SM Journal of Clinical and Medical Imaging

Research Article

The Synergistic Effect of Chronic Hyperglycemia and Dehydration on the Progression of Cerebral Infarction

Huanyin*

[1]Department of Neurology, Minhang Hospital, Fudan University, China.

Abstract

Background : Studies on the role of chronic hyperglycemia and dehydration in the progression of acute cerebral infarction have confirmed that chronic hyperglycemia can promote the progression of acute cerebral infarction, and dehydration can also accelerate the development of cerebral infarction. However, there are few studies on the co-effects of chronic hyperglycemia and dehydration on infarct core volume. Since it is not uncommon for stroke patients to have chronic hyperglycemia and dehydration at the same time, it is of certain clinical significance to study the interaction of the two on stroke.

Method: A total of 270 patients with acute cerebral infarction were included and admitted to hospital to improve the examination of glycosylated hemoglobin, blood urea nitrogen and blood creatinine. We would use blood urea nitrogen (BUN)/creatinine (Cr) ratio as a dehydration marker.The dehydrated group was defined as the blood urea nitrogen/creatinine ratio >15, and the non-dehydrated group was defined as the blood urea nitrogen/creatinine ratio ≤15. HbA1c >7% was defined as chronic hyperglycemia group, HbA1c ≤7% was defined as non-chronic hyperglycemia group. According to the above definition, they were divided into four groups: dehydration + chronic hyperglycemia group, dehydration + non-chronic hyperglycemia group, non-dehydration + chronic hyperglycemia group, and non-dehydration + non-chronic hyperglycemia group. At the same time, the magnetic resonance DWI examination was improved, the infarct core volume was processed by the software after the acute cerebral infarction magnetic resonance image, and the correlation between the infarct core volume and glycosylated hemoglobin and blood urea/creatinine ratio was evaluated.

Results: The core volume of cerebral infarction in chronic hyperglycemia group was larger (infarct volume >43.28ml, HBA1c IQR 6.5%). The core volume of cerebral infarction in dehydrated group was larger (infarct volume >43.28ml, BUN/Cr IQR 17.632). The core volume of cerebral infarction was the largest in dehydration + chronic hyperglycemia group, followed by dehydration + non-chronic hyperglycemia group, non-dehydration + chronic hyperglycemia group, and non-dehydration + non-chronic hyperglycemia group.

Conclusion: Chronic hyperglycemia in patients with acute cerebral infarction is likely to lead to dehydration, which is the main reason for the enlargement of the infarct core. Therefore, it is possible for patients with chronic hyperglycemia to avoid the expansion of the infarct core by correcting the key link of critical dehydration.

Keywords: Dehydration; Chronic hyperglycemia; Infarct core; Bun/Cr; HbA1c; Infarct progression.

INTRODUCTION

Cerebral infarction, also known as ischemic stroke, is one of the most common acute cerebrovascular diseases in our clinic. It is caused by various reasons, the local blood supply disorder of brain tissue, the appearance of brain tissue ischemia and hypoxia, and then produce clinical corresponding neurological deficits. In the clinical process, it is often encountered that a patient's condition continues to progress and aggravates 3 to 5 days after the onset of the disease [1]. These continuously aggravated neurological deficits often take doctors by surprise and make many patients and their families express that they cannot understand, which is easy to cause medical disputes. So, what factors are related to the progression of cerebral infarction? [2]. If we can have a means to judge the progress of cerebral infarction, it will bring great benefits to the doctor. However, there is no uniform international guidelines and consensus on progressive stroke. We have previously found that hyperglycemia may be a very important factor in the progression of cerebral infarction [3], or systemic dehydration of patients leads to cerebral hypoperfusion [4], which leads to the aggravation of cerebral infarction. But how does a brain infarction progress? What is its pathogenesis? We don't know much, and the growth of infarct size is a complex and dynamic process [5]. There's a lot of variation between patients, and we don't have any way of assessing how the size of a patient's infarct increases [6]. For example, is the progression of infarction due to the necrosis of brain tissue caused by ischemia-reperfusion injury? Or is it the poor quality of the collateral circulation of the cerebral artery that leads to the progression of cerebral infarction? Or is it due to the age of the patient and poor control of basal blood pressure? Or is it because of the level of blood sugar? All of these factors can influence the outcome of infarction, and we do not know if one of these factors is dominant or if they are combined. Therefore, we still need to further explore the specific factors affecting the progression of cerebral infarction.

