DOI: https://doi.org/10.53350/pjmhs22161290

ORIGINAL ARTICLE

Effect of Intensive vs Moderate Alveolar Recruitment Strategies Added to Lung Protective Ventilation on Postoperative Pulmonary Complications

MEHWISH NASEER[1], RAFIA TABASSUM[2], AAMIR FURQAN[3]
[1]*Assistant Professor of Anesthesiology, CMH Lahore Medical and Dental College*
[2]*Associate Professor of Anaesthesia, Peoples University of Medical and Health Sciences, Nawabshah*
[3]*Assistant professor of Anaesthesia, Dept. of Anaesthesia and ICU, Chaudhry Pervaiz Ellahi Institute of Cardiology (CPEIC), Multan*
Correspondence to: Aamir Furqan, Email: draamir2009@hotmail.com, Cell: 0333 6203152

ABSTRACT

Aim: to establish the effects of intensive alveolar recruitment therapy in decreasing the post-operative pulmonary complications.
Methodology: A randomized multi centered study was performed with patients in ICU having hypoxemia after a cardiac surgery. Patients were allocated to two groups (intensive vs moderate recruitment strategy) with ventilation having small tidal volume. Severity of post-operative pulmonary complications was primary outcome. Secondary outcome was duration of stay in hospital and ICU, hospital mortality and the rate of barotrauma.
Results: The pulmonary complication severity score of the intensive and moderate group patients was 1.58±0.91 and 2.10±1.01 respectively. The mean ICU stay, hospital stay and mechanical ventilation in ICU mean of the intensive group patients was 4.06±2.12 days, 10.10±3.21 days and 11.26±2.80 respectively. While, the mean ICU stay, hospital stay and mechanical ventilation in ICU mean of the moderate group patients was 4.70±2.04 days, 14.09±2.99 days and 12.15±2.08 respectively.
Conclusion: Patients having hypoxemia after a cardiac surgery, intensive alveolar recruitment therapy proves to be more helpful in decreasing the severity and occurrence of post-operative pulmonary complications as compared to moderate alveolar recruitment therapy.
Keywords: Alveolar recruitment, tidal volume, pulmonary complications.

INTRODUCTION

Postoperative morbidity and mortality are greatly increased by postoperative pulmonary complications after a cardiac surgery[1]. After open chest surgery, Lung inflammation is often activated by extracorporeal circulation resulting in atelectasis. This condition proves to be harmful for the mechanical ventilation[2]. It may be associated with pneumonia, hypoxemia, ARDS, and lung injury. The results of these complications are the increased utilization of all available resources, prolonged need for mechanical ventilation or oxygen therapy[3].

For the protection of lung parenchyma, various studies have been performed claiming that there may be reduction in postoperative complications with the help of lung protective ventilation[4]. Various methods have been adopted for this so far that includes reducing tidal volume or low tidal volume with alveolar retaining procedures[5].

These studies reflect that control groups were given non-protective mechanical ventilation having no PEEP and increased levels of VT[6]. Hence it was unable to determine the specified role of alveolar recruitment procedures[7]. The past studies were not able to establish the advantage of more intense alveolar recruitment strategy during abdominal surgery[8]. Rather it caused more trouble. There are a few numbers of studies in favor of intensive alveolar recruitment strategies in patients already having low VT ventilation[9]. It also proved that inflammation was reduced and lung function was improved without causing any complications[10].

This study determines the specified role of intense alveolar recruitment therapy for the reduction of intensity of clinical complications regarding the lungs in patients having hypoxemia and low VT ventilation after cardiac surgery.

METHODOLOGY

A randomized multi centered study was a performed in intensive care units of Peoples University of Medical & Health Sciences, Nawabshah, Chaudhry Pervaiz Ellahi Institute of Cardiology (CPEIC), Multan and CMH Lahore. The duration of study was from April 2019 to April 2021. Ethical clearance and informed consent were taken.

The eligibility criteria were patient having elective cardiac surgery, having hypoxemia at the time of admission in ICU. Exclusion criteria comprised of patients <18-80 years old, having previous lungs or cardiac surgery, suffering from neuromuscular disorder, BMI lower than 20 or greater than 40, left ventricular ejection fraction lower than 35%, MAP of pulmonary vessels greater than 35mmHg, requiring any emergency surgery or mechanical ventilation, more than 2µg/kg/min norepinephrine, having arrhythmia or non-responsive hypotension at the time of admission, having pneumothorax or being a participant in another study.

