

Correlation Between HAPC and Cerebral Infarction in Plateau Area

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Abstract

Objective: To explore the correlation between HAPC and cerebral infarction in high altitude area. **Methods:** A total of 83 patients with cerebral infarction who were randomly admitted to Naqu People's Hospital from January 2015 to December 2020 in Naqu District were selected as the observation group and 113 patients without cerebral infarction were randomly selected as the control group, in order to further explore the relationship between HAPC and cerebral infarction in high altitude area and select national standard hemoglobin as the main analysis object. **Results:** ① The rate of patients with high altitude polycythemia in the BCS group was 61.4%, which was higher than 59% reported by previous researchers. And is obviously higher than 41.6% of non-cerebral infarction group; ② The values of red blood cell count, hemoglobin and hematocrit in hematology were higher than those in the control group (all P values < 0.001, statistically significant); ③ The correlation analysis between ③HAPC and cerebral infarction showed a positive correlation. **Conclusion:** the existence of HAPC is one of the important factors leading to cerebral infarction.

Keywords

HAPC; Cerebral infarction hemoglobin.

1. Introduction

High Altitude Polycythemia, HAPC), is a chronic altitude disease in which human body is in high altitude (more than 2500 meters) for a long time and the compensatory excessive proliferation of red blood cells is caused by high altitude hypoxia. The most striking feature of HAPC and polycythemia vera, PV) is the absence of malignant transformation. In the "Qinghai Standard" in 2004, HAPC was defined as male hemoglobin concentration $\geq 210\text{g/L}$ and female hemoglobin concentration $\geq 190\text{g/L}$, and hypoxemia caused by chronic respiratory diseases and cardiovascular diseases must be excluded [1, 2].

Similar to the physiological changes of diseases caused by Zhen Hong's disease, when the polycythemia persists and progresses to a certain extent, it can lead to lesions in various systems of the body, such as cardiovascular system, lung system, brain system, digestive system, and reproductive system, Female patients may even cause poor prognosis during pregnancy [3, 4]. Therefore, exploring the specific pathogenesis of HAPC, studying its relationship with various systemic lesions in the body and poor prognosis of pregnancy and finding effective prevention and management measures are urgent issues to be solved for this kind of population. Naqu city is located in the plateau with an average altitude of 4500 meters, and the absolute oxygen content in the air is only 58% of that in the plain area. Hypoxia can induce a series of physiological reactions, the most significant of which is the compensatory increase of red blood cells and the increase of hemoglobin concentration [5, 6]. However, High altitude polycythemia,

HAPC) is more common in the Han population who migrate to the plateau, while it is relatively rare in the Tibetan population who live in the plateau. Years of research have shown that this is related to the adaptation of the genome of the Tibetan population to the high altitude, and the existence of an "anti-polycythemia" gene in its genome [7, 8]. However, there are still some Tibetan population whose red blood cell count has increased significantly, and this population has a significant correlation with the occurrence and development of various diseases [9].

An epidemiological survey conducted more than 10 years ago showed [10, 11] that in Ari region, located at an altitude of 4,500 meters, the incidence of polycythemia was up to 5.2%, while in Lhasa, at a relatively low altitude, the incidence was only 1.9%. Moreover, men are higher than women and herders are higher than farmers. However, a recent study showed that the Tibetan population had limited adaptation to high altitudes, with an altitude of 4,500 meters reaching the limit of biological adaptation. The incidence of polycythemia is as high as 34.7% in males and 33.1% in females among the Tibetan population who live at an altitude of 4,500 meters and above all the year round (for example, Ando County, Naqu City, at an altitude of 4,679 meters), Shuanghu County, Naqu City, which is located at an altitude of 5,018 meters, has an incidence rate of 65.3% for men and 65.1% for women.

Naqu City is located in northern Tibet with a population of about 500,000. Its western and northern counties of Nima, Shuanghu, Bango, Nierong, Shenza and Ando have a population of about 300,000. The population of these counties has long lived at an altitude of more than 4,500 meters. Therefore, for Naqu City, it not only has good scientific significance but also has extremely strong public health value to fully study the relationship between polycythemia and human diseases and find effective primary, secondary and tertiary prevention strategies.