Our previous studies have shown that chronic hyperglycemia has a certain influence on the prognosis of acute cerebral infarction [7]. At the same time, many people use blood glucose levels to predict poor

Submitted: 31 January, 2026 | **Accepted:** 18 February, 2026 | **Published:** 19 February, 2026

***Corresponding author:** Huanyin, Department of Neurology, Minhang Hospital, Fudan University, Shanghai 201101, China.

Citation: Huanyin (2026) The Synergistic Effect of Chronic Hyperglycemia and Dehydration on the Progression of Cerebral Infarction. SM J Clin Med Imaging 8: 7.

outcomes of stroke, but how blood glucose affects the development of cerebral infarct size is still controversial. Chronic hyperglycemia, the patient's glycated hemoglobin level, reflects the patient's blood glucose level in the 3 months before the onset of the disease, and is associated with the prognosis of cerebral infarction. We have also found that in clinical patients, if dehydration is present, cerebral infarction is progressive [8]. In these dehydrated patients, we can stop the progression of infarction and improve neurological function by rehydration or by enhancing volume expansion. So, are there patients with chronic hyperglycemia, which is due to the presence of dehydration, that is, because of high blood glucose, leading to cell dehydration, which aggravates the deterioration of brain function, leading to an increase in the area of cerebral infarction?

Diffusion weighted imaging (DWI) [9], in magnetic resonance imaging is the only noninvasive method that can detect the diffusion motion of water molecules in living tissues. After cerebral infarction, cells produce toxic edema that restricts the diffusion of water molecules. Therefore, DWI can detect high-signal images within a few minutes after cerebral infarction, and the size of this image can be used to evaluate the size of the patient's cerebral infarction area.

After cerebral infarction, there is local hemodynamic impairment around the infarct core [10], and without effective intervention, the extent of the impairment will spread spatially over time. The infarct core may then spread to nearby tissue, causing irreversible damage to the healthy tissue surrounding the infarct [11]. As a result, the area surrounding the high signal on DWI can be transformed into a infarct. Therefore, in clinical practice, can we calculate the core volume of cerebral infarction through DWI examination, and then calculate the dehydration and glycosylated hemoglobin to evaluate the prognosis of patients with cerebral infarction?

MATERIAL AND METHODS

We included 270 hospitalized patients with acute cerebral infarction within 24 hours of onset between 2019 and 2021 [Table 1]. The exclusion criteria wererenal insufficiency (creatinine > 1.5 mg/dl), malignant tumor, no informed consent, or without blood samples. The study was approved by the ethics committee of Minhang Hospital, Fudan University. All patients or their family members or legal representatives provided written informed consent after being informed of the study protocol. Demographic and clinical data were collected on admission, including demographic data (age, sex, body mass index [BMI]), vascular risk factors (smoking status, alcohol abuse, hypertension, diabetes mellitus, hypercholesterolemia, atrial fibrillation, coronary heart disease, a history of stroke, medication history (antithrombotic use, statin use, antihypertensive agent, anticoagulant, anti-glycemic agent), laboratory parameters (BUN/Cr, HbA1c), and other biochemical variables(high-sensitivity C-reactive protein, Homocysteine, fasting blood glucose, low density lipoprotein cholesterol, triglycerides etc), were measured using routine laboratory methods on the second day after admission. All patients underwent 3.0T MRI scans within 24 hours of admission (uMR780; United Imaging Healthcare; Shanghai, China, with a commercial 24-channel head-and-neck coil). The stroke region obtained from DWI images was manually segmented on the graphical user interface of

Table 1: Baseline characteristics by levels of Bun/Cr Ratio in acute ischemic stroke.

	All(n=270)	Dehydration (Bun/Cr Ratio>15) (n=145)	Normal (Bun/Cr Ratio≤15) (n=125)
Age, medians (IQRs) ,years	62(56–72)	63(54-71)	61(55-73)
Female, (%)	98(48.3)	56(49.6)	42(46.7)
BMI, medians (kg/m 2, IQR)	26.3(24.4–27.7)	25.9(24.2-26.8)	26.5(24.6-28.1)
Vascular risk factors, n (%)			
Smoking status	51(25.1)	27(23.9)	24(26.7)
Alcohol abuse	47(23.2)	28(24.8)	19(21.1)
Hypertension	136(67.0)	78(69.0)	58(64.4)
diabetes mellitus	93(45.8)	56(49.5)	37(41.1)
Hypercholesterolemia	81(39.9)	44(38.9)	37(41.1)
Atrial fibrillation	34(16.7)	17(15.0)	17(18.9)
Coronary heart disease	47(23.2)	25(22.1)	22(24.4)
Previous stroke	45(16.7)	19(16.8)	26(28.9)
Pre-stroke treatment			
Antithrombotic use	96(47.2)	53(46.9)	43(47.8)
Statin use	58(28.6)	33(29.2)	25(27.8)
Antihypertensive agent	85(41.9)	45(39.8)	40(44.4)
Anticoagulant	6(2.96)	3(2.92)	3(3.33)
Antiglycemic agent	40(19.7)	23(20.3)	17(18.9)

