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Research Article

Seasonal Changes of Hemorheology in Patients with Intracerebral Hemorrhage in Acute Phase

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Abstract: ***Objective.*** To explore the seasonal changes of hemorheology in patients with intracerebral hemorrhage in acute phase. ***Methods.*** The hemorheology indexes were detected in 100 acute cerebral hemorrhage patients and 30 normal persons. The observed group were divided into summer group, transition season group and winter group according to traditional solar terms, then the hemorheology indexes of different groups were compared. ***Results.*** Compared with control group, the whole blood viscosity increased with statistical significance(P<0.05). The whole blood viscosity of four cut blood rates and plasma viscosity were further compared in summer group, transition season group and winter group, and the indexes were the highest in winter group. Compared with transition season group, the erythrocyte aggregation index and erythrocyte transformation index acute intracerebral hemorrhage patients were decreased in winter group and summer group. The whole blood viscosity, plasma viscosity and erythrocyte sedimentation rate(ESR) compared in each group were increased with statistical significance. There were no significant statistical differences in hematocrit(HCT) among each groups(P>0.05). ***Conclusion.*** The hemorheology indexes in acute intracerebral hemorrhage patients are influenced by changes of different seasons and The blood of acute cerebral hemorrhage patients shows a concentrated tendency. The whole blood viscosity and plasma viscosity of acute cerebral hemorrhage patients were increased more obviously in winter group, which may be a pathophysiological basis of high incidence of acute cerebral hemorrhage in cold season and increase of severe cases.

Keywords: Climate, Acute intracerebral hemorrhage, Hemorheology

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1 Introduction

Intracerebral hemorrhage (ICH) is a type of stroke with high incidence, high mortality, high disability, high recurrence rate, high economic burden and other characteristics without specific treatment[1]. The mechanism of brain injury after ICH is more complicated, involving a series of complex pathological pathways and biochemical reaction processes[2]. At present, more studies have shown that abnormal blood rheology is an important risk factor of cerebrovascular disease. However, there are still few reports on hemorrhagic cerebrovascular disease. There are many studies on cerebral hemorrhage and seasonality at local and abroad, but there are only a few reports on the changes of hemorheology in cerebral hemorrhage in different seasons[3, 4]. In different seasons, temperature changes can affect the ability of blood vessels to regulate, further affecting blood rheology. In this study, we examined the hemodynamic parameters of patients with ICH in different seasons to explore the changes and clinical significance of hemorheology in patients with ICH under different seasonal conditions.

2 Information and methods

2.1 Subjects of the study

Hundreds of patients in the Department of Neurology, Jiangsu University Affiliated Hospital from January 2014 to January 2015 were observed, including 58 males and 42 females; aged 40 to 80 years with the median age of 61.57±3.49 years. The inclusion criteria for acute cerebral hemorrhage were based on the diagnostic criteria for the cerebrovascular disease[3] developed by the Chinese Medical Association 13th National Conference on Neurology (2010), confirmed by cranial CT and magnetic resonance imaging. Whereas, exclusion criteria are patients with transient ischemic attack and cerebral infraction; subarachnoid hemorrhage and intracranial hemorrhage caused by blood disease, tumor or trauma; patients with non-acute cerebral hemorrhage; those who died within 24 hours after admission to acute cerebral hemorrhage; patients with severe primary diseases such as the liver, kidney, hematopoietic system and endocrine system. The control group was a normal physical examination in the hospital, a total of 30 cases including 28 males and 12 females; aged 42 to 78 years with a median age of 58.73±5.24 years. They are a healthy person who has done blood pressure, blood sugar, liver and kidney function, chest X-ray, electrocardiogram tests to exclude hypertension, diabetes, hyperlipidemia, cardiovascular and cerebrovascular diseases, kidney and blood circulatory system diseases.

2.2 Methods of the study

All patients were admitted to the hospital within 24 hours (before treatment). In the control group, 4 ml of venous blood (heparin anti-coagulated) was taken on the day of the physical examination. The high-cut (200 s-1, mPa·s), medium-cut (50 s-1, mPa·s) and a low cut (5 s-1, mPa·s) was measured using LBY-N6B automatic blood rheometer analyzer and supporting reagents produced by Beijing Plymouth Co. Ltd. They were evaluated by the whole blood viscosity at four shear rates, plasma viscosity, erythrocyte aggregation index and erythrocyte deformation index. Hematocrit (HCT) was determined by the Wen's method while the blood sedimentation was measured by the Weiss method.

All patients underwent CT scan (FLEXSCAN-T966 whole body spiral CT machine, GE, USA) before the treatment to determine the location of the bleeding and understand the hematoma. The size of the hematoma is calculated according to the Tada's formula. Hematoma volume = length x width x number of CT layer/2.

The cerebral hemorrhage group was divided into three groups according to the solar terms[6]. The division of seasons is divided into winter groups according to the traditional solar terms in Zhenjiang. Before the snowfall to the spring equinox, the 2015 solar calendar will be from November 7 to March 20. Summer group: From grain buds to before autumn equinox, the solar calendar from May 21 to September 22. Transition season group: From spring equinox to before grain buds and the autumn equinox to before small snow, the solar calendar from March 21 and May 20 and the solar calendar from September 23 to November 6.

2.3 Statistical analysis

Measurement data were expressed as s, t-test and one-way analysis of variance were used for comparison between groups. The LSD method was used for comparison between the two groups. $P<0.05$ was considered statistically significant. All data were analyzed using SPPS 17.0 software package.

