



# Assessment value of transcranial Doppler hemodynamic typing for prognosis of patients with acute middle cerebral artery infarction

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## ARTICLE INFO

### Article history:

Received  
Received in revised form  
Accepted  
Available online

### Keywords:

Acute middle cerebral artery infarction  
Transcranial Doppler  
Hemodynamic

## ABSTRACT

**Objective:** To analyze the assessment value of transcranial Doppler hemodynamic typing for prognosis of patients with acute middle cerebral artery infarction. **Methods:** A total of 54 cases of patients with acute middle cerebral artery infarction who received treatment in our hospital from January 2014 to June 2015 were included for study, and according to different types, they were divided into total occlusion group 17 cases, partial occlusion group 28 cases and non-occlusion group 9 cases. Differences in levels of infarction-related proteins, coagulation-related indicators, illness-related factors, etc in circulating blood of three groups were compared, and the correlation of middle cerebral arterial systolic velocity (Vs) and diastolic velocity (Vd) with above indicators was further analyzed. **Results:** Vs and Vd values of non-occlusion group were higher than those of total occlusion group and partial occlusion group, and Vs and Vd values of partial occlusion group were higher than those of total occlusion group; serum Gelsolin, PT, APTT and TT values of non-occlusion group were higher, SAA, Apo- C II, HbA1c, GSP, A  $\beta$ , HSP70, FIB, D-D, Copeptin, P-selectin, PTX3, TPO and FFA values were lower, and compared with partial occlusion group and total occlusion group, differences were significant; Gelsolin, PT, APTT and TT values of partial occlusion group were higher than those of total occlusion group, and SAA, Apo- C II, HbA1c, GSP, A  $\beta$ , HSP70, FIB, D-D, Copeptin, P-selectin, PTX3, TPO and FFA values were lower than those of total occlusion group; middle cerebral arterial Vs and Vd values were directly proportional to Gelsolin, PT, APTT and TT values, and inversely proportional to SAA, Apo- C II, HbA1c, GSP, A  $\beta$ , HSP70, FIB, D-D, Copeptin, P-selectin, PTX3, TPO and FFA values. **Conclusions:** Transcranial Doppler hemodynamic typing can be the reliable way to judge the severity of acute middle cerebral artery infarction, and has great value in assessing disease prognosis.

## 1. Introduction

Middle cerebral artery is the common occluded blood vessel in acute cerebral infarction, and intravenous-intra-arterial thrombolysis in the time window is the best treatment plan. Early symptoms of acute cerebral infarction patients are spontaneously improved or aggravated, and can all lead to hemodynamic index change of cerebral perfusion, and the change is associated with spontaneous thrombolysis, re-occlusion and collateral circulation

establishment[1,2]. Research suggests that transcranial Doppler sonography (TCD) can accurately determine the hemodynamic state of occluded blood vessels, and can monitor in real time for many times in the course of disease development. At present, the value of TCD in assessing the prognosis of patients with acute middle cerebral artery infarction remains uncertain, and it would be specifically analyzed in the research.

## 2. Materials and methods

### 2.1. General information

A total of 54 cases of patients with acute middle cerebral artery

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Fund Project: Science and Technology Bureau of Shuanghe City, the Fifth Division, Bole, Xinjiang NO: 2014AE024.

infarction who received treatment in our hospital from January 2014 to June 2015 were included for study, received hemodynamic detection by transcranial Doppler sonography (TCD) and were divided into total occlusion group 17 cases, partial occlusion group 28 cases and non-occlusion group 9 cases according to different types. Total occlusion group included 10 male cases and 7 female cases, they were 43-72 years old, and the average was  $(59.38\pm 5.76)$  years; partial occlusion group included 17 male cases and 11 female cases, they were 41-70 years old, and the average was  $(58.62\pm 6.11)$  years; non-occlusion group included 6 male cases and 3 female cases, they were 44-71 years old, and the average was  $(59.37\pm 6.04)$  years. Differences in gender, age and other baseline information were not significant among three groups ( $P>0.05$ ).

## 2.2. TCD detection

The TC-2012 type transcranial Doppler instrument (EME, Germany) was used for hemodynamic detection, and unaffected-side middle cerebral artery blood flow signal and spectrum changes were examined through the temporal window check so as to clear the temporal window penetrability. Affected-side inspection was carried out in accordance with the Alexandrov cerebrovascular detection process, middle cerebral artery was searched through the temporal window, and vascular systolic velocity (Vs) and diastolic velocity (Vd) were measured. According to the involved blood flow signal and spectrum changes, etc in lesion-side middle cerebral artery, cerebral infarction was divided into three types: total occlusion, partial occlusion and non-occlusion.