IQR, interquartile range; NIHSS, National Institutes of Health Stroke Scale.
*P value for difference between dehydration and normal hydration group, using chi-square for percentages and Kruskal-Wallis test for medians.

MATLAB software. In order to improve the segmentation accuracy, the DWI image is filtered in advance. The lesion area was then identified and sectioned by two experienced neuroradiologists. Finally, the segmentation results are fused with the original DWI image and displayed to check whether the segmentation results are accurate. All patients admitted to hospital were given a National Institutes of Health Scale (NIHSS) score by an experienced neurologist. The ratio of creatinine to urea nitrogen was calculated. If the ratio was greater than 15, it indicated that the patient was dehydrated. If the ratio was less than 15, it indicated that the patient was not dehydrated. HbA1c >7% was defined as chronic hyperglycemia, HbA1c ≤7% was defined as non-chronic hyperglycemia.

The average age of the 270 patients included was 65 years old (56-73), among which 126 were females (46.7%) and 144 were males (53.3%). The average BMI (kg/m2, IQR) of these patients was 26.8(25.5-27.3). Vascular risk factors included: hypertension in 176 cases (64.8%), diabetes mellitus in 106 cases (39.3%), coronary heart disease in 76 cases (28.1%), hypercholesterolemia in 85 cases (31.5%), atrial fibrillation in 38 cases (14.1%), transient ischemic attack in 45 cases (16.7%). There were 56 smoking patients, accounting for 20.7%.

Pre-stroke treatment included 145 patients receiving antithrombotic therapy (53.7%) and 84 patients receiving statin therapy (31.1%). In the acute stage of cerebral infarction, 58 patients (21.5%) received r-TPA thrombolytic therapy. The mean NIH score of all 270 patients before admission was 7 (4-12), and the mean volume of cerebral infarction was 5.32 mm^3 (1; 67-14.77), The average time from the onset of cerebral infarction to the hospital was 5.1 hours, and the mean time from admission to MRI completion was 7.5 hours.

Etiological classification of stroke included: 80 cases of cardiogenic embolism, accounting for 29.6%, 68 cases of small artery occlusion, accounting for 25.2%, 67 cases of large atherosclerosis, accounting for 24.8%, 32 cases of other causes, accounting for 11.9%, 23 cases of unknown cause, accounting for 8.5%.

Laboratory results indicated that the mean value of high-sensitive C-reactive protein was 0.42mg/ml, the mean value of homocysteine was 19.2umol/l, the mean value of rapid blood sugar was 5.48mmol/l, and the mean value of brain-derived neurotrophic factor was 22.1ng/ml.

STATISTICAL ANALYSIS

Continuous data are summarized as a median (interquartile range [IQR]), and categorical variables are presented as a number (percent) of subjects. The Kruskal-Wallis test and chi-square test were used to compare the two groups. Bivariate correlations were analyzed using Spearman's Rank correlation considering the abnormal distribution of data. Binary logistic regression analysis was used to adjust for possible confounding factors. Furthermore, a semiparametric approach with univariate and multivariate quartile regression analysis was used to evaluate the relationship between median NIHSS score and DWI infarct volume quartiles. Results were expressed as adjusted odds ratios (OR) with the corresponding 95% confidence interval (CI). All statistical analysis was performed with R language (https://www.r-project.org/)as a processing environment. Statistical significance was defined as $P < 0.05$.