3 Results

Compared with the control group, the whole blood viscosity (1 s-1, mPa·s, 50 s-1, mPa·s, 200 s-1, mPa·s) in the cerebral hemorrhage group showed an increasing trend and was statistically significant ($P<0.05$). The whole blood viscosity of the four groups and plasma viscosity were further compared between the transitional season group, summer group and winter group of cerebral hemorrhage patients ($P<0.01$) and the highest was the winter group. Compared with the transitional season group, the red blood cell aggregation and deformation indexes of the patients in the summer group and winter group showed a downward trend. The whole blood viscosity, plasma viscosity and erythrocyte sedimentation rate were increased ($P<0.05$). Hematocrit was not statistically significant between the three groups. See Table 1.

Table 1. Hemorheological parameters of normal control group and cerebral haemorrhage group in different seasons($\bar{x} \pm s$)

Item	Normal control group	Brain hemorrhage group		
	(n=30)	Over-season group (n=35)	Summer group (n=20)	Winter group (n=45)
Whole blood viscosity (1 s-1, mPa·s)	18.03±0.49	20.89±0.56▲	22.04±0.68▲ ★	25.16±0.67▲ ★
Whole blood viscosity (5 s-1, mPa·s)	9.09±0.28	9.19±0.23○	9.64±0.27▲ ★	10.46±0.25▲ ★

Whole blood viscosity (50 s-1, mPa·s)	4.74±0.11	4.80±0.07▲	4.89±0.12▲ ★	5.07±0.14▲ ★
Whole blood viscosity (200 s-1, mPa·s)	3.91±0.10	4.02±0.09▲	4.10±0.13▲ ★	4.80±0.07▲ ★
Plasma viscosity	1.12±0.10	1.16±0.10	1.41±0.02 ★	1.42±0.05 ★
Erythrocyte aggregation index	6.51±0.61	6.59±0.69	6.16±0.17 ★	5.65±0.25 ★
Red blood cell deformation index	1.81±0.33	1.93±0.36	1.18±0.19 ★	0.81±0.01 ★
HCT (%)	0.53±0.04	0.54±0.05	0.45±0.0▲ ★	0.43±0.02 ★
ESR	4.47±0.89	6.21±1.74	8.03±1.29 ★	8.22±3.20 ★

○: $P<0.05$, compared with the control group; ▲: $P<0.01$ compared with the control group; ★ : $P<0.05$, compared with the transitional season group.

4 Discussion

Many experimental studies and epidemiological surveys showed that the incidence of ICH has a certain seasonality, high in winter and low in summer. From the above experimental data, it can be found that the number of patients with ICH in the winter group is nearly twice that of the summer group. The seasonal variation trend was observed in the whole blood viscosity group, plasma viscosity and erythrocyte sedimentation data of ICH patients, which showed that the transitional season group<summer group<winter group, the comparison between groups was statistically significant ($P<0.05$). The seasonal variation trend of red blood cell aggregation index and red blood cell deformability in the three groups of data was the transitional season group>summer group>winter group. It shows that in the cold season of winter, the blood concentration of patients with cerebral hemorrhage is more obvious, and the blood viscosity is larger. Studies have shown that cold stimulation causes the body to be in a stress-responsive state, and the lupus-sympathetic-adrenal medulla system excitability is significantly increased[7]. After brain injury, a large amount of catecholamine neurotransmitters such as norepinephrine are released is the main cause of abnormal blood rheology[8, 9]. Data reported by Liu Yulin et al.[10] shows that low temperature can lead to increased blood viscosity, decreased red blood cell aggregation ability and poor deformability. Under cold stress, vasoconstriction is obvious, blood flow in tissues and organs is decreased, body metabolic rate is decreased, white blood column ratio in plasma is imbalanced, fibrinogen is elevated, blood is hypercoagulable, plasma viscosity is increased, and erythrocyte sedimentation rate is increased[11]. Thus, it is speculated that this may be an important basis of pathophysiological changes for the incidence of winter cerebral hemorrhage.

Studies have shown that blood rheology is affected by ambient temperature and humidity. If the body is in a pathological condition, it will further aggravate the deterioration of blood rheology and result in a virtuous circle. Animal data by Yang Feng et al.[12] shows the rheological indicators will increase when the ambient temperature is below 10°C and above 21°C. Weng Miaocheng et al.[13] believe that blood rheology indicators are the best in the temperature range of 16°C–28°C. Blood viscosity will increase to varying degrees when the temperature is too high or too low. The incidence of cerebral hemorrhage during summer is low. Considering heat stress, vasodilation, reduced blood pressure and wall shear stress, which can reduce the damage of the blood vessel wall and further reduce the occurrence of hemorrhagic cerebrovascular disease. At high temperatures, blood flow is accelerated, and red blood cells are more difficult to aggregate, resulting in a decrease in red blood cell aggregation index and a reduce in deformability. Continuous increase in temperature can lead to dehydration of the body, microcirculatory disorders, accelerated erythrocyte sedimentation rate and increased blood viscosity. In conclusion, patients with cerebral hemorrhage have obvious hemorheological abnormalities in the acute phase and have different manifestations in different seasons. In the cold winter, blood viscosity increases significantly which may be an important reason for the incidence of winter cerebral hemorrhage, recurrence rate, risk of rebleeding and high incidence of adverse outcomes. Therefore, to explore the changes of blood rheology and its seasonal influencing factors after cerebral hemorrhage, it is of great clinical significance to clarify its internal law, take active and effective interventions, and improve the prognosis of patients with cerebral hemorrhage. At the same time, it also provides objective evidence for doctor-patient communication[14]. The effects of temperature on blood rheology after ICH need to be collected in future research work for further study and discussion.

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