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EFFECTS OF POSITIVE AIRWAY PRESSURE VENTILATION DURING CARDIOPULMONARY BYPASS ON POST-OPERATIVE PULMONARY OXYGENATION

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Contribution

SAH, AF, AF and MARB conceived the idea, designed and conducted the study and analyzed the data. SAS helped in acquisition of data and did statical analysis. MWT did critical review. All authors contributed significantly to the submitted manuscript.

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ABSTRACT

Objective: To evaluate the impact of continuous positive airway pressure during cardiac surgery on post-operative pulmonary dysfunction after coronary artery bypass grafting.

Methodology: This randomized control trial was conducted in Chaudhry Pervaiz Ellahi Institute of Cardiology, Multan from January 2016 to July 2016. All patients meeting the inclusion criteria who were planned to undergo CABG surgery using cardiopulmonary bypass were selected. Patients were randomly allocated into two groups. Group I: (CPAP group): in this group continuous positive airway pressure was continued after application of aortic cross clamp during surgery. Group II (Study group): in this group ventilation was kept stopped during the whole surgical procedure. $P < 0.05$ was considered significant.

Results: Total of 150 patients were divided in two equal groups of 125 patients each. No significant difference between age and gender of patients in CPAP and control group was observered. Mean bypass time and cross-clamp time was also same in two groups. PaO2/FiO2 Ratio after one hour and four hour of surgery was significantly high in CPAP group as compared to Non-ventilation group with $p=0.001$ and 0.03 respectively. Alveolar-arterial oxygen gradient after one hour of extubation was $21.47+1.03$ kPa in CPAP group versus $27.73+2.19$ kPa in non-ventilation group with $p=0.001$. Similarly alveolar-arterial oxygen gradient after four hours of surgery was also significantly less in CPAP group $19.18+2.04$ kPa versus $20.80+2.57$ kPa in non-ventilation group with $p=0.001$. Mechanical ventilation time after surgery was also significantly less in CPAP group $5.12+1.89$ hours in CPAP group versus $6.36+2.57$ hours in non-ventilation group ($p = 0.001$).

Conclusion: Application of continuous positive airway pressure (CPAP) at 10 cm of H_2O during cardiopulmonary bypass had a significant positive impact on post-operative pulmonary oxygenation.

Keywords: Cotinuous positive airway pressure, alveolar-arterial oxygen gradient, PaO2/FiO2

INTRODUCTION

Post-operative respiratory dysfunction (PPD) is one of the most important complications of cardiopulmonary bypass and is of main concern for both the anesthesiologist and the cardiac surgeon. PPD varies from minor respiratory distress to the development of acute respiratory distress syndrome (ARDS).[1] Pathophysiology of postoperative pulmonary dysfunction is still not clear. However there are several surgery related factors that can be responsible for the development of PPD e.g. induction of general anesthesia, median sternotomy for surgery, use of cardiopulmonary bypass, dissection of internal mammary artery, use of hypothermia during surgery and discontinuation of lung oxygenation after application of aortic cross clamp.[2]

Common manifestation of PPD include pleural effusion with incidence rate ranging from 27 to 95 percent, atelectasis (incidence rate 16 to 88 percent), hypoxemia and ARDS.[3,4] Although ARDS is a rare complication and occurs in 0.5 to 1.7% patients but it is associated with very high mortality rate of more than 50%.[5,6] Numerous techniques have been used to prevent the incidence of post-operative pulmonary dysfunction, of these ventilatory strategies e.g. low tidal volume ventilation and continuous positive airway pressure have gained a particular importance.[7]

This study was conducted to evaluate the impact of continuous positive airway pressure during cardiac surgery on post-operative pulmonary dysfunction after coronary artery bypass grafting.

METHODOLOGY

This randomized control trial was conducted in Chaudhry. Pervaiz Ellahi Institute of Cardiology, Multan. This trail was conducted from January 2016 to July 2016. All patients meeting the inclusion criteria who were planned to undergo CABG surgery using cardiopulmonary bypass were selected. Patients were randomly allocated into two groups. Patients with valvular heart disease, pre-operative heart failure and pre-operative chronic obstructive pulmonary disease (COPD) were excluded. Written informed consent was taken from patients before selecting them for study. Patients were randomly allocated into two groups. Group I: (CPAP group): In this group continuous positive airway pressure was continued after application of aortic cross clamp during surgery. Group II (Study group): In this group ventilation was kept stopped during the whole surgical procedure

In all patients, arterial and venous line access was achieved before induction of anesthesia. Anesthesia induction was done with the aid of midazolam 0.14 mg. kg^{-1}, atracurium 0.5 mg. kg^{-1}, fentanyl 10 μg. kg^{-1} and ventilation with 100% O_2 for three minutes. After induction of anesthesia and shifting the patient to mechanical ventilation, central jugular venous access was achieved by using central vein catheter. In CPAP group, CPAP was continued at 10 cm of H_2O during cardiopulmonary bypass. In control group, ventilation was stopped and lungs were left opened at normal atmospheric pressure. Ventilation was started before discontinuation from cardiopulmonary bypass. Arterial blood gas analysis was carried out after intubation, after one hour of CPB and four hours of CPB. Patients were followed up till they discharged from the hospital.