## 2.3. Infarction-related proteins

Gelsolin (GSN), amyloid A (SAA), apolipoprotein C II (Apo-C II), glycosylated hemoglobin (HbA1c), glycosylated serum protein (GSP),  $\beta$ -amyloid (A $\beta$ ) and heat shock protein 70 (HSP70) were detected.

## 2.4. Coagulation-related indicators

Prothrombin time (PT), activated partial thromboplastin time (APTT), thrombin time (TT), fibrinogen (FIB) and D-dimer (D-D) levels were detected.

## 2.5. Illness-related factors

Copeptin, P-selectin, pentraxin 3 protein (3 (PTX3), thrombopoietin (TPO) and free fatty acid (FFA) levels were detected.

## 2.6. Statistical methods

SPSS 20.0 software was used to input and analyze data, measurement data comparison among three groups was performed by variance analysis and correlation analysis by Pearson test. Differences were considered to be statistically significant at a level of  $P<0.05$ .

## 3. Results

### 3.1. Lesion-side middle cerebral artery blood flow indicators of three groups

Vs of total occlusion group was  $(24.18\pm 2.09)$  cm/s, Vs of partial occlusion group was  $(54.18\pm 4.88)$  cm/s and Vs of non-occlusion group was  $(117.56\pm 9.67)$  cm/s; Vd of total occlusion group was  $(3.41\pm 0.35)$  cm/s, Vd of partial occlusion group was  $(23.16\pm 2.09)$  cm/s and Vd of non-occlusion group was  $(57.43\pm 4.98)$  cm/s. Vs and Vd values of non-occlusion group were higher than those of total occlusion group and partial occlusion group, and Vs and Vd values of partial occlusion group were higher than those of total occlusion group ( $P<0.05$ ).

### 3.2. Infarction-related proteins

In the occurrence and progress process of acute cerebral infarction, the levels of a variety of proteins dramatically change in the body, they are the important factors affecting the prognosis and outcome of cerebral infarction and the detection of infarction-related protein levels is a reliable way to judge illness severity, treatment efficacy and prognosis. In the research, detection of serum infarction-related protein levels showed that serum Gelsolin of non-occlusion group was higher, SAA, Apo-C II, HbA1c, GSP, A $\beta$  and HSP70 were lower, and compared with partial occlusion group and total occlusion group, differences were significant ( $P<0.05$ ); Gelsolin value of partial occlusion group was higher than that of total occlusion group, and SAA, Apo-C II, HbA1c, GSP, A $\beta$  and HSP70 values were lower than those of total occlusion group ( $P<0.05$ ), shown in Table 1.

### 3.3. Coagulation-related indicators

One of the main causes of acute cerebral infarction is coagulant function abnormality, and continuous coagulant function abnormality can promote the further aggravation of cerebral infarction. In the research, the blood coagulation-related index levels were detected after the attack, and the results showed that serum PT, APTT and

TT values of non-occlusion group were higher than those of partial occlusion group and total occlusion group while FIB and D-D values were lower than those of partial occlusion group and total occlusion group; PT, APTT and TT values of partial occlusion group were higher than those of total occlusion group while FIB and D-D values were lower than those of total occlusion group ( $P<0.05$ ), shown in Table 2.

3.4. Illness-related factors

There are many factors in serum that are directly related to acute brain infarction, which may participate in the occurrence and development process of cerebral infarction. In the research, circulating blood was drawn from patients to detect the levels of Copeptin, P-selectin and other factors, and the results showed that serum Copeptin, P-selectin, PTX3, TPO and FFA values of non-occlusion group were lower than those of partial occlusion group and total occlusion group, and Copeptin, P-selectin, PTX3, TPO and FFA values of partial occlusion group were lower than those of total occlusion group ( $P<0.05$ ), shown in Table 3.

3.5. Correlation of Vs and Vd with cerebral infarction

Vs and Vd values in patients with acute middle cerebral artery infarction were directly proportional to Gelsolin, PT, APTT and TT values, and inversely proportional to SAA, Apo- C II, HbA1c, GSP, A β, HSP70, FIB, D-D, Copeptin, P-selectin, PTX3, TPO and FFA

values ( $P<0.05$ ), shown in Table 4.

Table 4

Comparison of the correlation of Vs and Vd with cerebral infarction.