RESULTS

The Relationship between infarct volume and NIHSS score [Figure 1 + Table 2]

Q1 indicates small infarct volume, BUN/Cr is 13.935, NIHSS score is less than 5 points, Q2 infarct volume is larger than Q1, BUN/Cr is 14.016, NIHSS score is greater than 5 points, Q3 infarct volume is larger than Q2, BUN/Cr is 15.57, greater than 15, NIHSS score is greater than Q2 score. Q4 had the largest infarct volume, the BUN/Cr was 17.632, and the NIHSS score was much higher than 10 points. From the above comparison, it can be found that the size of the infarct was positively correlated with the NIHSS score, and the larger the infarct size, the higher the NIHSS score. we also adopted univariate and multivariate quartile regression models to estimate stroke severity for infarct volumes quartiles. Other data included age, sex, BMI, risk factors, clinical information, and treatment prior to stroke.

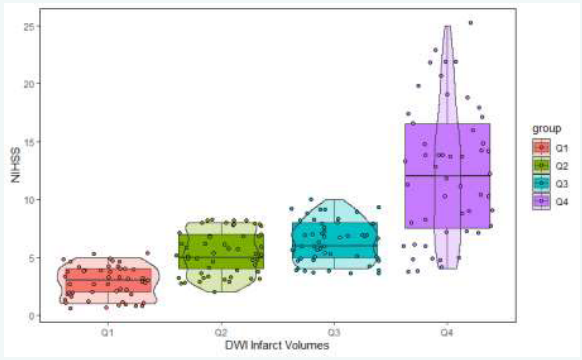

Figure 1: Infarct severity (NIHSS score) was correlated with infarct volume

The relationship between infarct volume and glycosylated hemoglobin [Figure 2 and Table 3].

When the HbA1c IQR is 6%, the infarct volume is less than 0.907ml; when the HbA1c IQR is 6.3%, the infarct volume is between 0.907 and 3.16ml; when the HbA1c IQR is 6.5%, the infarct volume is greater than 43.28ml, indicating that the higher the HbA1c is, the larger the infarct volume is. In patients with large infarct volume, the interquart interval of HbA1c was 6.5%, indicating that the core volume of infarction was correlated with chronic hyperglycemia (HbA1c) , possible confounders: sex, age, BMI, risk factors, clinical information (including time from onset, the biochemical examination, and MR imaging) [Table 3, Figure 2].

The relationship between glycosylated hemoglobin and dehydration

There is no dehydration, that is, the BUN/Cr ratio is less than 15, the HbA1c IQR is 6%, there is dehydration, the BUN/Cr ratio is greater than

Table 2: The relationship between infarction volume and dehydration on DWI was analyzed based on univariate and quartile regression

DWI Infarct Volumes (ml)	Bun/Cr Ratio (IQR) [&]	Multivariate change in Bun/Cr Ratio (95% CI), [a,&]	P value [b]
Q1(< 0.078)	13.935 (12.267–15.984)	0.87 (0.2580671–0.971169)	< 0.001
Q2(0.078–0.907)	14.016(12.74–17.298)	1.26 (0.0004668037–0.901353)	< 0.001
Q3(0.907–3.16)	15.57 (13.7–18.45)	1.52 (0.00003945544–0.8670062)	0.092
Q4(> 43.28)	17.632 (16.053–21.658)	1.34(0.003637542-0.9264152)	–

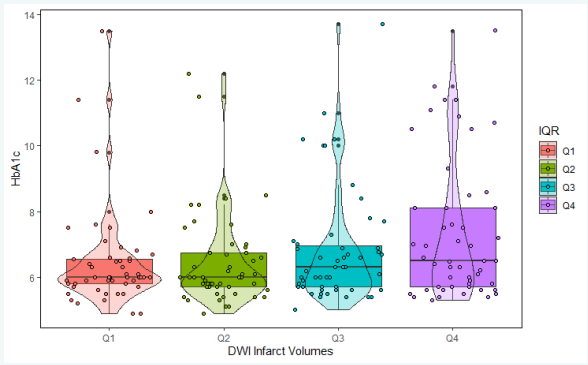

Figure 2: Infarct volume and chronic hyperglycemia.