Patients were randomly allocated to two group i.e. lung-protective ventilation with moderate alveolar recruitment strategy or lung-protective ventilation with intense alveolar recruitment strategy. Regarding the blinding, due to the difference in ventilator setting, the research team was not blinded in the initial hours. The extent of post-operative pulmonary complications was the primary upshot in the duration of hospital stay scored from 1-5. Where 0 represented no symptoms, 4 depicted reintubation within 48 hours and 5 showed death before discharge. The independent analysis of bed side radiographs was done by two pulmonary specialists who were blinded. The assessment of complication and severity of complication was done on daily basis until the discharge from hospital. The secondary outcome included duration of hospital stay, duration of stay in ICU, rate of barotrauma and hospital mortality. Data was analyzed by SPSS version 25.0.Chi square test was applied for comparison of categorical variables and P value of <0.05 was determined as statistically significant.

RESULTS

Total 390 patients were included in this study (195 in each group). The mean weight, gender distribution, BMI, PBW, creatinine, euro score and parsonnett score in both groups is shown in Table I.

The pulmonary complication severity score of the intensive and moderate group patients was 1.58±0.91 and 2.10±1.01 respectively. The difference was statistically significant at (p=0.000) (Table. II).The mean ICU stay, hospital stay and mechanical ventilation in both the groups is presented in table 2. (Table. II). Hospital death, barotrauma, need of supplemental O2>24 hours within first 5 days, extended use of NIV, pneumonia, hospital wound infection, blood loss >300 mL in first 6 hours after surgery, cardiovascular complications whole hospital stay, septic shock, atrial fibrillation and reoperation in both groups is shown in Table. II.

Table 1: Baseline characteristics of the patients

Variables	Intensive n=195	Moderate n=195	Test of Sig.
Gender			
Male	(66.2%) n=129	(73.3%) n=143	χ^2=2.38,p=0.123
Female	(33.8%) n=66	(26.7%) n=52	

LVEF	(60.5%) n=118	(58.5%) n=114	χ^2=0.17,p=0.680
Hypertension	(90.8%) n=177	(75.9%) n=148	χ^2=15.52,p=0.000
Dyslipidemia	(63.6%) n=124	(64.1%) n=125	χ^2=0.011,p=0.916
Diabetes mellitus	(49.7%) n=97	(53.8%) n=105	χ^2=0.65,p=0.418
Angina	(50.8%) n=99	(40%) n=78	χ^2=4.56,p=0.033
Previous AMI	(20%) n=39	(30.8%) n=60	χ^2=5.97,p=0.015
Smoking status	(23.1%) n=45	(26.2%) n=51	χ^2=0.49,p=0.481
Heart failure	(16.4%) n=32	(18.5%) n=36	χ^2=0.285,p=0.593
RV dysfunction	(7.7%) n=15	(8.2%) n=16	χ^2=0.035,p=0.852
Liver disease	(5.1%) n=10	(2.1%) n=4	χ^2=2.66,p=0.102
Weight (kg)	71.70±2.20	64.87±2.90	t=26.13,p=0.000
BMI (kg/m^2)	29.21±3.05	27.08±2.84	t=7.14,p=0.000
PBW (kg)	61.62±3.09	60.18±2.72	t=5.86,p=0.000
Creatinine (mg/dL)	1.27±0.73	1.32±0.41	t=-0.787,p=0.432
Euro score	2.91±1.06	2.96±1.23	t=-0.422,p=0.673
Parsonnet score	6.97±2.17	8.05±1.97	t=-5.09,p=0.000

Table 2: Outcome analysis of the patients

Variables	Intensive n=195	Moderate n=195	Test of Sig.
Primary outcome			
pulmonary complication severity score	1.58±0.91	2.10±1.01	t=-5.31,p=0.000
Dichotomized as grade			
≥2	(64.1%) n=125	(81%) n=158	χ^2=25.41,p=0.000
≥3	(17.4%) n=34	(15.9%) n=31	
≥4	(18.5%) n=36	(3.1%) n=6	
Secondary outcomes			
ICU stay (days)	4.06±2.12	4.70±2.04	t=-3.06,p=0.000
Hospital stay (days)	10.10±3.21	14.09±2.99	t=-12.67,p=0.000
Mechanical ventilation in ICU mean	11.26±2.80	12.15±2.08	t=-3.57,p=0.000
Hospital death	(1.5%) n=3	(5.6%) n=11	χ^2=4.74,p=0.029
Barotrauma	(1%) n=2	(1.5%) n=3	χ^2=0.203,p=0.653
Need of supplemental O2>24 hours within first 5 days	(60.5%) n=118	(76.4%) n=149	χ^2=11.41,p=0.000
Extended use of NIV	(5.6%) n=11	(14.9%) n=29	χ^2=9.05,p=0.003
Pneumonia	(12.3%) n=24	(15.4%) n=20	χ^2=0.77,p=0.376
Hospital wound infection	(10.8%) n=21	(9.7%) n=19	χ^2=0.111,p=0.739
Blood loss >300 mL in first 6 hours after surgery	(8.2%) n=16	(4.6%) n=9	χ^2=2.09,p=0.148
Cardiovascular complications, whole hospital stay	(4.1%) n=8	(3.6%) n=7	χ^2=0.067,p=0.792
Septic shock	(8.7%) n=17	(9.7%) n=19	χ^2=0.122,p=0.726
Atrial fibrillation	(3.1%) n=6	(7.2%) n=14	χ^2=3.37,p=0.066
Reoperation	(5.6%) n=11	(8.7%) n=17	χ^2=1.38,p=0.239