	Vs		Vd	
	Determination coefficient r	P	Determination coefficient r	P
Gelsolin	0.672	<0.05	0.583	<0.05
SAA	-0.573	<0.05	-0.627	<0.05
Apo- C II	-0.593	<0.05	-0.593	<0.05
HbA1c	-0.612	<0.05	-0.627	<0.05
GSP	-0.648	<0.05	-0.573	<0.05
A β	-0.638	<0.05	-0.627	<0.05
HSP70	-0.609	<0.05	-0.559	<0.05
PT	0.583	<0.05	0.563	<0.05
APTT	0.562	<0.05	0.581	<0.05
TT	0.559	<0.05	0.673	<0.05
FIB	-0.617	<0.05	-0.604	<0.05
D-D	-0.632	<0.05	-0.593	<0.05
copeptin	-0.593	<0.05	-0.627	<0.05
P-selectin	-0.627	<0.05	-0.583	<0.05
PTX3	-0.583	<0.05	-0.621	<0.05
TPO	-0.603	<0.05	-0.557	<0.05
FFA	-0.521	<0.05	-0.593	<0.05

4. Discussion

Acute middle cerebral artery infarction is a common type of ischemic stroke, and the incidence is second only to internal carotid artery occlusion. Thrombolysis is currently the best way to treat cerebral infarction and restore blood flow, and in the process of thrombolysis treatment, TCD can be used for dynamic monitoring of residual blood flow in target vessels[3]. Current study shows that

Table 1

Comparison of serum infarction-related protein levels among three groups.

Groups	Gelsolin (μg/L)	SAA (mg/L)	Apo- C II (g/L)	HbA1c (%)	GSP (mmol/L)	A β (ng/mL)	HSP70 (pg/mL)
Total occlusion	45.82±4.39	17.34±1.64	0.23±0.03	8.11±0.79	4.17±0.43	1.76±0.15	29.57±3.05
Partial occlusion	61.28±6.29	11.52±1.09	0.18±0.03	6.09±0.58	2.29±0.23	1.42±0.16	24.83±2.76
Non-occlusion	103.76±10.52	8.39±0.76	0.11±0.02	4.38±0.42	1.78±0.15	1.13±0.12	19.45±1.54
F	8.342	7.913	5.923	7.032	6.182	5.738	8.293
P	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Table 2

Comparison of coagulation-related indicator values among three groups.

Groups	PT (s)	APTT (s)	TT (s)	FIB (g/L)	D-D (μg/L)
Total occlusion	11.43±1.34	21.09±2.81	15.82±1.76	3.42±0.36	6 721.93±503.77
Partial occlusion	12.07±1.35	25.43±2.76	17.75±1.69	2.79±0.28	1 923.53±154.38
Non-occlusion	13.23±1.43	29.38±2.09	19.02±1.47	2.17±0.32	735.38±65.17
F	5.034	5.834	6.119	6.498	12.394
P	<0.05	<0.05	<0.05	<0.05	<0.05

Table 3

Comparison of serum illness-related factor levels among three groups.

Groups	Copeptin (pmol/L)	P-selectin (μg/L)	PTX3 (μg/L)	TPO (pg/mL)	FFA (nmol/mL)
Total occlusion	12.39±1.76	60.54±6.19	19.39±2.63	113.28±15.66	412.36±40.57
Partial occlusion	9.12±0.87	37.62±3.87	11.27±1.34	97.55±9.38	338.46±30.95
Non-occlusion	6.27±0.59	20.51±2.38	7.21±0.69	76.39±7.05	214.39±20.67
F	8.342	8.938	7.283	11.293	15.302
P	<0.05	<0.05	<0.05	<0.05	<0.05

there are different hemodynamic characteristics in patients with cerebral infarction before the implementation of therapy such as thrombolysis, they are related to the degree of vascular occlusion, so some scholars put forward that TCD can serve as an effective noninvasive method to judge condition and treatment effect[4]. There are few domestic related reports about the role of TCD in assessment of patients with middle cerebral artery infarction, this kind of cerebral infarction patients were selected as the research subjects of the research and were divided into total occlusion group, partial occlusion group and non-occlusion group according to the occlusion condition in infarction vessels, and TCD detection showed that Vs and Vd values of non-occlusion group were the highest, and with the increase of degree of occlusion in target vessels, Vs and Vd values declined. In order to define the correlation of Vs and Vd value with the prognosis of patients, a series of illness-related indicators were further detected in the research.

