

Calculation of the Shunt Flow in Aorto-Pulmonary Collateral Artery model rat with Left Pulmonary Artery ligation under Hypoxia environment

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Introduction

Cyanotic congenital heart disease with functional single ventricle often develops aorto-pulmonary collateral arteries (APCA). It is known that APCA can cause the hemodynamically left-to-right shunt and become a burden on the systemic ventricle. It often causes heart failure and pleural effusion, inhibits the growth of pulmonary artery, and affects the remodeling of pulmonary artery. However, detailed study on the mechanisms of APCA development is limited, because the animal models are not reproducible.

Objectives

The purpose of this study is to clarify the timing of APCA expression, and the changes in shunt volume by using animal model.

Methods

Five-week-old Sprague Dawley rat (100-150g) underwent the operation that rats were ligated left pulmonary artery with hilar region under left thoracotomy, and divided into 2 groups: hypoxic (HO) group (10% of FiO₂) and room air (RA) group (21% of FiO₂). These rats were measured the blood flow of bilateral ventricular outflow tract using transthoracic ultrasonography and transit time ultrasound probe placed around their aorta and main pulmonary artery, and made up to 10 rats at each timing (3day, 1, 2, 3, and 4 weeks after operation). In this model, the pulmonary and aorta output was defined as the functional systemic output (Q_s) and pulmonary output (Q_p). Because the aortic output was the flow that added up the Q_p and the quantity of APCA shunt. The Q_p/Q_s was compared in these groups (HO and RA).

Results

The Q_p/Q_s in the HO group was increased more earlier than in RA group significantly, but in RA group caught up with even level since 3 weeks after operation. The Q_p/Q_s in the HO group was significantly elevated from 1 week after operation compared to the control. The calculation of Q_p/Q_s by ultrasonography was good correlated with it by transit time ultrasound probe (R=0.70).

Conclusions

We could create the APCA animal model reproducibly. The quantity of APCA flow in HO group increased earlier than in RA group. Although the Q_p/Q_s in RA group caught up with it in HO group since 3 weeks after operation. In this study, the development of APCA was accelerated from hypoxic environment.