Cerebral infarction is a kind of common comprehensive disease caused by insufficient blood supply of brain tissue and irreversible damage of brain caused by blood circulation disorder of brain, eventually leading to ischemia, hypoxic necrosis or encephalomalacia of localized brain tissue. This disease is also called ischemic stroke. It belongs to the category of "stroke" in traditional medicine, mainly with the typical symptoms of sudden coma, unconsciousness, hemiplegia, distortion of your mouth and tongue and unsmooth speech. According to the epidemiological survey and statistics, the mortality rate of cerebrovascular diseases ranks second in the world, and cerebral infarction alone accounts for as much as 60%–80%. Every year, there are about 2 million new cases of cerebral infarction in China, and about 1.5 million patients die from cerebral infarction. It has the characteristics of high morbidity, high mortality (about 30%), high disability rate (about 70% of patients with hemiplegia and other disabilities), and easy to relapse, which has seriously affected the health of the residents and brought a huge burden to the national health insurance and individuals.

Studies have shown that [12] hypererythrocytosis can further induce cerebral infarction. Thus, HAPC may be a factor that cannot be ignored in the induction of cerebral infarction in high altitude area. This paper summarizes 83 cases of cerebral infarction patients randomly admitted to the Department of Neurology Outpatient of Naqu People's Hospital from 2019 to 2020 in Naqu area as the observation group and 113 cases of non-cerebral infarction patients randomly selected as the control group, in order to further explore the relationship between HAPC and cerebral infarction in high altitude area.

2. Information and Methods

2.1. General Information

The 196 patients included were all Tibetans who lived in the plateau for a long time, with the highest age of 87 years old and the lowest of 36 years old. There were 128 males and 68 females. There were 83 cases in the observation group and 113 cases in the control group.

2.2. Inclusion Criteria

Patients with cerebral infarction in the experimental group and patients with non-cerebral infarction in the control group. The diagnosis of ischemic stroke met the 2014 criteria of the Guidelines for Diagnosis and Treatment of Acute Ischemic Stroke in China; The diagnosis of HAPC was according to the criteria of the 6th International Conference on Highland Medicine in 2004, that is, for the patients who lived at an altitude of > 2500 m for a long time, the hemoglobin of men was > 210 g/L and that of women was > 190 g/L. Written informed consent was provided by all enrollees. The investigation was approved by the local hospital ethics committee. All experiments were performed in accordance with approved guidelines and regulations.

2.3. Detection Methods

Cerebral infarction was confirmed by CT or MRI in all patients of the observation group, Fasting venous blood was drawn from all included patients, and red blood cell count, hemoglobin, and hematocrit were selected as analysis objects. Changes of blood values caused by medication were excluded before blood collection.

2.4. Data Processing

Hemoglobin values were used as measurement data, and the difference between two groups was compared using Student's t test. Onset or not was counted data, and the correlation between HAPC and cerebral infarction was examined by non-parametric Spearman rank correlation test. Statistical analysis was performed using SPSS 22.0 software. $P < 0.05$ was considered to be statistically significant.

3. Result

3.1. General Data Description Between Groups

Table 1. HAPC proportion between observation group and control group

Group	HAPC	Non-HAPC	Proportion
Observation group	51	32	61.4%
control group	47	66	41.6%

Note: the proportion of patients with HAPC in the observation group was 61.4%, while that in the control group was 41.6%, which was significantly higher in the observation group than in the control group.

3.2. T-test for Difference Between Groups

Table 2. T test for differences in hematology between the observation group and the control group

Test item	Observation group	control group	T value	P value
hemoglobin	180.26±38.73g/L	149.35±33.61g/L	5.962	<0.001
Red blood cell count	7.04±0.25 (×10 ¹²)	5.832±0.301 (×10 ¹²)	29.783	<0.001
Hematocrit	81.12±7.31	55.26±5.62	27.999	<0.001

Note: P-values of hemoglobin, red blood cell count and hematocrit of the observation group and the control group are all less than 0.001.

