HOSTED BY
ELSEVIER

Contents lists available at ScienceDirect

Asian Pacific Journal of Tropical Medicine

journal homepage: http://ees.elsevier.com/apjtm

Original research https://doi.org/10.1016/j.apjtm.2017.10.029

Electrophysiological changes of autonomic cells in left ventricular outflow tract in guinea pigs with iron deficiency anemia complicated with chronic heart failure

Ling Fan[1], Li-Feng Chen[2✉], Jing Fan[3]

[1]Department of Hematology, The First Affiliated Hospital of Hebei North University, 075000 Zhangjiakou, Hebei, China

[2]Department of Physiology, Basic Medical College, Hebei North University, 075000 Zhangjiakou, Hebei, China

[3]Department of Obstetrics and Gynecology, The Sixth Hospital of Zhangjiakou, 075000 Zhangjiakou, Hebei, China

ARTICLE INFO

Article history:
Received 24 Aug 2017
Received in revised form 22 Sep 2017
Accepted 25 Oct 2017
Available online 6 Nov 2017

Keywords:
Iron deficiency anemia
Chronic heart failure
Guinea pig model
Autonomic cells
Left ventricular outflow tract
Electrophysiology

ABSTRACT

Objective: To investigate the electrophysiological changes of autonomic cells in left ventricular outflow tract in guinea pigs with iron deficiency anemia complicated with chronic heart failure.

Methods: Guinea pigs model of iron deficiency anemia complicated with chronic heart failure in 10 guinea pigs of the experimental group was made by feeding a low iron diet, pure water and subcutaneous injection of isoproterenol. The control group consisting of 11 guinea pigs was given normal food, normal water and injected with normal saline. The left ventricular outflow tract model specimen was also prepared. The standard microelectrode technique was used to observe electrophysiological changes of autonomic cells in the outflow tract of left ventricular heart failure complicated with iron deficiency anemia in guinea pig model. The indicators of observation were maximal diastolic potential, action potential amplitude, 0 phase maximal depolarization velocity, 4 phase automatic depolarization velocity, repolarization 50% and 90%, and spontaneous discharge frequency.

Results: Compared with the control group, 4 phase automatic depolarization velocity, spontaneous discharge frequency and 0 phase maximal depolarization velocity decreased significantly ($P < 0.01$) and action potential amplitude reduced ($P < 0.01$) in model group. Moreover, repolarization 50% and 90% increased ($P < 0.01$).

Conclusions: There are electrophysiological abnormalities of the left ventricular outflow tract in guinea pigs with iron deficiency anemia complicated with heart failure.

1. Introduction

Clinically, iron deficiency anemia complicated with chronic heart failure is a relatively common disease [1]. More than half of the patients died of sudden cardiac death caused by various malignant ventricular arrhythmias [2]. It is found that the ventricular arrhythmias originating from the outflow tract are closely related to the slow response autonomic cells existing in the ventricular outflow tract tissue [3,4]. In order to study the electrophysiological changes of autonomic cells in left ventricular outflow tract in patients with iron deficiency anemia complicated with chronic heart failure, this experiment was designed.

2. Materials and methods

2.1. Experimental animals

Guinea pigs, weighing 250–350 g, both male and female, were purchased from the Beijing Gold Muyang Experimental Animal Breeding Co. Ltd. (animal license: SCXK (Beijing) 2010-0001).

2.2. Grouping

The guinea pigs were randomly divided into two groups: experimental group (iron deficiency anemia complicated with chronic heart failure group, $n = 18$) and control group ($n = 12$).

First author: Ling Fan, Department of Hematology, The First Affiliated Hospital of Hebei North University, 075000 Zhangjiakou, Heibei, China.
Tel: +86 18931316102.
E-mail: zjkclf@163.com
✉Corresponding author: Li-Feng Chen, Department of Physiology, Basic Medical College, Hebei North University, 075000 Zhangjiakou, Hebei, China.
E-mail: yunnth@163.com

Peer review under responsibility of Hainan Medical University.
Foundation project: This work was supported by Zhangjiakou Project of Science and Technology Studies and Development Planning (Grand No. 1321078D).