Data compilation and analysis was done using SPSS v23. Percentages and frequancies were calculated for qualitative variables like gender and smooking history. Mean and strandrad deviaton was calculated for quantitative variables like age, pre operative ejection fraction, bypass time, cross clamp time, PaO_2/FiO_2 ratio at intubation, 1 hour and 4 hours, A-a O_2 gradient after intubation, 1hour and 4hours. Ventilaton tme, ICU stay and Hospital stay. Unpaired t-test was used to compare parametric variables. Chi-square test was used to compare non-parametric variables.

RESULTS

Total of 150 patients were divided in two equal groups of 125 patients each. Demographic and operative characteristics of patients are shown in Table 1. There was no significant difference between age and gender of patients in CPAP and control group. Mean bypass time and cross-clamp time was also same in two groups.

PaO2/FiO2 Ratio after intubation was not significantly different between the groups. PaO2/FiO2 Ratio after one hour and four hour of surgery was significantly high in CPAP group as compared to Non-ventilation group with $p=0.001$ and 0.03 respectively. Alveolar-arterial oxygen gradient after intubation was same between the groups. Alveolar-arterial oxygen gradient after one hour of extubation was 21.47+1.03 kPa in CPAP group versus 27.73+2.19 kPa in non-ventilation group with $p < 0.001$. Similarly alveolar-arterial O2 gradient after four hours of surgery was also significantly less in CPAP group 19.18+2.04 kPa versus 20.80+2.57 kPa in non-ventilation group with $p=0.001$. Mechanical ventilation time after surgery was also significantly less in CPAP group 5.12+1.89 hours in CPAP group versus 6.36+2.57 hours in non-ventilation group with $p=0.001$. We did not found any significant difference in ICU stay and Hospital stay of patients in CPAP and non-ventilation group with $p=0.89$ and 0.15 respectively (Table 2).

DISCUSSION

In this study we evaluated the effect of CPAP at 10 cm H_2O during cardiopulmonary bypass on post-operative oxygenation. There was significant effect of CPAP on post-bypass oxygenation parameters. Loeckinger et al.

Table 1: Comparison of Demographic and Operative Variables in Study Population (n=150)

Variables	CPAP Group	Control Group	P-value
Number of patients	75	75	
Age (Y)	58.24 ± 8.03	56.38 ± 7.69	0.15
Male Gender (%)	70 (93.3)	68 (90.7)	0.54
Smoking History (%)	24 (32.0)	32 (42.7)	0.17
Pre-op EF	50.66 ± 9.63	50.40 ± 10.09	0.86
Bypass Time (min)	110.16 ± 23.12	113.11 ± 30.59	0.50
X-clamp Time (min)	63.62 ± 15.75	63.21 ± 18.07	0.88

EF= Ejection Fraction, X-clamp= cross clamp

Table 2: Comparison of Clinical Parameters of Study Population (n=150)

Variables	Ventilation Group	Non-Ventilation Group	P-value
PaO_2/FiO_2 Ratio after intubation	333.84±12.62	337.09±18.33	0.21
PaO_2/FiO_2 Ratio after 1 hour of surgery	321.70±13.22	295.60±9.90	<0.001
PaO_2/FiO_2 Ratio after 4 hours of surgery	295.93±19.07	289.08±19.09	0.03
A-a O_2 gradient after intubation (kPa)	17.86±0.95	17.83±0.92	0.86
A-a O_2 gradient after 1 hour of CPB (kPa)	21.47±1.03	27.73±2.19	<0.001
A-a O_2 gradient after 4 hour of CPB (kPa)	19.18± 2.04	20.80±1.86	<0.001
Ventilation time (hours)	5.12±1.89	6.36±2.57	0.001
IUC Stay (hours)	31.91+10.26	34.58+12.34	0.89
Hospital Stay (days)	7.34+3.65	7.41+3.65	0.15

CPB= Cardiopulmonary bypass, ICU= Intensive care unit

concluded that CPAP at 10 cm H_2O during CPB improves post-bypass oxygenation. [8] In their study arterial PaO_2 was significantly higher and alveolar-arterial O_2 gradient was smaller in CPAP groups as compared to the control group. Our study supported the results of this study. Alavi et al and colleagues also concluded that post-operative O_2 saturation and partial pressure of PaO_2 is high in patients treated with continuous positive airway pressure at 10 cm H_2O as

compared to the patients without ventilation during CPB.[9]

However Figueiredo et al did not found any significant effect of CPAP on post-bypass oxygenation. They concluded that CPAP during CPB did not have any significant effect on post-operative pulmonary gas exchange.[10] Berry et al. and Altmay et al. also did not found any significant beneficial effect of using CPAP during cardiopulmonary bypass on post-bypass pulmonary oxygenation.[11,12] The reason for this difference is not known. A meta-analysis concluded have concluded that CPAP during cardiopulmonary bypass have significant effects on post-operative oxygenation parameters after surgery.[13] It has also been postulated that application of continuous positive airway pressure (CPAP) during cardiopulmonary bypass aids in cardiac de-airing after surgery.[14,15]