Table 3. Correlation between haptic and cerebral infarction

		Cerebral infarction	HAPC
Cerebral infarction	Correlation coefficient	1.000	0.187**
	Sig. (double-tailed)		0.009
	N	196	196

*coefficient is 0.009, indicating that the incidence of cerebral infarction and HAPC was positively correlated

4. Discussion

There are many factors causing cerebral infarction, Recent studies have found that [13–15] the decline of blood flow and deformation ability is one of the most important factors. The increase in blood viscosity will cause a decrease in cerebral blood flow velocity, leading to the appearance of cerebral infarction. Hematological indicators studied in this paper: red blood cell count, hemoglobin, and hematocrit, The abnormal increase of these indicators will cause the increase of blood viscosity [16, 17].

The clinical symptoms of cerebral infarction are mainly manifested as sudden headache, dizziness, accelerated heart rate, elevated blood pressure, and tachypnea [18, 19], The main causes of cerebral infarction are blood lipids and carotid atherosclerosis, which belongs to the systemic lesion and is also the key factor for the triggering of ischemic stroke, High cholesterol in blood lipids is a reaction of lipoprotein metabolism, while total cholesterol shows the effect of limiting fibrin degradation, thus promoting the gradual increase of hemagglutinin, High density lipoprotein cholesterol exhibits anti-atherosclerotic properties [20, 21]; Low density lipoprotein cholesterol is the main lipoprotein carrying cholesterol in the blood, which generates products such as lipid peroxides and aldehydes through the action of free radicals, Besides, lysine in low density lipoprotein cholesterol undergoes oxidative modification and accumulation, forming oxidized and modified low density lipoprotein cholesterol, Low density lipoprotein cholesterol is easily taken up by the "scavenger" receptor of macrophages, leading to cholesterol accumulation, leading to the formation of foam cells and triggering of atherosclerosis, Cholesterol-rich lipoprotein has a structure similar to that of low-density lipoprotein cholesterol, thus promoting cholesterol deposition, which is mainly located in the artery wall, It can limit the fibrinolysis on the surface of endothelial cells by changing the plasminogen binding site, thereby promoting the formation and increase of vascular smooth muscle cells, and finally leading to the formation of thrombosis [22–25].

Cerebral infarction is a common dangerous, acute and severe disease in neurology department, So far, there have been many articles summarizing its characteristics [26–28], but the study on the relationship between high altitude polycythemia and cerebral infarction is rare. The special geographical environment of Naqu People's Hospital in Naqu region leads to a large number of patients with cerebral infarction treated with high altitude polycythemia. Hypoxia at high altitude leads to compensatory increase and aggregation of red blood cells as well as increase of hematocrit. Then it causes the increase of blood viscosity, affects blood microcirculation, aggravates cerebral ischemia and hypoxia, reduces cerebral blood flow and causes cerebral infarction. Patients with long-term erythrocytosis are prone to form hemodynamic changes [29, 30], including blood viscosity, and microthrombus, After polycythemia, blood flow slows down, making blood cells easily adhere to the vascular wall, causing damage to endothelial cells, which then initiates the endogenous clotting pathway. Therefore, patients with repeated long-term diseases are more likely to suffer from cardiovascular and cerebrovascular diseases [31, 32].

The results of this study showed that the proportion of patients with high altitude polycythemia in the brain-acupuncture group was 61.4%, up from 59% previously reported by researchers.

And is obviously higher than 41.6% of non-cerebral infarction group; However, in hematology examination, the red blood cell count, hemoglobin and hematocrit were all higher than those in the control group, and the P values were all < 0.001, showing statistical significance. The correlation analysis of HAPC and cerebral infarction showed that they were positively correlated. In summary, the presence of HAPC is one of the important factors that increase the incidence of cerebral infarction. Results ① The rate of patients with high altitude polycythemia in the BCS group was 61.4%, which was higher than 59% reported by previous researchers. And is obviously higher than 41.6% of non-cerebral infarction group; ② The values of red blood cell count, hemoglobin and hematocrit in hematology were higher than those in the control group (all P values < 0.001, statistically significant); ③ The correlation analysis between ③HAPC and cerebral infarction showed a positive correlation.

Naqu City is located in northern Tibet with a population of about 500,000. The population of most counties in the west and north of the country live in the environment with an altitude of 4500 meters for a long time. Therefore, for Naqu City, it not only has good scientific significance but also has extremely strong public health value to fully study the relationship between polycythemia and cerebral infarction and find effective primary, secondary and tertiary prevention strategies.

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