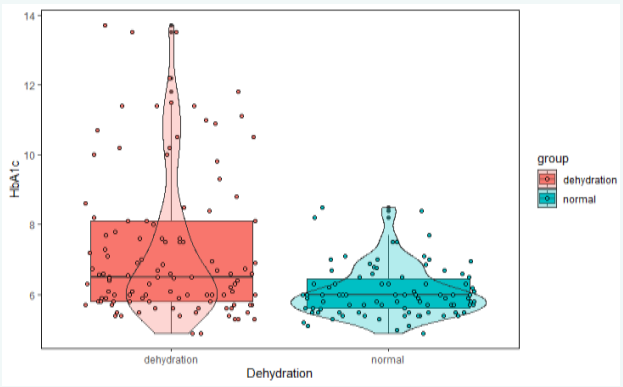

Figure 3: The relationship between glycosylated hemoglobin and dehydration

Table 3: The relationship between infarction volume and dehydration on DWI was analyzed based on univariate and quartile regression

DWI Infarct Volumes (ml)	HbA1c (IQR)	Multivariate change in HbA1c (95% CI)	P value [b]
Q1(< 0.078)	6(5.8–6.558)	0.43 (0.2580671–0.971169)	0.29
Q2(0.078–0.907)	6(5.7–6.744)	0.40 (0.00000004646681–0.7447058)	0.17
Q3(0.907–3.16)	6.3(5.7–6.947)	0.49 (0.0000001101058–0.7629836)	1
Q4(> 43.28)	6.5 (5.7–8.1)	0.59(0.000003268045- 0.8270757)	–

15, the HbA1c IQR is 6.5%, indicating that the dehydrated patients have higher HbA1c. [Table 4, Figure 3,Figure 4].

As a result, we divided the patients into 4 groups. Multivariate regression analysis showed that patients with dehydration plus chronic hyperglycemia had the highest quartile of infarct volume, patients with dehydration plus normal blood sugar had a smaller infarct volume than those with dehydration plus chronic hyperglycemia, patients without dehydration plus chronic hyperglycemia had a smaller infarct volume than those with dehydration plus normal blood sugar, and patients without dehydration plus chronic blood sugar had a smaller infarct volume than those with dehydration plus normal blood sugar. The infarct volume was minimal, indicating that patients with dehydration and chronic hyperglycemia had the largest infarct volume. [Table 5-7].

DISCUSSION

Cerebral infarction is due to the sudden decrease or stop of the blood flow in the local blood supply artery of the brain tissue, resulting in the necrosis and softening of the brain tissue caused by cerebral ischemia and hypoxia in the blood supply area of the blood vessel, and accompanied by the clinical symptoms and signs of the corresponding parts [12]. In clinic, most of the symptoms are hemiplegia, slurred speech, disturbance of consciousness, dysphagia and other neurological function loss symptoms. The clinical manifestations of cerebral infarction are varied, and are related to the site of injury, the size of cerebral ischemia vessels, the severity of ischemia, the condition of collateral circulation, and whether there are other diseases complicated [13]. Clinically, some cerebral infarction patients are very mild, even asymptomatic, called

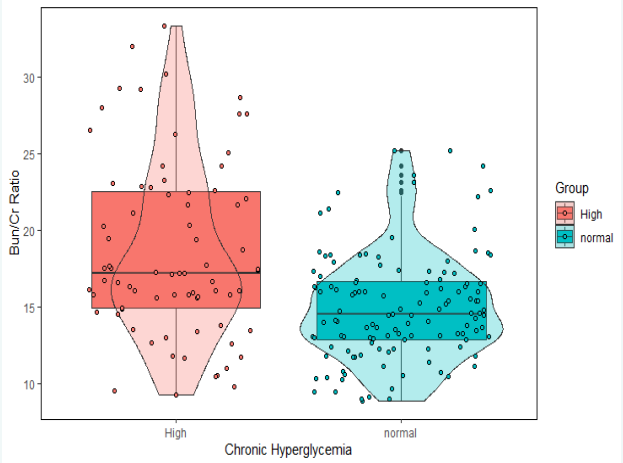

Figure 4: Relationship between dehydration and chronic hyperglycemia

Table 4: The relationship between infarction volume and dehydration on DWI was analyzed based on multivariate and quartile regression

DWI Infarct Volumes (ml)	Bun/Cr Ratio (IQR) [&]	Multivariate change in Bun/Cr Ratio (95% CI), a[&]	P value b	HbA1c (IQR) [&]	Multivariate change in HbA1c (95% CI), a[&]
Q1(< 0.078)	13.935 (12.267–15.984)	0.87(0.2580671–0.971169)	< 0.001	6(5.8–6.558)	0.43 (0.2580671–0.971169)
Q2(0.078–0.907)	14.016(12.74–17.298)	1.26 (0.0004668037–0.901353)	< 0.001	6(5.7–6.744)	0.40 (0.00000004646681–0.7447058)
Q3(0.907–3.16)	15.57 (13.7–18.45)	1.52 (0.00003945544–0.8670062)	0.092	6.3(5.7–6.947)	0.49(0.0000001101058–0.7629836)
Q4(> 43.28)	17.632 (16.053–21.658)	1.34(0.003637542-0.9264152)	–	6.5 (5.7–8.1)	0.59(0.000003268045-0.8270757)

