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Change of blood rheology in newborn and its cerebrovascular damage

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ABSTRACT

Objective: To explore the blood rheology, changes in myocardial enzyme spectrum and brain damage in newborn whose hematocritg (HCT) are among 60%-65%. **Methods:** A total of 100 cases newborn whose HCT among 60%-65% with blood routine examination were set as observation group, 100 cases newborn whose HCT <60% were set as control group, compared the blood rheology, changes in myocardial enzyme spectrum and brain damage between two groups. **Results:** The HCT, whole blood viscosity (high), whole blood viscosity (low shear), erythrocyte aggregation index, erythrocyte rigidity index, aspertate aminotransferase, creatine kinase, creatine kinase isoenzyme, lactate dehydrogenase, Vs, Vs and the abnormal rate of aEEG examination in observation group were significantly higher than the control group, the difference had statistical significance, RI in observation group were significantly lower than the control group, the difference had statistical significance. **Conclusions:** newborn whose HCT among 60%-65% but not with polycythemia have appeared and cerebrovascular lesions, it should cause clinical positive value.

1. Introduction

Hematocritg (HCT) mainly reflects the degree of blood stasis, neonatal polycythemia (NP) was defined as HCT is greater than 65% in the venous blood of the newborn within one week clinically[1−3]. NP is a common neonatal disease, many clinical studies have shown that the increased erythrocyte and blood viscosity cause the slow blood flow, the increased vascular resistance indexes causing tissue hypoxia and nutrient supply reduction, especially the serious heart and brain damage[4−6]; and the formation of micro thrombosis will aggravate the tissue and organ perfusion, causing organ injury[7−10]. The study concluded that the safety range of HCT was less than 55%[11], our study aims to explore the changes of blood rheology, myocardial enzyme spectrum and brain damage in newborn whose HCT are among 60%-65%. Reports as follows.

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2. Materials and methods

2.1. General information

Newborn from March 2015 to December 2015 were selected as the research object, 100 cases newborn whose HCT among 60%-65% with blood routine examination were selected as observation group, including boy 56 cases, girl 44 cases; the age from 3 to 5 d with an average (3.98±0.82) d; the body weight from 2 652 to 3 672 g with an average (3 182.60±484.62) g. 100 cases newborn whose HCT <60% were set as control group, including boy 60 cases, girl 40 cases; the age from 3 to 5 days with an average (4.02±0.85) d; the body weight from 2 609 to 3 655 g with an average (3 154.83±480.17) g. Excluded the newborns with cerebral hemorrhage, asphyxia history, other brain injury, congenital heart disease, central nervous system infection and blood coagulation disorder. All the families of newborns were informed the consent and voluntarily participate in this study. All newborns had blood rheology, myocardial enzyme spectrum, cranial ultrasound and amplitude integrated electroencephalogram (aEEG) examination.

2.2 .Inspection methods

2.2.1. Hemorheology

Venous blood 3 mL and heparin anticoagulation were taken. R-80A blood rheometer (Beijing gtmsteellex Co.) and supporting reagents for hemorheology examination were used for whole blood viscosity, plasma viscosity, red cell aggregation index, red cell aggregation index, red cell electrophoresis index, red cell deformation index and red cell rigidity index.

2.2.2. Myocardial enzymes

Venous blood 3 mL were taken. Hitachi 7180 type automatic biochemical analyzer and supporting reagent were used for myocardial enzyme spectrum detection, including aspartate aminotransferase, creatine kinase, creatine kinase and lactate dehydrogenase.

2.2.3. Color Doppler ultrasonography of head

In supine position and a quiet state for newborns, German DWL2000 TCD type Doppler diagnostic instrument was used. The probe frequency was 3.5 MHz. From both two sides of the temporal, the three form consistent flow spectrum of the anterior cerebral artery, middle cerebral artery and posterior cerebral artery was accessed. Hemodynamic parameters, including peak systolic velocity (Vs), end diastolic velocity (Vd) and resistance index (RI) were measured.

2.2.4. aEEG examination

The cerebral function monitor produced by American Nicoict company was used, and the international standard electrode installation method and the 8 lead method were performed to observe the sleep wake cycle, epileptic activity and background activity amplitude. The results were divided into normal and abnormal, including mild and severe abnormalities.

2.3. Statistical treatment

SPSS 18.0 software was used for statistical analysis, the measurement data were expressed as Mean±SD. the data between the group was compared by *Chi* square test and the independent *t* test, $P<0.05$ was considered as statistically significant difference.

3. Results

3.1. Hemorheology indexes of two groups

In observation group, the HCT, whole blood viscosity (high shear) and whole blood viscosity (low shear), red cell assembling indexand red cell rigidity index were significantly higher than those in the control group ($P<0.05$). The plasma viscosity, red cell electrophoresis index and red cell deformation index had no significant difference ($P>0.05$) between the two groups (Table 1).

3.2. Myocardial enzyme spectrum of two groups

In observation group, the aspartate aminotransferase, creatine kinase, creatine kinase isoenzyme and lactate dehydrogenase were significantly higher than those in the control group ($P<0.05$) (Table 2).

Table 1

Hemorheology indexes of the two groups.

Groups	Cases	HCT (%)	Plasma viscosity (mPa • s)	Whole blood viscosity (mPa s)		Red cell assembling index	Red cell electrophoresis index	Red cell deformation index	Red cell rigidity index
				high shear	low shear				
Observation group	100	62.54±2.01*	1.21±0.13	10.65±2.20*	6.01±0.43*	2.23±0.36*	3.21±0.45	0.67±0.32	6.01±0.72*
Control group	100	51.25±10.33	1.20±0.14	7.93±1.18	4.17±0.43	1.67±0.34	3.47±0.51	0.73±0.34	4.28±0.67

Ps: Compared with the control group, *$P< 0.05$.