In present study, PaO2/FiO2 Ratio after 1 hour of surgery was 321.70+13.22 in CPAP group versus 295.60+9.90 in non-ventilation group. This difference was statistically highly significant with $p = 0.001$. PaO2/FiO2 Ratio after 4 hours of surgery was also higher in CPAP group 295.93+19.07 versus 289.08+19.09 in non-ventilation group with p-value 0.03. Similarly we also found smaller alveolar-arterial (A-a) O2 gradient in patients in whom CPAP was used during CPB. A-a O2 gradient after one hour of surgery was 21.47+1.03 kPa in CPAP group and 27.73+2.19 kPa in non-ventilation group ($p<0.001$). A-a O2 gradient after four hours of surgery was also significantly less in CPAP group 19.18+2.04 kPa versus 20.80+2.57 kPa in non-ventilation group ($p <0.001$). We also found short mechanical ventilation time in CPAP group.

CONCLUSION

Observations of our clinical trail concluded that application of continuous positive airway pressure (CPAP) at 10 cm H_2O during cardiopulmonary bypass has a significant positive impact on post-operative pulmonary oxygenation.

REFERENCES

1. Roger VL, Go AS, Lloyd-Jones DM, Adams RJ, Berry JD, Brown TM, et al. Heart disease and stroke statistics 2011 update a report from the American Heart Association. Circulation. 2011;123(4):18-209.
2. Taggart DP. Respiratory dysfunction after cardiac surgery: effects of avoiding cardiopulmonary bypass and the use of bilateral internal mammary arteries. European journal of cardio-thoracic surgery. 2000;18 (1):31-7.
3. Vargas FS, Uezumi KK, Janete FB, Terra-Filho M, Hueb W, Cukier A, et al. Acute pleuropulmonary complications detected by computed tomography following myocardial revascularization. Revista do Hospital das Clínicas. 2002;57(4):135-42.
4. Weiner P, Zeidan F, Zamir D, Pelled B, Waizman J, Beckerman M, et al. Prophylactic inspiratory muscle training in patients undergoing coronary artery bypass graft. World journal of surgery. 1998;22(5):427-31.
5. Milot J, Perron J, Lacasse Y, Létourneau L, Cartier PC, Maltais F. Incidence and predictors of ARDS after cardiac surgery. CHEST Journal. 2001;119(3):884-8.
6. Christenson J, Aeberhard J-M, Badel P, Pepcak F, Maurice J, Simonet F, et al. Adult respiratory distress syndrome after cardiac surgery. Vascular. 1996;4(1):15-21.
7. Al Jaaly E, Zakkar M, Fiorentino F, Angelini GD. Pulmonary Protection Strategies in Cardiac Surgery: Are We Making Any Progress? Oxidative medicine and cellular longevity. 2015;2015.
8. Loeckinger A, Kleinsasser A, Lindner KH, Margreiter J, Keller C, Hoermann C. Continuous positive airway pressure at 10 cm H2O during cardiopulmonary bypass improves postoperative gas exchange. Anesthesia & Analgesia. 2000;91(3):522-7.
9. Alavi M, Pakrooh B, Mirmesdagh Y, Bakhshandeh H, Babaee T, Hosseini S, et al. The effects of positive airway pressure ventilation during cardiopulmonary bypass on pulmonary function following open heart surgery. Research in Cardiovascular Medicine. 2013;2(2):79.
10. Figueiredo LCd, Araújo S, Abdala RCS, Abdala A, Guedes CAV. CPAP at 10 cm H2O during cardiopulmonary bypass does not improve postoperative gas exchange. Revista Brasileira de Cirurgia Cardiovascular. 2008;23(2):209-15.
11. Berry C, Butler P, Myles P. Lung management during cardiopulmonary bypass: is continuous positive airways pressure beneficial? British journal of anaesthesia. 1993;71(6):864-8.
12. Altmay E, Karaca P, Yurtseven N, Özkul V, Aksoy T, Özler A, et al. Continuous positive airway pressure does not improve lung function after cardiac surgery. Canadian Journal of Anesthesia. 2006;53(9):919-25.
13. Schreiber J-U, Lancé MD, de Korte M, Artmann T, Aleksic I, Kranke P. The effect of different lung-protective strategies in patients during cardiopulmonary bypass: a meta-analysis and semiquantitative review of randomized trials. Journal of cardiothoracic and vascular anesthesia. 2012;26(3):448-54.
14. Mansour M, Massodnia N, Mirdehghan A, Bigdelian H, Massoumi G, Alavi ZR. Evaluation of effect of continuous positive airway pressure during cardiopulmonary bypass on cardiac de-airing after

open heart surgery in randomized clinical trial. Advanced biomedical research. 2014;3.

15. Al-Rashidi F, Blomquist S, Höglund P, Meurling C, Roijer A, Koul B. A new de-airing technique that reduces systemic microemboli during open surgery: a prospective controlled study. The Journal of thoracic and cardiovascular surgery. 2009;138(1):157-62.