxygenation in different positions

	Supine	semi sitting	right lateral	left lateral
PaO_2	84.5±32.1	83.3±29.23	91.7±30.42	96.4±28.9
O_2Sat	92.9±5.38	92.9±5.24	94.6±3.93	95.7±3.32
P value	0.00	0.00	0.00	0.00

In the lateral decubitus position , the dependent lung receive greater blood flow than the non-dependent lung (18).In awake spontaneously breathing patients, the dome of the lower diaphragm is pushed higher in to the chest allowing in to contract more efficiently .

Thus, there is no significant ventilation-perfusion are mismatch in this patients are better in the dependent lung.

However, in patients whit cardiomegaly ,the enlarged cardiac chamber may compress lung in the left lateral position in their chest radiographs was due to other cardiac chamber enlargement .a change posture from supine t left lateral brought about a significant improvement in patients whit severe mitral stenosis whit severe pulmonary arterial hypertension .This possibly due to the posteriori located enlarged left atrium compressing the lung parenchyma, brunch or pulmonary vasculature in the supine position(14).

Study in spontaneously breathing patients whit unilateral lung disease have shown that arterial oxygenation improves whit healthy lung in the dependent position (19, 21).

In patients whit bilateral lung disease arterial oxygenation is best in the right lateral decubitus position. This may be due to the higher anatomic volume of right lung and the minimal compression of lungs by heart in this posture (22).

The mechanism of improvement of oxygenation during positioning may be due to improvement in the ventilation: perfusion mismatch. Gravitational influence causes an increase in blood flow through the well-ventilated non-pathologic dependent lung, whereas there is a decrease in blood flow to the poorly ventilated pathologic lung. This improves the ventilation perfusion mismatch.

There is evidence that dependent lunge in the decubitus position is associated whit a reduction in functional residual capacity when PEEP was no used. PEEP used in the study played a major role in maintaining small airway patency in the dependent lung and preserved alveolar patency (23).

There is evidence to support lateral positioning in patients whit unilateral pulmonary disease, less is known about the effect of lateral positioning on oxygenation in patients whit bilateral pulmonary disease. At 10 to 30 minutes after a lateral position change, cardiac output and heart rate may not be same as in the supine position, but these changes in most mechanically ventilated patients are not clinically significant(8,23,24,25,26).

Early evidence demonstrated that cardiovascular changes can be highly individualized and may be most prominent in patients whit low cardiac output and in patients who are hypothermic and/or receiving vasoactive medications (25).

More recent evidence suggests that lateral positioning of critically ill patients who are hypoxemic or have low cardiac output does not endanger tissue oxygenation (27).

Peter j and co-workers (2006) in study that 33 subjects whit no, unilateral, or bilateral pulmonary infilterates on chest radiograph participated shown that, lateral positioning had no beneficial effect on gas exchange. However, in ventilated patients who were hemodynamic ally stable. It was well tolerated

and not associated whit significant serious adverse events (21).

Table 4: Comparison of mean differences between the two situations studied hard and fast criteria in PaO_2

Status	Mean differences PaO_2	Sd	P Value
Couple 1 semi supine, sitting	1.213	25.419	0.713
Couple 2 lying on his back and right lateral	-7.188	28.718	0.057
Couple's 3 lying to the back and left lateral	-11.895	24.250	0.000
Couple 4 semi -sitting, and lying to the right lateral	-8.401	14.575	0.000
Couple 5 semi-sitting and lying to the left lateral	-13.108	20.751	0.000
Couple 6 left and right lateral	-4.706	16.718	0.033

G.D.Puri (2005) in his study was showed the effect of different positions (supine, left and right lateral position), on arterial oxygenation in 42 valvular heart disease patients planned for cardiac surgery. In this study right lateral position improves arterial oxygenation in valvular heart disease patients' whit an enlarged left ventricle (10).

Hardi JA and co-workers (2002) in study tested 46 lung-healthy elderly. They concluded that the significant difference in PaO_2 in sitting and supine positions clearly that the position needs to be considered both when attempting to establish reference values and when evaluating gas exchange in elderly persons (12).

5. Conclusion

Lateral position improves arterial oxygenation in the coronary artery bypass patients, whereas left lateral position was the most effective position in this patients.

Acknowledgement

This study is part of M.SC thesis for Tayyebe Mahvar (B-90/0022). Special thanks to Arvand International Division and Ahvaz Jundishapur University of Medical Science for the financial support.