Table 2

Myocardial enzyme spectrum of=two groups (U/L).

Groups	*n*	Aspartate aminotransferase	Creatine kinase	Creatine kinase isoenzyme	Lactate dehydrogenase
Observation group	100	47.12±20.33*	198.35±88.21*	20.15±7.72*	2 11.63±67.78*
Control group	100	26.11±12.56	154.22±76.53	16.64±7.73	188.31±54.89

Ps:Compared with the control group, *$P< 0.05$.

3.3 .Cerebral blood flow parameters of ttwo groups

In observation group, the Vs and Vd were significantly higher than those in the control group, while RI was significantly lower than that in the control group ($P<0.05$) (Table 3).

Table 3

Cerebral blood flow parameters of two groups.

Groups	*n*	Vs (cm/s)	Vd (cm/s)	RI
Observation group	100	37.32±3.56	13.09±1.52	0.61±0.08
Control group	100	33.54±3.41	10.42±1.23	0.70±0.10

3.4. aEEG examination results of ttwo groups

In observation group, the results of aEEG examination was normal in 76 cases, abnormal in 24 cases including 22 cases mild abnormality and 2 cases severe abnormalities, the abnormal rate was 24.0%. In control group, the results of aEEG examination was all normal, there was significant difference in aEEG examination between the two groups (P<0.05).

4. Discussion

Hemorheology is a new subject, which includes blood flow and blood coagulation, cell viscoelasticity and aggregation. Studies found that for many patients with cardiovascular and cerebrovascular diseases, there existed a variety of changes in blood rheology indicators before the appearance of clinical obvious symptoms and signs, so hemorheology is often used to predict diseases[12]. Hemorheology indicators mainly include macro and crowd indicators, while macro indicators include whole blood viscosity and plasma viscosity. The whole blood viscosity mainly reflects the resistance and friction in the blood, high shear and low shear blood viscosity reflects the blood viscosity when the blood flow is fast and slow. The former represents the deformability of red cells, and the latter represents the aggregation of red cells, but it also affected by the plasma viscosity. The plasma viscosity mainly reflects plasma fibrin content, and it is determined by the large molecular substance in the plasma and inversely proportional to the blood volume[13]. Through the observation of blood viscosity, aggregation, flow, platelet aggregation, red cell deformation and other indicators, hemorheology study the rheology of blood vessels and blood flow from the microscopic and macroscopic view[14]. Gavriilaki found[15] that in NP children, the change of blood viscosity was closely related to the heart and brain damage, performance for the obviously increased high shear and low shear whole blood viscosity, red cell aggregation index and the obviously decreased red cell deformation index. In this study, we first reported the changes of hemorheology in newborns whose HCT between 60%-65%. We found that compared with the control group that HCT less than 60%, HCT, whole blood viscosity (high shear), whole blood viscosity (low shear), red cell aggregation index, red cell rigidity index in the observation group were significantly higher than those in the control group, and the differences were all statistically significant. While there was no significant difference in plasma viscosity, red cell electrophoresis index and red cell deformation index between the two groups. The results showed that abnormal hemorheology existed in newborns whose HCT between 60%-65%. The reasons may be that HCT was positively correlated with whole blood viscosity, the higher HCT, the higher whole blood viscosity. The increased blood viscosity will cause the slowed blood flow, the bigger possibility of red cell aggregation collision and the increased red cell aggregation index. The low blood flow velocity can cause tissue oxygen and acid poisoning, hemoglobin and red cell increase, coupled with the decreased blood pH value, red cell elasticity decreased, resulting in the increased red cell rigidity index[16,17].

By track deformation, red cells through smaller diameter capillaries to carry out material exchange, which is the basic function of red cells. Large number of red cells increases blood flow velocity, local microcirculation disturbance and insufficient blood oxygen and nutrient supply, resulting in a large number of generated free radicals. On the one hand, the integrity of the cell membrane will damage, and causes the damage of the tissue and organ function; On the other hand, metabolic disorder causes the accumulation of metabolites, causing heart and brain injury, and myocardial enzyme spectrum increase[18,19]. Ancochea found[20] that in NP children, the increased pulmonary vascular resistance resulting in decreased cardiac output, which further aggravated cerebral ischemia. We also found that in observation group, the myocardial enzyme indexes aspartate aminotransferase, creatine kinase, creatine kinase isoenzyme and lactate dehydrogenase were all significantly higher than those in the control group. Alsafadi found[21] that in NP children, Vs and Vd decreased while RI increased in anterior cerebral artery and middle cerebral artery. We also found that in observation group, Vs and Vd were significantly decreased while RI was significantly increased compared with those in the control group, and aEEG examination results showed the abnormal rate in the observation group was 24.0%, which was significantly higher than that in the control group and the difference had statistical significance. The reasons may be that the higher HCT, the increased blood stasis and blood viscosity, the gradually decreased cerebral blood flow perfusion, causing brain tissue ischemia and anoxia and brain damage. And the longer duration of the HTC, the more severe brain injury[21,22].

In summary, we found the newborns whose HCT among 60%-65% but not with polycythemia have appeared blood rheology changes and cerebrovascular lesions. Clinically, we need to improve the blood rheology, myocardial enzyme spectrum, head Doppler ultrasound and aEEG examination for this part of the newborns, so as to early detection of brain damage, and to take targeted interventions to reduce the risk of cardiovascular and neurological sequelae.

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