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Does 'Micro Ventilation' during Cardio Pulmonary Bypass Help in Improving Oxygenation in the Immediate Postoperative Period after Cardiac Surgery?

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Abstract

Aims: Lung complications after cardiopulmonary bypass are well described. Various methods have been adopted by surgeons for lung protection. Lung preservation during cardiopulmonary bypass is controversial. In this study we investigated whether ventilation during cardiopulmonary bypass with low tidal volumes helps in improving oxygenation post operatively. *Methods and Material:* Two groups of patients were studied here, one group was not ventilated during cardiopulmonary bypass (group A) and the other group was ventilated (group B). A total of 50 patients were studied, out of which 25 were not ventilated (Group A) and 25 were ventilated during cardiopulmonary bypass (Group B). The partial pressure of oxygen in arterial blood, arterial oxygen saturation and hours of ventilation were compared in the two groups at various intervals. *Statistical Analysis Used:* The Statistical software SPSS 15.0 was used for the analysis of the data and Microsoft Word ™ and Excel ™ have been used to generate graphs and tables. *Results:* There was no increase in pO2 or saturations in the ventilated group either at time of extubation [P=0.985] or 24 hours after surgery [P=0.944]. There was no significant difference in the total hours of ventilation between the two groups [P=0.678]. *Conclusions:* There was no significant difference in the measured parameters between the two groups. There is no improvement in lung function by ventilating with low volume tidal ventilation during cardiopulmonary bypass.

Keywords: Cardiopulmonary Bypass; Ventilation; Outcomes.

Introduction

Pulmonary complications are one of the most common and significant causes of morbidity following cardiac surgery. It is more common in patients with preexisting lung disease or with cardiopulmonary bypass time more than three hours [1]. Atelectasis is one of the common complications after cardiac surgery. During cardiopulmonary bypass lungs are not perfused and are usually collapsed. Atelectasis results in reduced lung compliance and functional residual capacity. Tidal volume and minute ventilation will be reduced and work of breathing will be increased. Atelectasis can be prevented by maintaining a positive end expiratory pressure of 10 cm of H_2O or above [2]. Complement activation and neutrophil sequestration are also considered to be important reasons for pulmonary dysfunction after cardiopulmonary bypass. So lung preservation during cardiopulmonary bypass is important for avoiding respiratory complications in the immediate postoperative period. Mechanical ventilation prevents pulmonary endothelial dysfunction due to reperfusion after cardiopulmonary bypass [3].

Cardiopulmonary bypass leads to pulmonary and systemic inflammatory response. The pulmonary effects of this inflammatory response lead to decreased lung compliance, pulmonary edema, increased intrapulmonary shunt fraction and decreased functional residual capacity. After cardiopulmonary bypass, functional residual capacity is reduced up to 40–50% during the first 24 hours after extubation. After general anesthesia, functional residual capacity is decreased by only 20–30% [4].

Materials and Methods

Fifty contiguous patients who underwent various types of cardiac surgery under cardiopulmonary bypass were recruited for the study. Patients were randomized into two groups - A and B. Group A was not ventilated and group B was ventilated on cardio pulmonary bypass. The difference in partial pressure of oxygen in the arterial blood (pO2) was studied and compared. Pre operative arterial oxygen saturation (SpO2) and post operative pO2 and oxygen saturation immediately after shifting to the postoperative ICU, at the time of extubation and twenty four hours after surgery were compared. Intra operatively the ventilated group were ventilated at a respiratory rate of five per minute with PEEP 10 cm of H2O and tidal volume of three ml per kilogram body weight. In the cardiopulmonary bypass circuit, the same type of tubings was used for all patients. Medtronic Affinity NT Oxygenator (Minneapolis, USA) was used in all the patients. Pall arterial line filter (Pall Corporation, New York, USA) was used for all patients. Leucocyte reduction filters were not used.

Exclusion Criteria

Patients having right to left shunts and atrial septal defect or ventricular septal defect with severe pulmonary hypertension were excluded from the study. Cases of coronary artery bypass grafting which are routinely done off pump in our institute were also excluded.

Results

The following parameters were analyzed- Hours of ventilation, pO2 on shifting the patients to ICU at 40% FiO2, pO2 immediately after extubation with oxygen 2L/minute through nasal prongs, pO2 24 hrs after surgery on room air.

Statistical Methods

Statistical software: The Statistical software SPSS 15.0 was used for the analysis of the data and Microsoft Word ™ and Excel ™ have been used to generate graphs and tables.

