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COMPARISON OF TWO VENTILATION MODES IN PATIENT UNDERGOING CORONARY ARTERY BYPASS GRAFT SURGERY

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Abstract:
Introduction:
Pulmonary dysfunction is a frequent postoperative complication in patients undergoing coronary artery bypass graft (CABG) surgery and atelectasis is thought to be one of the main causes. Development of atelectasis is associated with decreased lung compliance and impairment of oxygenation. Post-CPB-induced lung atelectasis accounts for most of the marked post-CPB increase in intrapulmonary shunt and hypoxemia. Mechanical ventilation can be harmful to these atelactic lungs, especially when high tidal volumes and pressures that cause lung over distension are used. Pressure-controlled ventilation (PCV) needs frequent titration of the inspiratory pressure to deliver a set tidal volume, whereas pressure-regulated volume-controlled (PRVC) ventilation mode provide the target tidal volume with the lowest possible airway pressure.
Material & Methods:
Prospective observational study was conducted involving 60 patients operated in cardiovascular and thoracic surgery operation theater, Nair Hospital Mumbai central. study was conducted over a period of one year from February 2017 to January 2018.
Result:
In terms of demographic data both modes were comparable. After comparing both the modes it was observed that PaO2/FiO2 ratio was better in PCV group half hour after induction and after CPB the end of surgery while no significant difference between two modes on postoperative ray changes and length of ICU stay.
Conclusion:
PCV mode offers better oxygenation in terms of PaO2/FiO2 at the end of the surgery after CPB.
Key Words: PCV, CVC, CABG

Introduction:

Pulmonary dysfunction is a frequent postoperative complication in patients undergoing coronary artery bypass graft (CABG) surgery and atelectasis is thought to be one of the main causes.[1,2] Development of atelectasis is associated with decreased lung compliance and impairment of oxygenation.[3]Post-CPB-induced lung atelectasis accounts for most of the marked post-CPB increase in intrapulmonary shunt and hypoxemia.[4,5] Mechanical ventilation can be harmful to these

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atelactic lungs, especially when high tidal volumes and pressures that cause lung over distension are used.[6,7] Pressure-controlled ventilation (PCV) needs frequent titration of the inspiratory pressure to deliver a set tidal volume, whereas pressure-regulated volume-controlled (PRVC) ventilation mode provide the target tidal volume with the lowest possible airway pressure.

Cardiopulmonary bypass associated with production of reactive oxygen species and oxidative stress. As CPB is negative catabolic state and associated with anaerobic metabolism also hemolysis, ischemia, and perfusion injury and neutrophils activation during CPB play a pivotal role in oxidative stress and the associated activation of pro inflammatory and pro apoptotic signaling pathways which can affect the function and recovery of multiple organs such as the myocardium, lungs, and kidneys and influence clinical outcomes. The improvement of oxygenation index intra operatively with adequate strategies of mechanical ventilation may reduce ROS burst and oxidative stress during CPB. So determination of mode of ventilation with better oxygenation index may be beneficial for patients undergoing CABG surgeries for better recovery.[8,9]

Appropriate techniques of mechanical ventilation decreases the incidence of pulmonary complications.[10-12] It was observed that Pressure Control Ventilation (PCV) mode has better lung function recovery than Volume control ventilation (VCV) mode in the intraoperative period or while undergoing CABG surgery on pump or Cardiopulmonary bypass (CPB).[10] If PCV used as mechanical ventilation mode during anesthesia it has certain advantages like in some circumstances, in which variable flow rates are preferred or when pressure and volume limitations are required. With this background present study was planned to compare effect of intra operative volume controlled ventilation mode and pressure controlled ventilation mode in patients undergoing CABG surgery.

Objective:

1. To compare effects of PCV and VCV on gas exchange

Material & Methods:

Prospective observational study was conducted involving 60 patients operated in cardiovascular and thoracic surgery operation theater, Nair Hospital Mumbai central. study was conducted over a period of one year from February 2017 to January 2018. The study was initiated after obtaining permission from the institutional ethics committee. It was done after obtaining informed consent from patient.