Table 5: The relationship between dehydration and DWI infarct volume was analyzed by single factor regression

Bun/Cr Ratio	**DWI Infarct Volumes (IQR) [&]**	**Multivariate change in DWI Infarct Volumes (95% CI), [a,&]**	**P value [b]**
nomal(< 15)	0.3789 (0.0575–1.2205)	0.87(3.055579E-18–0.3382649)	<0.001
Dehydration(>15)	1.55(0.506–6.797)	1.49 (0.000000000000035063–0.6874845)	

Table 6: Interquartile interval of chronic dehydration

Group	Bun/Cr Ratio (IQR) [&]	Multivariate change in Bun/Cr Ratio (95% CI), a[&]
Chronic Hyperglycemia	17.175 (14.910–22.500)	1.31e+00 (5.151728e-03–9.508372e-01)
normal	14.489 (12.853–16.669)	6.16e-01 (5.907238e-04–9.580575e-01)

Table 7: The relationship between DWI and infarct volume was analyzed by multivariate regression analysis

Group	DWI Infarct Volumes (IQR) ml	Multivariate change in DWI Infarct Volumes (95% CI)	P value b
DH +CHG	1.8280 (0.6142–7.3942)	2.25 (6.106105e-09–7.238904e-01)	< 0.001
DH+N	1.2800 (0.1025–4.9518)	2.01e+00 (9.769274e-11–6.294877e-01)	< 0.0044
N +CHG	0.4666 (0.0651–1.2084)	7.19e-01 (2.053595e-05–6.766884e-01)	1
N+N	0.37890 (0.05675–1.21750)	1.10e+00(3.574995e-16 -3.362453e-01)	–