DISCUSSION

A study was conducted to determine if intense alveolar recruitment therapy is helpful in decreasing post op complication by adding it to protective ventilation having small tidal volume [11]. It was observed that the intensive group had a mean of 1.8 post complication while the moderate group had a mean of 2.1. Similarly, the duration of hospital stay was longer for the moderate alveolar recruitment therapy group i.e. 12.4 vs 10.9 days. The difference was also seen in terms of hospital mortality i.e. 25% for the intensive therapy group and 4.9% for moderate therapy group. Overall, the shift of primary outcome distribution was in the favor of intensive therapy group. Thence it was concluded that hypoxemic patient after a cardiac surgery intensive alveolar recruitment therapy proved to be more effective in terms of complications, hospital stay and mortality rates as compared to moderate therapy group.

Neto AS et al [12] states that the process of machinal ventilation is an efficacious life support technique used in a variety of clinical settings, nonetheless, it can't be generalized. It is advised by Neto AS et al [13] never to think of positive pressure ventilation therapy as an uncomplex and unthreatened procedure for the patients having a surgery under GA in whom the intervention is used for only a few minutes to hours or in severely ill patients who need ventilation for a period of days to weeks.

A study was done by Futier E et al [14] showed 10.5% of the patients belonging to lung protection group suffered from complications while 27.5% of the patients from non-protective group suffered from the pulmonary and extrapulmonary complications. After a period of seven days, only 5% of the patients receiving lung protective ventilation required intubation while 17% from non-protective group needed intubation due to respiratory failure.

The effects of Intensive alveolar recruitment therapy were studied by Bitker L et al [15] in patients undergoing cardiac surgery. The standard level of care in ICU and high-risk patients in Operation Theater is mechanical ventilation with low VT as it has been proved to be quite useful. The high levels of PEEP are more beneficial in cases of severer hypoxemia but remain unclear for patients of ARDS. Guray J et al [16] determine the effects of low tidal volume ventilation during the surgery in avoiding the post-operative complications by reviewing 12 such studies. 9 out of these 12 studies showed that there was no difference in 30-day mortality in both the groups of high tidal volume and low tidal volume. Four studies regarding spinal and abdominal surgery demonstrated that there is decreased incidence of post-op pneumonia in patients receiving ventilation with low VT. Similarly, low VT reduced the demand of post-operative non-invasive and intra-operative invasive ventilator support. Similarly, Santa CR et al [17] determined the advantages and disadvantages of high and low levels of PEEP in patients suffering from ARDS and acute lung injury.

It is still unclear how PEEP plays a role during general anesthesia in a surgery. Its observed that levels greater than 0cmH2O are protective against the pulmonary complications but at the same time they may cause circulatory insufficiency and cause injury to lungs as a result of overdistension. It was determined by a study conducted by Hemmes SN et al [18] if higher PEEP levels with recruitment strategies help in avoiding the post-op complications in patients at mechanical ventilation and low VT during general anesthesia. As shown by the results, the patients of higher PEEP value group experienced intra-op hypotension and required greater number of vasoactive drugs and 40% of these patients had post-op pulmonary complications. Patients in low PEEP group, 39% of post-op complications were seen.

In conventional clinical settings the average tidal volume used for mechanical ventilation ranges between 10-15ml/kg body weight. And it is believed to cause "stretch-induced" injury among patients having acute lung injury or ARDS. A study was conducted by Brower RG et al [19] to establish if low values of tidal volume help in ameliorating the outcomes in such patients.

Recent data demonstrates that post-operative pulmonary complications can be escaped with the use of low tidal volume says Schultz MJ et al [19]. It has been observed in many RCT and meta-analysis. Whereas, avoiding the risk of post-operative pulmonary complications by the high levels of tidal volume has been found to be less convincing. When high PEEP levels were compared to low PEEP levels, it was found that high PEEP level ventilation do not prove to be helpful is averting the complications but actually caused intra-operative complications. It was concluded

that low tidal volume during the surgery for ventilation are protective against post-operative pulmonary complications whereas the role of high PEEP values remains unclear.

