EFFECT OF VENTILATION ON PULMONARY EPITHELIAL PERMEABILITY DURING CARDIOPULMONARY BYPASS

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Ventilation of the lungs during cardiopulmonary bypass may have a protective effect against postoperative lung injury Lung disturbances after cardiopulmonary bypass include pulmonary endothelial, interstitial and epithelial damage that can be demonstrated by Tc-99m-labeled diethylenetriamine pentaacetic acid inhalation scintigraphy. This study was conducted on 22 patients with on-pump coronary bypass operation. The study group n=9) received ventilation: respiratory rate 6 breaths/min, tidal volume 200 ml, and fraction of inspired oxygen 50% during extracorporeal circulation. The control group was not ventilated during CPB. Inhalation scintigraphy was performed to all patients preoperatively and postoperatively within the first week. Preoperative and postoperative median epithelial clearances of the ventilated group were 68.41 and 55.80 minutes, respectively. In the nonventilated group, preoperative and postoperative clearances were 84.20 and 82.29 minutes, respectively. In both groups, there was no significant difference between preoperative and postoperative values. The effect of ventilation may not be detectable via Tc-99m-labeled diethylenetriamine pentaacetic acid inhalation scintigraphy.

Key Words: Ventilation; Cardiopulmonary bypass; Tc 99m DTPA; Pulmonary epithelial permeability; Pulmonary scintigraphy

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INTRODUCTION

Postoperative lung injury is one of the most frequent complications of cardiac surgery that has been believed to result from the use of cardiopulmonary bypass CPB). Lung disturbances after CPB include increased permeability (1) and pulmonary vascular resistance (2) as well as lung surfactant changes (3,4), because CPB exposes blood to the artificial surfaces activating neutrophils that cause subsequently pulmonary endothelial, epithelial and interstitial damage (5,6). This damage, contributing to an increase in the pulmonary epithelial permeability, can be demonstrated by the increased rate of transfer of Tc-99m-labeled diethylenetriamine pentaacetic acid Tc-DTPA) (7,8). On the other hand, ventilation, decreased tidal volumes and airway pressure during CPB, may help to attenuate the postoperative pulmonary dysfunction in patients after exposure to cardiopulmonary bypass (9). In this investigation, our interest

focused on ventilation of the lungs during CPB, whether or not have an effect detected by Tc-DTPA inhalation scintigraphy.

MATERIALS AND METHODS

The study was conducted on 22 patients with on-pump elective coronary bypass operation. One group n=9) received ventilation during extracorporeal circulation. Six of the 9 patients were men, and the mean age of the group was 60.22 years. The ventilation protocol of this group was as follows: respiratory rate: 6 breaths/min, tidal volume: 200 ml, and fraction of inspired oxygen: 50%. The control group n=13) was not ventilated during extracorporeal circulation. Eight of the 13 patients were men, and the mean age of the group was 58,38 years. The CPB technique was identical for all procedures and consisted of a roller pump with membrane oxygenator, asangineous prime volume, moderate hypothermia, routine heparinization and protamine sulphate reversal. Pulmonary artery was not clamped. Inhalation scintigraphy with Tc-DTPA was performed to all patients preoperatively and within the first postoperative week. Statistical analysis was done with Wilcoxon's signed rank test. The study protocol was approved by local ethical committee and the informed consent was obtained from each participant.

RESULTS

Mean time CPB for the study and control were 75.7 and 86.5 minutes and average cross-clamp time 40.1 and 46.4 minutes respectively. Preoperative and postoperative median epithelial clearances of the ventilated group were 68.41 and 55.80 minutes respectively. There was no statistical difference between these two values z= -0.899). On the other hand, preoperative and postoperative median epithelial clearances of the nonventilated group were 84.20 and 82.29 minutes respectively. Also in this group, there was no significant difference between preoperative and postoperative values z=-0.314).

DISCUSSION

Postoperative pulmonary disturbances in patients undergoing cardiopulmonary bypass may be manifested as conditions ranging from subclinical functional changes to ARDS (10). Subclinical abnormalities in pulmonary epithelial permeability was detected as increased radioaerosol lung clearance in patient with sepsis and trauma before the clinical manifestations of ARDS (11). Because the pathophysiology of CPB-associated pulmonary dysfunction may be similar to that seen in sepsis-related and trauma-related ARDS, pulmonary injury due to CPB may be shown as an increase of pulmonary epithelial clearance rate detected by Tc-DTPA inhalation scintigraphy (12). However, we did not find any difference between the preoperative and postoperative clearance rates of the two groups. The rates of clearance of 99mTc-DTPA had returned to preopertive values by 7 days after operation (13). However, there is evidence that pulmonary influences are not as important if the pump time remains below 2 hours. (14). On the other hand, it was reported that CABG with or without the use of CPB caused a similar degree of postoperative lung dysfunction(15,16). These results support the idea that CBP is only one of the many factors causing lung disease.
Vital capacity maneuver (17) or protective ventilation, with the aim to protect the lung during CPB, is observed in many studies (9,14,18,19). Though, there is no agreement on a single best technique to be used for this purpose. While a FiO2 of 100% is regarded as harmful (20), the preferred value is 50% (21). It is reported that, PEEP of 5 and 15 cmH2O leads to fluid accumulation within the lung parenchyma with a significant increase in the latter case (22). These issues can help in defining the technical framework of preventive ventilation.

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