asymptomatic cerebral infarction [14].There are also patients with recurrent hemiplegia, vertigo, slurred speech, etc., severe patients even have coma, combined with cardiac, liver and renal insufficiency, death. Therefore, in clinical practice, the occurrence and development of cerebral infarction is a complex dynamic process, and we do not have any clear means to predict the prognosis of patients with infarction. Previous evidence has shown that HbA1c is significantly related to the prognosis of cerebral infarction. Patients with significantly high HbA1c are more severe than those with cerebral infarction and are more likely to suffer from neurological deterioration in the early stage [15]. In this study, we also found that patients with high hemoglobin had large volume of DWI, high NIHSS score, high BUN/Cr ratio of more than 15, and dehydration [16]. These dehydration states can lead to increased neurological function in patients. If dehydration does not exist, that is, BUN/Cr ratio is less than 15, DWI volume is small, NIHSS score is low, the patient's neurological function will not progress significantly, and the likelihood of cerebral infarction is small. In actual clinical practice, only patients with high HbA1c combined with dehydration are more likely to further deteriorate the neurological function of cerebral infarction, leading to a high probability of disease progression. In the early stage of cerebral infarction, there will be ischemic penumbra around the infarction. If sufficient blood supply can be provided early to improve the condition of ischemic penumbra, the progression of cerebral infarction will be stopped [17]. If adequate blood supply is not provided to improve the condition of the ischemic penumbra, the ischemic penumbra sugars in serum. It is in the form of a slow, continuous irreversible glycation reaction, which can reflect the blood glucose level of the body for about 3 months [18]. High glycated hemoglobin can lead to will continue to progress, leading to further expansion of ischemia and further deterioration of neurological function in clinical practice. Glycated hemoglobin, which can reflect the concentration of blood glucose, refers to the product of the combination of hemoglobin in red blood cells and reduced hemoglobin in red blood cells in the blood, so the affinity with oxygen is reduced, resulting in hypoxia of tissues and cells, so that the stability and function of capillaries and red blood cells decline, leading to the occurrence of microcirculation disorders [19]. Thus, hypoxia of ischemic penumbra in patients with cerebral infarction is aggravated, leading to further deterioration of neurological function in cerebral infarction. So how does elevated HbA1c cause cells to dehydrate? With high glycated hemoglobin and high blood glucose levels, the crystal osmolality of the plasma is high, the water in the interstitium enters the blood vessels, the osmolality of the crystal in the interstitium increases, and the water enters the interstitium from within the cells, resulting in intracellular dehydration [20]. BUN is a nitrogenous substance in plasma in addition to protein, and Cr is the end product of protein metabolism in the human body. The ratio of the two helps to distinguish prerenal and renal parenchymosis. Generally, patients with dehydration are prerenal, so in patients with dehydration, due to reduced renal blood flow, Cr increased, but rarely more than 200umol/l, BUN can be significantly increased, so BUN/Cr is often greater than 10, and if it is renal lesions, Cr is often greater than 200 umol/l. It is considered that high BUN is associated with a high risk of ischemic stroke, and high BUN/Cr levels are associated with an increased risk of ischemic stroke [21]. We can also obtain more information during follow-up of these patients to assess the impact on stroke. At present, the BUN/Cr ratio is often used to evaluate the dehydration status of stroke patients [22]. In patients with acute ischemic stroke, dehydration in the days following onset was associated with increased BUN/Cr ratio and thromboembolic tendency. Patients with a high BUN/Cr ratio are prone to early neurological deterioration [23]. However, the increase of BUN/Cr ratio is more common in progressive stroke. On multivariate analysis, the value was greater than 15 and may be an independent predictor of progressive stroke. A glycated hemoglobin level of more than 7% is a predictor of progressive stroke, and elevated blood glucose levels are associated with microvascular and macrovascular damage [24]. It increases the breakdown of the blood-brain barrier, leading to neuronal damage, and diabetes increases neuronal degeneration and BBB permeability, disrupting AQP4 polarity, leading to the occurrence of ischemia-reperfusion injury [25]. Therefore, high glycated hemoglobin and chronic hyperglycemia lead to chronic dehydration, thus increasing neuronal degeneration and blood-brain barrier permeability, which can lead to the expansion of cerebral infarction area in patients and the progression of stroke. Therefore, in clinical practice, if we find that the glycated hemoglobin is high at the time of admission, there are patients with BUN/Cr ratio greater than 15 then, the possibility of progression of cerebral infarction is very high, which has a good guiding value for clinical prognosis, and can also guide doctors to control blood glucose as soon as possible, strengthen fluid infusion, give volume expansion, and avoid further dehydration. In fact, among hospitalized patients with acute cerebral infarction, dehydration is very common, patients with dehydration are more likely to have disease progression or death, dehydration is more likely to have ischemic penumbral zone, and if patients with dehydration are given fluid early to expand volume, then there will be a better outcome. However, this study also has its limitations. The pathophysiological mechanism of high HbA1c caused by dehydration has not been further verified in animal experiments, and the calculation of ischemic penumbra and core volume of infarction by DWI can only be evaluated by software, which is not accurate enough and will lead to bias. It is hoped that further studies can be conducted on animal models in the future.

REFERENCES

1. Zheng Y, Han Z, Zhao H, Luo Y. MAPK: A Key Player in the Development and Progression of Stroke. CNS Neurol Disord Drug Targets. 2020; 19: 248-256.

2. Ryu WS, Hong KS, Jeong SW Jung EP, Kim BJ, Kim J, et al. Association of ischemic stroke onset time with presenting severity, acute progression, and long-term outcome: A cohort study. PLoS Med. 2022; 19: e1003910.

3. Deng Y, Wu S, Liu J, Liu M, Wang L, Wan J, et al. The stress hyperglycemia ratio is associated with the development of cerebral edema and poor functional outcome in patients with acute cerebral infarction. Front Aging Neurosci. 2022; 14: 936862.

4. Zhang Y, Zhao B, Lai Q, Li Q, Tang X, Zhang Y, et al. Chronic cerebral hypoperfusion and blood-brain barrier disruption in uninjured brain areas of rhesus monkeys subjected to transient ischemic stroke. J Cereb Blood Flow Metab. 2022; 42: 1335-1346.

5. Heiss WD. Malignant MCA Infarction: Pathophysiology and Imaging for Early Diagnosis and Management Decisions. Cerebrovasc Dis. 2016; 41: 1-7.

6. Shi Z, Zheng WC, Yang H, Fu XL, Cheng WY, Yuan WJ. Contribution of dehydration to END in acute ischemic stroke not mediated via coagulation activation. Brain Behav. 2019; 9: e01301.

