

The Changes of pH and Partial Pressure of Oxygen in Blood at Chronic Heart Failure

*Nino Mamamtavrishvili**, *Giorgi Red'ko***, *Gulnara Tabidze**,
*Marina Iakobashvili**

* Scientific-Research Institute of Cardiology, Tbilisi, Georgia,

**TSMU Scientific-Research Institute of Experimental Medicine, Tbilisi, Georgia

Abstract

Disorders in myocardium metabolism taking place at heart failure are connected with reduced blood supply and promote decrease of ATP production, breaking of oxygen consumption, increase of lactate and hydrogen ions' production. In this connection study of changes of partial pressure of oxygen ions occurring in blood of patients with systolic and diastolic forms of heart failure seems to be of great interest. On the basis of obtained results it should be concluded that at systolic and diastolic forms of heart failure the development of acidosis and decrease of partial pressure of oxygen ions in blood take place. Due to all the above mentioned the disorders of metabolic processes and decrease of oxygen consumption develop in tissues, making preconditions for development of organism's antioxidant system insufficiency, activation of free-radical oxidation and progress of oxidative stress in the organism.

Keywords: *oxygen ions, partial pressure, blood pH, chronic heart failure, free radical oxidation, oxidative stress*

Today chronic heart failure (CHF) is considered not only the state of myocardium developed as a result of different pathologic changes but also the breaking of neuroendocrine regulation accompanied with metabolic disorders in patients suffering with systolic and diastolic cardiac dysfunctions [1].

Great number of references has been devoted to the issues of metabolic disorders during the recent years. Also new data on molecular-genetic violations underlying the CHF pathogenesis continue to appear, which allow us to reappraise a role for the neuroendocrine mechanisms in the development of this syndrome.

Neuroendocrine mechanisms evoking different functional changes in myocardium via oxidative stress and ischemia alter expression of genes in myocardium and induce apoptosis [2].

At the initial stage of CHF metabolic changes connected with reduced synthesis of ATP, disorder of oxygen consumption, intensification of lactate and hydrogen ions' production already appear against a background of

even slight changes in blood circulation [2]. As is known hypoxia (both systemic and regional), accompanying the CHF, significantly accelerates progress of left ventricle hypertrophy and remodeling, promotes activation of HIF/ α and HIF/ β factors induced by hypoxia, intensifies expression of endothelial growth controlling gene [3].

Proceeding from the above said we were aimed at studying the changes of partial pressure of hydrogen and oxygen ions at different forms of CHF, reflecting peculiarities of alterations in the metabolism of myocardium at this pathology.

Investigations were carried out at the Scientific-Research Institute of Cardiology on hospital patients with CHF developed against a background of hypertension and heart ischemic disease. Functional class of CHF was evaluated according to NYHA. To make difference between systolic and diastolic forms of insufficiency in patients belonging to II and III functional classes of NYHA Doppler-echocardiography method was used. The majority of patients corresponded to II -III NYHA functional classes.

Indices of blood pH and partial pressure of oxygen ions have been determined in 22 patients with systolic cardiac insufficiency and 18 patients with diastolic cardiac insufficiency. Control group was comprised of 10 practically healthy persons (age 45-70).

Blood pH and partial pressure of oxygen were measured according to the method of Astrup using the biological microanalyser OP-21012. The *Tab.1* shows the changes in blood pH and partial pressure of oxygen in patients with systolic and diastolic forms of cardiac insufficiency.

As can be seen from the data presented in the Table the value of pH in blood both at systolic and diastolic forms of cardiac insufficiency decreases by 3% as compared with control.

As to the partial pressure of oxygen in blood, this parameter was sharply decreased in patients with systolic insufficiency and as well as in those with diastolic cardiac insufficiency and made 42% of control index.

Lowering of blood pH at heart failure reduces hemoglobin's affinity to oxygen (Bor's effect) and conditions intensification of oxy-hemoglobin dissociation (donation).

Decrease of partial pressure of oxygen in blood should be caused by reduction of external respiration (ventilation) and blood circulation in capillaries of alveoli. Due to the latter hypoxia develops in the organism. Intensity of cellular respiration and synthesis of macroergic compounds in cardiomyocytes decrease. Cardiac ischemia becomes graver and systolic volume (stroke volume) decreases. The above mentioned in its turn causes impairment of blood circulation thus locking a vicious circle.

Thus it follows from the analysis of results obtained that in the course of systolic and diastolic forms of cardinal insufficiency acidosis and decrease of partial pressure of oxygen ions in blood take place breaking metabolic processes, proceeding in tissues, and reducing oxygen consumption by tissues. All this represents one of the mechanisms promoting antioxidant system insufficiency and development of oxidative stress on the background of free-radical processes activation [4].

Group of patients	Number of patients	pH	PO ₂
Control	10	7.35±0.05	48.0±5.0
Systolic insufficiency	22	7.23±0.05 p<0.01	18.8±4.5 p<0.001
Diastolic insufficiency	18	7.22±0.05 p<0.01	20.0±4.8 p<0.001

Tab.1 *Indices of pH and partial pressure of oxygen ions (PO₂) in blood of patients with systolic and diastolic forms of cardiac insufficiency.*

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Изменения рН и парциального давления кислорода в крови больных с хронической сердечной недостаточностью

*Нино Мамамтавришвили**, *Георгий Редько***, *Гульнара Табидзе**,
*Марина Иакобашвили**

*Институт кардиологии им. Л. Цинамдзгвришвили, Тбилиси, Грузия

**Кардиологическая клиника Тбилисского государственного медицинского университета,
Тбилиси, Грузия

Р Е З Ю М Е

Нарушения метаболизма миокарда при сердечной недостаточности связаны со снижением кровоснабжения, что способствует уменьшению образования ЧТФ, снижению утилизации кислорода, увеличению продукции лактата и ионов водорода. В связи с этим изучение парциального давления ионов кислорода и водорода в крови больных с систолической и диастолической сердечной недостаточностью представляет особый интерес. Полученные результаты позволяют заключить, что при вышеупомянутых формах сердечной недостаточности развивается ацидоз, уменьшается парциальное давление кислорода, что способствует нарушению метаболических процессов в тканях, снижению потребления кислорода и создает предпосылки для развития недостаточности антиоксидантной системы, активации свободнорадикального окисления и развития окислительного стресса в организме.

Ключевые слова: *ионы кислорода, парциальное давление, рН крови, хроническая сердечная недостаточность, свободнорадикальное окисление, окислительный стресс*