

Value of Percutaneous Oxygen Partial Pressure / Carbon Dioxide Partial Pressure Monitoring in Balloon Pulmonary Angioplasty

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Abstract: Objective: To monitor the levels and clinical value of transcutaneous partial pressure of oxygen (tcpO₂) and carbon dioxide (tcpCO₂) in patients undergoing balloon pulmonary angioplasty (BPA). **Methods:** Patients with chronic thromboembolic pulmonary hypertension (CTEPH) treated in our hospital from June 2020 to June 2021 were selected as the research object, and patients with conventional treatment in our hospital were selected as the control. The differences of tcpO₂, tcpCO₂, oxygen offset and carbon dioxide offset between the two groups were observed. **Results:** The levels of PaO₂ and tcpO₂ in CTEPH group were lower than those in control group (P < 0.001), and the levels of PaCO₂, tcpCO₂, oxygen offset and carbon dioxide offset were greater than those in control group. **Conclusion:** The levels of PaO₂ and tcpO₂ in CTEPH patients are low, and the levels of PaCO₂, tcpCO₂, oxygen offset and carbon dioxide offset are high, which are closely related to the prognosis of CTEPH patients.

1. Introduction

Chronic thromboembolic pulmonary hypertension (CTEPH) is an illness in which thrombus blocks pulmonary artery for a long time. This disease will continue to increase pulmonary vascular resistance and eventually develop to right heart failure and cause patients die. It is one of the diseases with high mortality. Most patients with CTEPH are transformed from patients with pulmonary embolism, and their onset cycle is no more than 2 years. About 10% of patients will turn to CTEPH. At the same time, because the onset of CTEPH is relatively hidden, many patients often have irreversible consequences when they find it, and the treatment cost is high^[1]. The disease is currently treated with pulmonary artery thrombus endarterectomy (PEA), but the PEA operation has some limitations, resulting in the unsatisfactory development of this kind of operation in China.

In recent years, the attempt to use CTEPH minimally invasive method - balloon pulmonary angioplasty (BPA) has been widely welcomed by patients. From the perspective of BPA, it has a wide range of application, less restrictions on operation, and belongs to minimally invasive intervention method with broader indications^[2].

From the amount of BPA operations and relevant experience in our hospital, it has a good foundation of clinical practice and can carry out corresponding clinical research. Transcutaneous partial pressure of oxygen (tcpO₂) and partial pressure of carbon dioxide (tcpCO₂) can monitor the BPA operation noninvasively and continuously, and can be considered as an important indicator for the evaluation of chronic thromboembolic pulmonary hypertension^[3]. Therefore, this research studied the levels of tcpO₂ and tcpCO₂ in patients who have balloon pulmonary angioplasty (BPA) and analyzed their clinical value.

2. Data and Methods

2.1 General Data of Objects

Patients with chronic thromboembolic pulmonary hypertension (CTEPH) treated with balloon

pulmonary angioplasty (BPA) in our hospital from June 2020 to June 2021 were selected as the research object, and patients who have chronic thromboembolic pulmonary hypertension (CTEPH) treated with conventional treatment in our hospital were selected as the control. Inclusion criteria: ① age \geq 20 years old; ② CTEPH diagnosed by laboratory examination; ③ volunteer and agree to participate in this study. Exclusion criteria: ① incomplete clinical data; ② those with serious organic diseases; ③ a history of serious mental illness. In line with the inclusion and exclusion criteria, a total of 90 cases (CTEPH group) was selected, 50 males and 40 females, aged from 30 to 68 years, and the average was 48.45 ± 3.28 years. A total of 80 patients with routine treatment (control group) was selected, 47 males and 43 females, aged 29 ~ 70 years, and the average was 48.59 ± 3.36 years. There was no statistical difference between the two groups in general data such as personal basic information, which was comparable. This research was approved by the ethics committee of our hospital.

2.2 Research Methods and Evaluation Indicators

The differences of tcpO₂ and tcpCO₂, oxygen offset and carbon dioxide offset between the two groups were observed. The detection instrument was CCX automatic blood gas analyzer (Japan XISEN Meikang Co., Ltd).

2.3 Statistical Methods

The data were analyzed by SPSS25.0 software. The measurement data was expressed in $\bar{x} \pm s$, using t-test, and the counting data was expressed in rate (%), using χ^2 test. The difference was statistically significant ($P < 0.05$).