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References

1. Banasik JL, Emerson RJ. Effect of lateral positions on tissue oxygenation in the critically ill. Heart lung.2001; 30:269-276.
2. Benomof JL, Alferey DD. An aesthesia for thoracic surgery. In: miller RD, ed.Anaesthesia, 5th edn, Philadelphia. USA; Churchill Livingston, 2000:1665-1752.
3. Chan M,Jensen L. Positioning effects on oxygen and relative pulmonary shunt in patients receiving mechanical ventilation after CABG. Heart lung. 1992;21 (5):448-56.
4. Chris winkelman,Ling –chun ching. Manual turns in patients receiving mechanical ventilation .Critical care nurse-2010; vol 30.
5. Dean E.Effect of body position on pulmonary function.Pbs Tber 1985; 65:613-618.
6. Doering L,Dracup K. Comparisons of cardiac output in supine and lateral position-Nurse Res.1988;37:114-118.
7. Erik de laat. Early post operative 30˚positioning after coronary artery surgery: influence on cardiac out put.Journal of clinical nursing.2006; in press.
8. Elisabeth L,George ,Leslie A. Effect of Positioning on Oxygenation in Single-Lung Transplant Recipients. American Journal of Critical Care (AJCC) 2002;11:66-75.
9. FJ.Patient positioning and the accuracy of pulmonary artery pressure measurements. International Journal of Nursing Studies1999; 136(6):495-505.
10. G.D. Puri, A. Dutta, N.K. Chinnan. Arterial oxygenation changes in valvular heart disease patients' whit cardiomegaly in different recumbent positions. European journal of anaesthesiology-2005; 22:834-838.
11. Gillespie DJ,Rehoder K.Body position and ventilation perfusion relationships in unilateral pulmonary disease.1987;91:75-79.
12. Gizella I.Bardoczky. Two-Lung and One-Long ventilation in patients whit Cpulseonic Obstructive Pulmonary Disease: The Effect of Position and FiO_2. Eur J Cardiothorac Surg 2008;34(5):995-999.
13. Hardie JA, Morkve O,Ellingsen I. Effect of body position on arterial oxygen tension in the elderly-Respiration-2002;69(2):123-128.

14. Hee Lee J, Kim M.W. Changes of precufaneous oxygen saturation by body position in newborn infants.Matern child health 2004;8(2):281-288.
15. I. Wani, S. Sangee, Q.Khan. M. Wani, Z.shah, A. Banerjee&D.Balsaree: Study To Compare The Supine Position Along Whit Mobilization Over Half Lying Position Head Up 45 Degree In patients Following Open Heart Surgery .The Internal Journal of Thoracic and Cardiovascular Surgery. 2009; Volum 13 Number 1.
16. Karen L.Jonson, Tim meyenbury. Physiological rational and current evidence fof therapeutic positioning of critically ill patients. AACN advanced crirical care-2009; volum 20, number 3, PP 228-240.
17. Kopp R,Kuhlen R,Max M,Rossaint R. Evidencebased medicine in the therapy of the acute respiratory distress syndrome.Intensive Care Med 2002;28:244-55.
18. Nelson LD,Anderson HP.Physiologic effects of steep positioning in the surgical intensive care unit.Arch Surg.1989;124:352-355.
19. Neagley SR,Zwillich CW.The effect of positional changes on oxygenation in patients whit pleural effusion .Chest 1985;88:714-717.
20. Palermo P.Lateral decubitus position general discomfort and worses lung function in chronic heart failure.Chest journal 2005.
21. Peter J. Thomas, B Phty (Hons). Lateral positioning of ventilated intensive care patients: A study of oxygenation ,respiratory mechanics, hemodynamics,and adverse events. Heart Lung-2007; 36:277-286.
22. PJ Thomas, JD Parats.Is there evidence to support the use of lateral positioning in intensive care? A systematic review.2007; Anaesthesia and intensive care .vol.35, Iss.2; pg.239, 17 pgs.
23. Remolina C,Edalman NH. Positional hypoxemia in unilateral lung diease,New englej med 1981;304:523-525.
24. RJ Emerson and JL Banasik. Effect of position on selected hemodynamic parameter in post operative cardiac surgery patients.Amj Crit Care-1994; 3:289-299.
25. Sikpe M, Ruegg D. Effect of acute body positional changes on the hemodynamics of rats whit and whihout myocardial infarction. The physiological society.2005;627-634.
26. Surat Tongyoo, Warakarn Vilaichone. The effect of lateral position on oxygenation in ARDS patients: A Pilote Study-J Med Assoc Thai-2006; 89(supple 5):S55-61.
27. Sonnenblick M,Melzer E,Rosin AJ. Body positional effect on gas exchange in unilateral pleural effusion .Chest 1983; 83:784-786.
28. Surat Tongyoo,Warakarn Vilaichone. The effect of lateral position on oxygenation in ARDS patients: A Piloted Study-J Med Assoc Thai-2006; 89(supple 5):S55-61.
29. Whitman GR, Howaniak DL. Comparison of cardiac output measurements in 20 degree supine and 20 degree right and left lateral recumbent position –Heart lung .1982; 11:256.
30. Zach MB,Pontoppidan H,Kazemi H. The effect of lateral position on gas exchange in pulmonary disease:a prospective Evaluation. Am Rev Respire Dis 1974;110:49-55.

6/12/2012