Descriptive statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean ± SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5% level of significance. The following assumptions on data is made,

Assumptions: 1. Dependent variables should be normally distributed, 2. Samples drawn from the population should be random, Cases of the samples should be independent Mann Whitney U test has been used to find the significance between two groups for parameters on non-interval scale Significant figures

+ Suggestive significance (P value: 0.05<P<0.10)

* Moderately significant (P value:0.01<P £ 0.05)

** Strongly significant (P value : P£0.01)

There was no significant difference with respect to age, weight or hours of ventilation between the two groups (Table 1,2)

The ventilated group did not show any improvement in oxygen saturation at any time during the first 24 hours (Table 4).

There was no improvement in pO2 in the ventilated group (Table 5).

Table 1: Comparison of Age, weight and pre operative SPO2

Baseline Variables	Micro-Ventilation		P value
	on	off	
Age in years	24.08±13.86	27.52±17.25	0.441
Weight (KG)	41.22±15.19	39.95±17.02	0.630
Pre-SPO2%	99.08±0.95	98.96±0.78	0.306

Table 2: Hours of ventilation

	Micro-Ventilation		P value
	On	Off	
Hours of ventilation	7.81±3.60	8.28±4.29	0.678

Table 3: Procedures

Procedures	Number of patients (n=50)	%
MV repair	24	48.0
ASD closure	18	36.0
MVR	3	6.0
AVR,MV Repair	2	4.0
RA Myxoma	1	2.0
VSD closure	2	4.0
AV repair	1	2.0

Table 4: Comparison of SpO2 among ventilated and non-ventilated patients

SPO2%	Micro-Ventilation		P value
	On	Off	
SpO2 in room air - pre op	99.08±0.95	98.96±0.79	0.630
SPO2 AT 40% on Shifting	99.07±1.25	99.23±0.59	0.548
SPO2 ON Extubation with Nasal Prongs 2L O2	98.69±1.06	98.88±0.92	0.514
SPO2 ON POD 1(24 HRS) ON Room Air	96.62±1.69	96.72±1.14	0.801

SpO2 = Oxygen saturation of arterial blood

Table 5: Comparison of pO2 among ventilated and non ventilated patients

PO2	Micro-Ventilation		P value
	On	Off	
PO2 @ 40% on Shifting	152.63±38.06	161.97±39.37	0.398
PO2 on Extubation with Nasal Prongs 2L O2	132.22±39.09	132.02±31.75	0.985
PO2 ON Room Air (24 HRS) ON POD 1	83.42±11.91	83.17±13.25	0.944

pO2 = partial pressure of Oxygen in arterial blood

Discussion

Cardiopulmonary bypass is associated with neutrophil activation, pulmonary sequestration, and release of inflammatory mediators leading to pulmonary dysfunction.

Activated neutrophils can damage lung tissues by release of proteolytic enzymes [5,7]. Leukocyte depletion during cardiopulmonary bypass may improve oxygenation in the early postoperative period. The duration of postoperative ventilation may be significantly shorter in the leucocyte depleted patients [6].

In this study the lung function among patients in both groups were assessed by comparing the oxygen saturation pre operatively and pO2 and oxygen saturation post operatively. pO2 and oxygen saturation were considered as important parameters and were assessed, as oxygen diffusion across the alveolo-capillary membrane is the final important step which lead to the reduction in tissue pO2 and associated morbidity.

It was considered that ventilating the lung during cardiopulmonary bypass will reduce pulmonary sequestration of neutrophils and compliment activation. Recent studies failed to demonstrate any difference in leukocyte sequestration or compliment activation by ventilating the lungs during cardio pulmonary bypass [7]. Endothelial dysfunction of the pulmonary arterial tree occurring after cardiopulmonary bypass contributes to pulmonary hypertension and respiratory failure in the postoperative period.

It is seen that mechanical ventilation prevents pulmonary endothelial dysfunction due to reperfusion after cardiopulmonary bypass and thereby increasing pO2 [3].

In this study there was no significant difference in pO2 and SpO2 in the ventilated and non-ventilated group. So it is concluded that low volume tidal ventilation during cardiopulmonary bypass does not improve pulmonary function during post operative period following cardiac surgery.

Conclusion

There was no significant difference in the measured parameters between the two groups. There is no improvement in lung function by ventilating with low volume tidal ventilation during cardiopulmonary bypass.

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Conflict of Interest: None

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