INCLUSION CRITERIA:

1. Patients having proven coronary artery disease. CABG surgery was not done in patients without proven coronary artery disease.
2. Patients posted for elective CABG surgery.
3. Sex: male and female.
4. Age: 35 to 65 years.

EXCLUSION CRITERIA

1. Patients with h/o COPD.
2. Patients with known pulmonary HTN.
3. Patients with EF<40% on 2D echo.
4. Patients with past or present CCF/RENAL FAILURE.
5. Patients with BMI >35.
6. Patients with significant h/o smoking addiction.

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SAMPLING METHOD : Study population was selected and divided by SNOSE METHOD (sequentially numbered opaque sealed envelope) method.

STUDY GROUP:

GROUP A- have pressure control ventilation mode during CABG SURGERY.

GROUP B- have volume control ventilation mode during CABG SURGERY

SAMPLE SIZE CALCULATION:

With α of 0.05, β of 0.20 (power of 80%), using reference value of 53.8 ± 6.4 (n= 17) of Oxygenation Index (mmHg) in PCV group, and 65.8 ± 7.4 (n= 17) for VCV group[13] using below mentioned formula, the sample size calculated was 6 per group. However, since sample size of 6 is not sufficient for most statistical analysis, and since resources like patients, investigative tools, time for research exist in sufficient quantity, it is planned to enroll minimum of 30 cases for each arm (total 60 cases) for the present study.

$$N=\frac{(Z_{\alpha/2}+Z_p)^2\ \alpha^2}{(\mu-\mu_0)^2}$$

Qualitative data was represented in form of frequency and percentage. Association between qualitative variables were assessed by Chi-Square test, with Continuity Correction for all 2 X 2 tables and by Fisher's Exact test for all 2 X 2 tables where Chi-Square test was not valid due to small counts. In presence of small counts in tables with more than two rows and/or columns, adjacent row &/or Column data will be pooled & Chi-Square Test reapplied. Continuity Correction were applied for all 2 X 2 tables after pooling of data. Fisher's Exact test was applied for all 2 X 2 tables where p-value of Chi-Square test not valid due to small counts, in-spite of pooling of data. Quantitative data was represented using Mean ± SD and Median & IQR (Interquartile range).

DETAILS OF STUDY PROCEDURE

-Procedure of study:

-After obtaining institutional ethics committee approval and consent from patients, we included 60 patients posted for CABG surgery and divided it into two groups.

-Division of patients done with SNOSE METHOD (sequentially numbered opaque sealed envelop) method.[14]

-Standard protocol was followed for all patients

-each patient was assessed a day prior to surgery in wards

-The procedure to be done was explained to the patient and written informed consent obtained for general anesthesia to be given.

-Blood investigations carried out at per requirement of surgery.

-Study protocol was given to the respective operation theatre in charge of anesthesia. He/she divided the group to which the patient belongs according to SNOSE Method.

- On arrival to the operating room standard monitors i.e. Non invasive Blood pressure monitor, -
- Electrocardiogram and Pulse oximeter were attached.
- Baseline blood pressure and heart rate readings obtained first.
- Pre induction ABG was taken and labelled as (To)

All the monitors attached including ECG , SPO2, NIBP.

And were given O2 by polymask @4L/min.

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Result:

Table No.1: Age wise distribution of Patients

Age group	Percentage	Percentage
Less than 60	37	61.7
60 & above	23	38.3
Total	60	100

Total 60 cases were studied out of which 37 were below 60 years of age comprising 61.7 % of study subjects, and 23 patients were 60 years or above comprising 38.3% of study subjects.

Table No.2: Gender & ventilation wise distribution of Patients

Gender	Ventilation		Total
	PCV	VCV	
Female	8 (26.7)	9 (30)	17 (28.3)
Male	22 (73.3)	21 (70)	43 (71.7)
Total	30 (100)	30 (100)	60 (100)

Out of 60 study participants 17 (28.3%) were females out of which 8(26.7%) put on PCV mode and 9(30%) put on VCV mode. Out of 43 (71.7%) males 22(73.3%) put on PCV mode and 21(70%) put on VCV mode. In total 30 patients put on PCV mode and 30 patients were on VCV mode.