After acute cerebral infarction, the levels of a variety of proteins change in the body, and they are believed to be involved in the occurrence and development of cerebral infarction. Gelsolin is actin-binding protein, and can regulate actin reorganization and promote the mutual transformation between cytoplasm gel and sol state in calcium-dependent way[5]. Gelsolin belongs to important cytoskeletal protein, cytoskeletal protein is degraded after cerebral infarction, Gelsolin can be gradually consumed as the disease progresses, and circulating blood level is on the decline. SAA belongs to tissue amyloid A precursor substance and is an acute phase protein, SAA levels rise rapidly in cases of acute stimulation, and the sensitivity is higher than C-reactive protein. Apo- C II is a water-soluble low molecular-weight protein, and is the cofactor of low density lipoprotein. Research shows that Apo- C II levels increase significantly in the early cerebral infarction, and with the improvement of disease, Apo- C II shows declining trend[6]. Both HbA1c and GSP can represent the patients' blood glucose levels over a period of time, and high blood glucose can aggravate the brain injury and brain edema, and expand brain tissue necrosis area. A  $\beta$  increases cerebrovascular contractility so as to participate in cerebrovascular damage, and studies have shown that A  $\beta$  levels increase significantly after cerebral infarction occurs, and is directly proportional to disease severity[7,8]. HSP70, also known as stress protein, can be massively expressed after cerebral infarction, and the higher the HSP70 level, the lower the cognitive function of patients. The research results showed that Gelsolin value of non-occlusion group was higher while SAA, Apo- C II, HbA1c, GSP, A  $\beta$  and HSP70 values were lower, and with the increase of occlusion degree in target vessels, Gelsolin value decreased while SAA, Apo- C II, HbA1c, GSP, A  $\beta$  and HSP70 values increased, indicating that the above indicators were closely related to cerebral infarction

condition and tendency, and were the intuitive indicators to judge the prognosis.

Under physiological state, the body's blood coagulation, anticoagulation and fibrinolytic system is in dynamic equilibrium state, above equilibrium is broken when the acute cerebral infarction occurs, the body's anticoagulant effect is reduced, and blood viscosity in circulating blood rises. PT, APTT, TT, FIB and D-D are the most common clinical coagulation-related indexes[9,10]. D-D is the degradation product that is generated through fibrinolytic enzyme hydrolysis after fibrin is cross-linked with activation factor XII, its level increase suggests there is thrombosis in vivo, and it is the marker of system hypercoagulability. PT, APTT and TT values show different degree of decrease after cerebral infarction while the FIB level increases, it indicates that the body is in hypercoagulability, and this is one of the internal causes of the occurrence and development of cerebral infarction. The research results showed that PT, APTT and TT values of non-occlusion group were higher while FIB and D-D values were lower, and with the rise of target vascular occlusion degree, PT, APTT and TT values decreased while FIB and D-D values increased[11]. It indicated that there is circulating hypercoagulability in patients with acute middle cerebral artery infarction, and coagulation factor levels are directly related to the disease severity and outcome. There are also many cytokines directly related to cerebral infarction in circulation, and Copeptin, P-selectin, PTX3, TPO and FFA are the five with more research. Copeptin is part of the arginine vasopressin carboxyl terminal, HPA axis is active in the acute phase of cerebral infarction, and Copeptin levels can directly reflect the extent of body's stress[12,13]. P-selectin is the specific indicator produced after the platelet activation, P-selectin levels in circulation rise sharply after acute cerebral infarction, and it is caused by thrombin and inflammatory mediator stimulation[14,15]. PTX3 is acute inflammatory reaction protein that belongs to the same family as CRP, and recent studies show that PTX3 levels increase significantly in acute coronary syndrome, and it is an independent risk factor of recent death in patients[16,17]. TPO is a positive hematopoiesis-regulating factor that can promote angiogenesis when acute cerebral infarction occurs, and exerts neurotrophic, anti-inflammatory and other effects. FFA is the main substance involved in atherosclerosis, and with disease improvement, FFA value decreases[18]. The study showed that serum Copeptin, P-selectin, PTX3, TPO and FFA values of non-occlusion group were lower, and with the increase of the degree of middle cerebral artery occlusion, the values of above indexes increased, indicating that they were closely related to the cerebral infarction condition and outcome.

There are numerous factors associated with disease severity and tendency in patients with acute middle cerebral artery infarction,

both sensitivity and specificity of an individual indicator are low, and combined detection of a variety of factors is complex and time-consuming, and not suitable for whole-process monitoring of the disease[19]. TCD can accurately reflect the hemodynamic indexes of infarction-related arteries, is with convenient operation, noninvasiveness and other characteristics, the correlation of Vs and Vd values with disease-related serological indexes from TCD detection was analyzed at last in the research, and the results showed that Vs and Vd values were directly proportional to Gelsolin, PT, APTT and TT value, and inversely proportional to SAA, Apo- C II, HbA1c, GSP, A  $\beta$ , HSP70, FIB, D-D, Copeptin, P-selectin, PTX3, TPO and FFA. It indicated that the data from TCD detection could directly represent the disease severity in patients with acute middle cerebral artery infarction, and real-time monitoring in the course of disease development could accurately judge the prognosis.

To sum up, it is concluded as follows: transcranial Doppler hemodynamic typing can be a reliable way to judge the severity of acute middle cerebral artery infarction, has great value in assessing disease prognosis, and is worth popularization in clinical practice in the future.

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