CONCLUSION

In patients having hypoxemia after a cardiac surgery, intensive alveolar recruitment therapy proves to be more helpful in decreasing the severity and occurrence of post-operative pulmonary complications as compared to moderate alveolar recruitment therapy.

REFERENCES

1. Sundar S, Novack V, Jervis K. Influence of low tidal volume ventilation on time to extubation in cardiac surgical patients. Anesthesiol. 2011;114 (5):1102-10.
2. Severgnini P, Selmo G, Lanza C. Protective mechanical ventilation during general anesthesia for open abdominal surgery improves post-operative pulmonary function. Anesthesiol. 2013;118(6):1307-21.
3. Zupancich E, Paparella D, Turani F. Mechanical ventilation affects inflammatory media to in patients undergoing cardiopulmonary bypass for cardiac surgery: a randomized clinical trial. J Thorac Cardiovasc Surg. 2005;130(2):378-83
4. Chu EK, Whitehead T, Slutsky AS. Effects of cyclic opening and closing at low-and high volume ventilation on broncho alveolar lavage cytokines. Crit Care Med. 2004;32(1):168-74.
5. Briel M, Meade M, Mercat A. Higher vs lower positive end-expiratory pressure in patients with acute lung injury and acute respiratory distress syndrome: systematic review and meta-analysis. JAMA. 2010;303(9):865-73.
6. Terragni PP, Rosboch G, Tealdi A. Tidal hyperinflation during low tidal volume ventilation in acute respiratory distress syndrome. Am J Respir Crit Care Med. 2007;175(2):160-66.
7. Neto AS, Schultz MJ, Abreu G. Intraoperative ventilation strategies to prevent postoperative pulmonary complications: Systematic review, meta-analysis, and trial sequential analysis. Best Pract Res Clin Anaesthesiol. 2015;29(3):331-40.
8. Hajjar L, Galas F, Nozawa E, Leme A, Shigemi C, Barbas C et al. Effects of alveolar recruitment in patients after cardiac surgery: a prospective, randomized, controlled clinical trial. Critical Care. 2008;12(Suppl 2):P314.
9. Ferguson ND. Low tidal volumes for all? JAMA. 2012;308(16):1689-90.
10. Leme AC, Hajjar AL, Volpe MS, Fukushima JT, Santiago RRS, Osawa EA et al. Effect of Intensive vs Moderate Alveolar Recruitment Strategies Added to Lung-Protective Ventilation. JAMA. 2017;317(14);00-00.
11. Neto AS, Schultz MJ. Optimizing the settings on the ventilator High PEEP for all? JAMA. 2017;317(14):1413-14.
12. Neto AS, AmatoMBP, Schultz MJ. Dissipated Energy is a Key Mediator of VILI: Rationale for Using Low Driving Pressures. Annual Update in Intensive Care and Emergency Medicine. 2016:p311-322.
13. Futier E1, Constantin JM, Paugam-Burtz C, Pascal J, Eurin M, Neuschwander A, et al. A trial of intraoperative low-tidal-volume ventilation in abdominal surgery. N Engl J Med. 2013;369(5):428-37.
14. Bitker L, Richard JC. Intensive alveolar recruitment strategy in the post-cardiac surgery setting: one PEEP level may not fit all. J Thorac Dis. 2017;9(8):2288–92.
15. Guay J1, Ochroch EA. Intraoperative use of low volume ventilation to decrease postoperative mortality, mechanical ventilation, lengths of stay and lung injury in patients without acute lung injury. Cochrane Database Syst Rev. 2015;(12):CD011151.
16. Santa Cruz R1, Rojas JI, Nervi R, Heredia R, Ciapponi A. High versus low positive end-expiratory pressure (PEEP) levels for mechanically ventilated adult patients with acute lung injury and acute respiratory distress syndrome. Cochrane Database Syst Rev. 2013;(6):CD009098.
17. Hemmes SN, Gama de Abreu M, Pelosi P, Schultz MJ. High versus low positive end-expiratory pressure during general anaesthesia for open abdominal surgery (PROVHILO trial): a multicentre randomised controlled trial. Lancet. 2014;384(9942):495-503.
18. Brower RG, Matthay MA, Morris A, Schoenfeld D, Thompson BT, Wheeler A. Ventilation with lower tidal volumes as compared with traditional tidal volumes for acute lung injury and the acute respiratory distress syndrome. N Engl J Med. 2000;342(18):1301-8.
19. Schultz MJ, Abreu MG, Pelosi P. Mechanical ventilation strategies for the surgical patient. Curr Opin Crit Care. 2015;21(4):351-7.