Table No.3: BMI & Ventilation mode wise distribution

BMI	Ventilation Mode		Total
	PCV	VCV	
Normal	9	9	18
Overweight	21	19	40
Obese	0	2	2
Total	30	30	60

Out of 60 subjects 30 were on PCV mode out of which 9(30%) have normal BMI, 21 (70%) were overweight. And out of 30 patients on VCV 9(30%) have normal BMI, 19(63.3) were overweight , and 2(6.7%) were obese.

Table No.4: Comparison of pao2 within & between the group PCV & VCV

Sr No.	T1	T2	T3	P value #
PCV	251.75(44.47)	248.38(38.98)	268.26(41.81)	<0.001
VCV	213.69(45.17)	245.41(42.41)	233.46(48.27)	<0.001
P Value@	0.002	0.778	0.004	

p-value@ - for the Independent t test between PCV & VCV group.

p-value# - for comparison within the group.

Patient who had been kept on PCV mode shows PaO2 value mean (SD) at T1,T2,T3 as 251.75(44.47),248.38(38.98),268.26(41.81) respectively with p value <0.001 which is less than 0.05 hence statistically significant. Also patients who kept on VCV mode shows PaO2 value mean (SD) at T1,T2,T3 as 213.69(45.17),245.41(42.41),233.46(48.27) respectively with p value <0.001

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which is less than 0.05 hence statistically significant. Hence at time T1 when PCV and VCV groups compared p value is 0.002 which is less than 0.05 which is statistically significant. At T2 when PCV and VCV groups compared p value is 0.778 which is more than 0.05 which is statistically insignificant. At time T3 when PCV and VCV groups compared p value is 0.004 which is less than 0.05 which is statistically significant.

Table No.5: Comparison of Fio2 Within & Between The Group PCV & VCV

Sr No.	T1	T2	T3	P value #
PCV	0.63(0.007)	0.63(0.006)	0.63(0.008)	<0.001
VCV	0.64(0.017)	0.63(0.011)	0.63(0.001)	<0.001
P Value@	0.032	0.327	0.035	

p-value@ - for the Independent t test between PCV and VCV group.
p-value# - for comparison within the group.

Patient who had been kept on PCV mode shows FiO2 value mean (SD) at T1,T2,T3 as 0.63(0.007),0.63(0.006),0.63(0.008) respectively with p value <0.001 which is less than 0.05 hence statistically significant. Also patients who kept on VCV mode shows FiO2 value mean (SD) at T1, T2, T3 as 0.64(0.017), 0.63(0.011), 0.63(0.001) respectively with p value <0.001 which is less than 0.05 hence statistically significant. Hence at time T1 when PCV and VCV groups compared p value is 0.032 which is less than 0.05 which is statistically significant. At T2 when PCV and VCV groups compared p value is 0.327 which is more than 0.05 which is statistically insignificant. At time T3 when PCV and VCV groups compared p value is 0.035 which is less than 0.05 which is statistically significant.

Table No.6: Comparison Of Pao2/Fio2 Within & Between the Group PCV & VCV

Sr No.	T1	T2	T3	P value #
PCV	398.42 (70.84)	393.45 (61.80)	423.41 (64.77)	<0.001
VCV	334.84 (74.02)	387.35 (67.25)	370.58 (76.62)	<0.001
P Value@	0.001	0.716	0.006	

p-value@ - for the Independent t test between PCV and VCV group.
p-value# - for comparison within the group.

Patient who had been kept on PCV mode shows PaO2/FiO2 value mean (SD) at T1,T2,T3 as 398.42(70.48),393.45(61.80),423.41(64.77) respectively with p value <0.001 which is less than 0.05 hence statistically significant. Also patients who kept on VCV mode shows PaO2/FiO2 value mean (SD) at T1, T2, T3 as 334.84(74.02), 387.35(67.25), 370.58(76.62) respectively with p value <0.001 which is less than 0.05 hence statistically significant. Hence at time T1 when PCV and VCV groups compared p value is 0.001 which is less than 0.05 which is statistically significant.
At T2 when PCV and VCV groups compared p value is 0.716 which is more than 0.05 which is statistically insignificant. At time T3 when PCV and VCV groups compared p value is 0.006 which

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is less than 0.05 which is statistically significant. Hence at time T2 only PaO2/FiO2 ratio value has no relation with mode of ventilation.