The experimental group was given the homemade low iron diet in which formula did not add salt and the material in the formula was soaked with 1% EDTA-2Na to remove iron ions in feed [5], and drank pure water along with subcutaneous injection of isoproterenol [6]. The control group was given normal food, normal water and injected with normal saline, the dose and time were the same as the experimental group. After 6 weeks, 10 cases survived in the experimental group, 11 cases survived in the control group. Animal breeding, care and all experiments were performed in adherence to Hebei North University animal experiment center guidelines and approved by Animal Ethics Committee.

2.3. Determination of modeling results in the experimental group

After 6 weeks, the right common carotid artery of guinea pigs in experimental group was intubated, and the RM6240 signal acquisition system (Chengdu instrument factory) was used to collect the following indexes: heart rate, blood pressure, left ventricular systolic pressure, left ventricular diastolic pressure, left ventricular end diastolic pressure, left ventricular systolic maximum velocity and left ventricular diastolic maximum velocity in order to determine whether the model of heart failure was made successful. After the above indexes were collected, blood from the carotid artery was bled in a 1 mL test tube, and the hemoglobin content, red blood cell count and serum iron content were measured.

2.4. Preparation of left ventricular outflow tract specimens and measurement of left ventricular outflow tract specimen's action potential

After cardiac function was measured and carotid artery blood sampling were taken, the heart was removed quickly and placed in the modified Locke solution saturated with O_2. Left ventricular outflow tract tissue specimens were made [3,4]. The prepared specimens were fixed on the silicone rubber in the perfusion chamber with Locke fluid by a stainless steel needle at constant temperature (36 ± 0.5) °C, constant speed (5 mL/min) perfusion, perfusion continuously filling pure O_2 fluid, pH 7.4. Standard intracellular microelectrode technique was used to record the spontaneous slow action potential of the outflow tract which was collected by RM6280 multi-channel physiological signal acquisition and processing system (Chengdu instrument factory).

2.5. Statistical analysis

Software SPSS version 16.0 was used for statistical analysis. Mean ± SD was used to express the measurement data. Software SPSS version 16.0 was used to carry out the test of homogeneity of variances. Data of homogeneity of variance ($P > 0.10$) in multiple groups were compared using one-way ANOVA, and student's t-test was used for the comparison of two groups. $P < 0.05$ was considered statistically significant difference.

3. Results

3.1. The changes of cardiac function and hemodynamic indexes

The cardiac function indexes of two groups were shown in Table 1. Compared with the control group, the blood pressure of the experimental group significantly reduced ($P < 0.01$), the absolute values of left ventricular systolic pressure, left ventricular diastolic pressure, left ventricular systolic maximum velocity and left ventricular diastolic maximum velocity significantly decreased ($P < 0.01$) while left ventricular end diastolic pressure significantly increased ($P < 0.01$).

3.2. Comparison of blood indexes between the control group and experimental group

Compared with the control group, the hemoglobin content, red blood cell count and serum iron content in the experimental group significantly decreased ($P < 0.01$, Table 2).

Table 1

Comparison of cardiac function indexes between two groups of guinea pigs (mean ± SD).

Groups	n	Heart rate (time/min)	Blood pressure (mmHg)	Left ventricular systolic pressure (mmHg)	Left ventricular diastolic pressure (mmHg)	Left ventricular end diastolic pressure (mmHg)	Left ventricular systolic maximum velocity (mmHg/s)	Left ventricular diastolic maximum velocity (mmHg/s)
Control group	11	244.7 ± 23.8	52.63 ± 5.98	67.23 ± 6.65	−5.35 ± 1.63	1.18 ± 0.67	2992.91 ± 525.76	−2911.58 ± 496.28
Experimental group	10	247.3 ± 21.2	42.75 ± 6.11**	53.99 ± 7.01**	−2.78 ± 1.76**	4.02 ± 1.15**	1985.56 ± 472.46**	−1906.76 ± 427.59**

Compared with control group, **: $P < 0.01$.

Table 2

Comparison of blood indexes between the control group and experimental group (mean ± SD).

Groups	n	Hemoglobin content (g/L)	Red blood cell count ($\times 10^{12}$/L)	Fe (mg/L)
Control group	11	141.98 ± 16.04	6.03 ± 0.61	442.36 ± 52.31
Experimental group	10	84.62 ± 18.51**	4.18 ± 0.69**	367.40 ± 54.37**

Compared with control group, **: $P < 0.01$.