3. Results

3.1 Comparison of tcpO₂ and tcpCO₂ in the Two Groups

Table 1 shows that the levels of PaO₂ and tcpO₂ in CTEPH group were lower than those in the control group ($P < 0.001$), and the levels of PaCO₂, tcpCO₂, oxygen offset and carbon dioxide offset were higher than those in the control group ($t = -14.146, -37.156, -10.839, -20.573, P < 0.001$)

Table 1 Comparison of tcpO₂ and tcpCO₂ in the two groups

Indicators	BPA group (n=90)	control group(n=90)	t value	P value
PaO ₂	83 ± 1.38	90 ± 1.36	41.910	$P < 0.001$
paCO ₂	37 ± 1.06	36 ± 1.05	-14.146	$P < 0.001$
tcpO ₂	47 ± 1.12	66 ± 1.21	78.839	$P < 0.001$
tcpCO ₂	49 ± 1.13	40 ± 1.14	-37.156	$P < 0.001$
Oxygen offset	0.47 ± 0.98	0.29 ± 0.87	-10.839	$P < 0.001$
Carbon dioxide offset	0.38 ± 0.07	0.15 ± 0.05	-20.573	$P < 0.001$

Table 2 shows that the prognosis of CTEPH patients was positively correlated with the levels of PaO₂ and tcpO₂, and negatively correlated with the levels of PaCO₂, tcpCO₂, oxygen offset and carbon dioxide offset ($P < 0.05$).

Table 2 Correlation between percutaneous oxygen partial pressure, carbon dioxide partial pressure

and prognosis

Patient prognosis vs	r value	p value
PaO ₂	0.435	0.005
PaCO ₂	-0.419	0.014
tcpO ₂	0.389	0.018
tcpCO ₂	-0.447	0.002
Oxygen offset	-0.405	0.010
Carbon dioxide offset	-0.424	0.008

4. Conclusion

Chronic thromboembolic pulmonary hypertension (CTEPH), due to the human body's long-term influence of thromboembolic pulmonary artery occlusion, makes the pressure in the lung increase sharply, accompanied by severe hypoxic respiratory function limitation and pulmonary capillary endothelial cell injury. Patients with balloon dilatation of pulmonary artery (BPA) can better relieve the clinical obstruction of the artery. In the process of treatment, failure caused by hypoxic respiratory dysfunction will cause death, threatening the life safety of patients. Therefore, exploring an important index that can reflect the condition of CTEPH can better have reference value for surgical prognosis during BPA process and after treatment [4].

PaO₂ and PaCO₂ can reflect the state of microcirculation tissue from clinical practice by detecting the oxygen and carbon dioxide pressure of subcutaneous capillaries, and then reflect the route of oxygen delivery in human tissue [9-11]. In practice, PaO₂ and PaCO₂ can greatly monitor BPA. In recent years, PaO₂ and PaCO₂ have become sensitive indicators to evaluate the oxygen pathway of peripheral tissues, and the need to monitor arterial blood gas in the process of BPA has also become an important standard to evaluate the oxygenation of whole-body tissues [5]. The blood gas changes of CTEPH patients often fluctuate greatly and are extremely unstable. The detection of PaO₂ and PaCO₂ can not only alleviate the pain of patients, but also help nurses' workload and efficiency.

The comparison of tcpO₂, tcpCO₂ and other indicators between the two groups showed that the levels of PaO₂ and tcpO₂ in CTEPH group were lower than those in the control group, and the levels of PaCO₂, tcpCO₂, oxygen offset and carbon dioxide offset were greater than those in the control group. The difference was statistically significant. Relevant studies [6] show that when patients have arterial embolism disorder, the levels of oxygen offset and carbon dioxide offset will change with the operation of BPA, which is also in line with the results of this study.

To sum up, the changes of CTEPH can be effectively found through percutaneous oxygen partial pressure / carbon dioxide partial pressure monitoring, and the skin is the first important organ to reflect hypoxia and ischemia. This organ that reflects microcirculation disorder can also predict the changes of microcirculation disorder in the process of balloon pulmonary dilatation (BPA), so as to give effective data reference for further treatment and prognosis. The correlation analysis between tcpO₂ and tcpCO₂ and the prognosis of CTEPH patients showed that the prognosis of CTEPH patients was positively correlated with the levels of PaO₂ and tcpO₂, and negatively correlated with the levels of PaCO₂, tcpCO₂, oxygen offset and carbon dioxide offset.

It is further proved from the results of this experiment that the detection of tcpO₂ and tcpCO₂ is helpful to judge the prognosis after the treatment of CTEPH through BPA, and provides data support for further treatment. It has good clinical application value and is worth clinical application.

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