Table No.7 Association Between Post Operative X-Ray Finding & Mode Of Ventilation

Post OP X ray findings	Ventilation mode		Total
	PCV	VCV	
Normal	28 (93.3%)	23 (76.7%)	51 (85%)
Atelectasis	2 (6.7%)	7 (23.3%)	9 (15%)
Total	30 (100.0%)	30 (100.0%)	60 (100.0%)

(X2 = 3.268, p-value = 0.073)

Postoperative chest x ray findings and occurrence of atelectasis post operatively has no relation with mode of ventilation.

Table No.8: Association Between Mode of Ventilation & ICU Stay of Patients

ICU stay	Ventilation mode		Total
	PCV	VCV	
<4 days	12 (40%)	9 (30%)	21 (35%)
≥4 days	18 (60%)	21 (70%)	39 (65%)
Total	30 (100.0%)	30 (100.0%)	60 (100.0%)

(X2 = 0.659, p-value = 0.294)

Intraoperative mode of ventilation and ICU stay was not significantly associated.

Discussion:

Study was planned to observe the effects of PCV and VCV mode on gas exchange intra operatively in patients undergoing CABG surgery. PaO2/FiO2 ratio was calculated from arterial blood gas analysis at different time period in which baseline T0, half hour after induction T1, 15 min post CPB after initiation of ventilation T2, and at end of surgery just before the shifting T3 were calculated. We observed any significant postoperative chest x ray findings within the duration of ICU stay and length of stay (LOS) in ICU. The feedback from surgeons was taken regarding encroachment of lungs in surgical field while harvesting LIMA (left internal mammary artery) in both modes of ventilation. PaO2 at T1,T2,T3 respectively was (251.75±44.47), (248.38±38.98), (268.26±41.81) in PCV mode and (213.69±45.17), (241.41±42.41), (233.46±48.27) respectively in VCV mode. These are within the range of moderate hyperoxia. As there are various deleterious effects of sever hyperoxia like vasoconstriction, parasympathetic activation, myocardial vaso constriction like effects, enhanced ischemia and reperfusion injury etc. Study done by Elmer J et al[15] moderate hyperoxia is not associated with decreased survival and organ dysfunctions as compared to severe hyperoxia which is associated with decreased survival and organ dysfunctions.[15] So in our study, PaO2 values were in the range of moderate hyperoxia (100-300) not in severe hyperoxia (>300) which would be beneficial to improve organ function.[15]

At T2, PaO2/FiO2 was (393.45±61.80) in PCV mode and (387.35±67.25) in VCV mode when independent t test applied between these two groups gives (p = 0.716) which was statistically insignificant. At T3, PaO2/FiO2 was (423.41±61.77) in PCV mode and (370.58±76.62) in VCV

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mode when independent t test applied between these two groups gives (p=0.006) which was statistically significant. This value was at the end of procedure just before the shifting to ICU. This is most crucial period to maintain better oxygenation and hemodynamics. So it is desirable to maintain moderate hyperoxia which was achievable with PCV mode.

Tulay Hosten et al (2016) did similar study shown PaO2/FiO2 values at T1,T2,T3 in VCV mode as 324.68±47.85, 360.00±38.00, 275.13±51.13 respectively and in PCV mode as 309.75±60.88,350.00±30.00,326.00±21.00 shown better oxygenation with PCV at the end of surgery(T3) and where as values at T1 and T2 were similar in both modes. During and after cardiac surgery high concentration of oxygen routinely administered to prevent cellular hypoxia.[16] Due to increased microcirculatory heterogeneity in low and high flow capillaries oxygen delivery to tissue may be hampered.[17] Other factors are hypothermia, blood transfusion, fluid shift, anemia, myocardial dysfunction which hamper tissue oxygenation.[18] As PCV gives better oxygenation at the end of surgery which might be beneficial to prevent tissue hypoxia.

Conclusion:

We conclude that in patients undergoing CABG surgery while comparing PCV mode and VCV mode, both modes of ventilation can be used for CABG surgery with CPB which are standard of care while PCV mode offers better oxygenation in terms of PaO2/FiO2 at the end of the surgery after CPB.

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