DEVELOPMENT OF EXTRALUMINAL FLOW OXYGENATOR FOR A RAT CPB MODEL.

Shunsuke Uchiyama (1) , Hirohito Sumikura (1) , Yutaka Fuji (2) , Akihiko Homma (1)

1. Graduate school of Science and Engineering, Graduate School of Tokyo Denki University, Japan;
2. Department of Clinical Engineering and Medical Technology, Niigata University of Health and Welfare, Japan.

Introduction

Currently, a rat cardiopulmonary bypass (CPB) model is used to study the mechanism of biological reaction during CPB [1]. This study was used the intraluminal flow oxygenator in view of the blood volume of the rats. However, the extraluminal flow oxygenator are used in actual clinical practice. Therefore, the application of the extraluminal flow oxygenator to the rat CPB model would be possible to simulate the CPB close to the clinical conditions.

The purpose of this study is to develop the extraluminal flow oxygenator applicable to rat CPB model. In this study, the extraluminal flow oxygenator was prototyped, and biochemical and inflammatory markers were evaluated using the rat CPB model.

Methods

The extraluminal flow oxygenator was consisted of an acrylic housing, gas caps, a polyurethane polymer, and a polypropylene hollow fibre membrane (HFM) bundle. The HFM bundle porosity, effective membrane surface area, and priming volume were 30 %, 0.023 m^2, 2.7 mL, respectively. The rat CPB model consisted of the extraluminal flow oxygenator, a polyvinyl chloride tubing line, and a roller pump. The priming volume of this system was 8 mL.

The experiments were divided into 3 groups: SHAM group (n=5), a CPB with intraluminal flow oxygenator (n=7), and a CPB with extraluminal flow oxygenator (n=7). The SHAM group only underwent the surgery. After the start of the experiment, pump flow was maintained 60 mL/kg/min, and blood samples were collected three time points: before the start of circulation, 60 minutes and 120 minutes after the start of circulation (end of experiment). Biochemical markers, cytokines (TNF-α, IL-6, IL-10), PLT count were measured for evaluation. This study was conducted with the approval of the Niigata University of Health and Welfare Animal Care and Use Committee.

Results

Table 1 presents the changes in hemodynamics, PaO_2 and $PaCO_2$, in CPB with extraluminal flow oxygenator during the experiments (mean ± standard deviation (SD)). The blood pressure and the Hb were maintained around 75 mmHg and 9.5 %, respectively, and the CPB was maintained without blood transfusion. It was possible to confirm oxygenation and carbon dioxide removal from the blood.

Table 1: Hemodynamics, blood gases partial pressures before and during CPB with extraluminal flow oxygenator.

	Pre	60min	120min
MAP (mmHg)	104±13	82±12	75±14
HR (beat/min)	384±34	361±20	358±30
PaO_2 (mmHg)	101±11	273±56	268±55
$PaCO_2$ (mmHg)	39±4	35±4	35±4
Hb (g/dL)	15.4±1.1	9.6±1.6	9.5±1.4

In the CPB with extraluminal flow oxygenator group at 60 and 120 minutes after the start of circulation, the PLT count was significantly preserved compared to the CPB with intraluminal flow oxygenator group. However, TNF-α, IL-10, and IL-6 were not significantly different in each CPB groups (Fig. 1(a)-(d)).

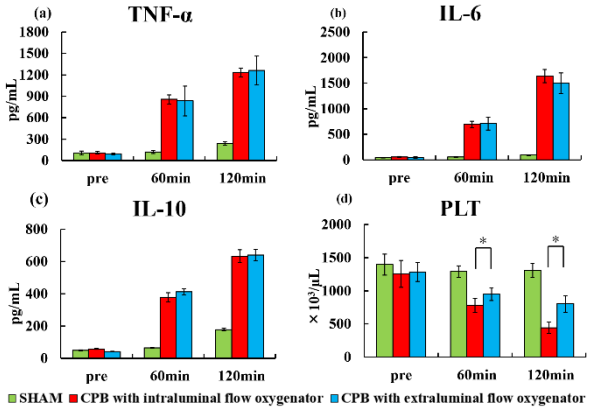

*Figure 1: Inflammatory markers: TNF-α, IL-6, IL-10, and PLT in all of groups during the experiments. *P < 0.05 versus CPB with intraluminal flow oxygenator at the same periods. (mean ± SD).*

Discussion

The extraluminal flow oxygenator has lower pressure drop than the intraluminal flow oxygenator, it is possible that PLT was preserved in the extraluminal flow oxygenator. Hemodynamics were maintained in the CPB with extraluminal flow oxygenator group, and there was no significant difference in the inflammatory markers in each CPB group. Therefore, it is suggested that the developed extraluminal flow oxygenator is applicable to rat CPB model.

References

1. Yutaka Fujii et al, Artificial Organs, 37:1034-1040, 2013.