7. Lee SH, Kim Y, Park SY, Kim C, Kim YJ, Sohn JH. Pre-Stroke Glycemic Variability Estimated by Glycated Albumin Is Associated with Early Neurological Deterioration and Poor Functional Outcome in Prediabetic Patients with Acute Ischemic Stroke. Cerebrovasc Dis. 2021; 50: 26-33.

8. Liu K, Pei L, Gao Y, Zhao L, Fang H, Bunda B, et al. Dehydration Status Predicts Short-Term and Long-Term Outcomes in Patients with Cerebral Venous Thrombosis. Neurocrit Care. 2019; 30: 478-483.

9. Debs N, Rasti P, Victor L, Cho TH, Frindel C, Rousseau D. Simulated perfusion MRI data to boost training of convolutional neural networks for lesion fate prediction in acute stroke. Comput Biol Med. 2020; 116: 103579.

10. Tsukada N, Katsumata M, Oki K, Minami K, Abe T, Takahashi S, et al. Diameter of fluorescent microspheres determines their distribution throughout the cortical watershed area in mice. Brain Res. 2018. 1679: 109-115.

11. Scalzo F, Hao Q, Alger JR, Hu X, Liebeskind DS. Regional prediction of tissue fate in acute ischemic stroke. Ann Biomed Eng. 2012; 40: 2177-2187.

12. Patil S, Darcourt J, Messina P, Bozsak F, Cognard C, Doyle K. Characterising acute ischaemic stroke thrombi: insights from histology, imaging and emerging impedance-based technologies. Stroke Vasc Neurol. 2022; 7: 353-363.

13. Shang W, Zhang Y, Xue L, Li W. Evaluation of collateral circulation and short-term prognosis of patients with acute cerebral infarction by perfusion-weighted MRI. Ann Palliat Med. 2022; 11: 1351-1359.

14. Kimura T, Kashimura S, Nishiyama T. Asymptomatic Cerebral Infarction During Catheter Ablation for Atrial Fibrillation: Comparing Uninterrupted Rivaroxaban and Warfarin (ASCERTAIN). JACC Clin Electrophysiol. 2018; 4: 1598-1609.

15. Zhang Z, Qian M, Ge Z, Zhou P, Liu J, Chen J. Effects of blood glucose and glycosylated hemoglobin levels on intravenous thrombolysis in patients with acute cerebral infarction and type 2 diabetes mellitus. Pak J Med Sci. 2019; 35: 862-867.

16. Tsai YH, Yang JL, Lee IN, Yang JT, Lin LC, Huang YC, et al. Effects of Dehydration on Brain Perfusion and Infarct Core After Acute Middle Cerebral Artery Occlusion in Rats: Evidence From High-Field Magnetic Resonance Imaging. Front Neurol. 2018; 9: 786.

17. Wang RY, Yang YR, Chang HC. The SDF1-CXCR4 Axis Is Involved in the Hyperbaric Oxygen Therapy-Mediated Neuronal Cells Migration in Transient Brain Ischemic Rats. Int J Mol Sci. 2022; 23.

18. Dude AM, Drexler K, Yee LM. Glycosylated hemoglobin A1c prior to delivery and neonatal hypoglycemia in pregnancies complicated by diabetes. Am J Obstet Gynecol MFM. 2022; 4: 100670.

19. Verma N, Liu M, Ly H, Loria A, Campbell KS, Bush H, et al. Diabetic microcirculatory disturbances and pathologic erythropoiesis are provoked by deposition of amyloid-forming amylin in red blood cells and capillaries. Kidney Int. 2020; 97: 143-155.

20. Brar PC, Tell S, Mehta S, Franklin B. Hyperosmolar diabetic ketoacidosis-- review of literature and the shifting paradigm in evaluation and management. Diabetes Metab Syndr. 2021; 15: 102313.

21. Peng R, Liu K, Li W, Yuan Y, Niu R, Zhou L, et al. Blood urea nitrogen, blood urea nitrogen to creatinine ratio and incident stroke: The Dongfeng-Tongji cohort. Atherosclerosis. 2021. 333: 1-8.

22. Watanabe K, Stöhr EJ, Akiyama K, Watanabe S, González-Alonso J. Dehydration reduces stroke volume and cardiac output during exercise because of impaired cardiac filling and venous return, not left ventricular function. Physiol Rep. 2020; 8: e14433.

23. Wu FF, Hung YC, Tsai YH. The influence of dehydration on the prognosis of acute ischemic stroke for patients treated with tissue plasminogen activator. BMC Cardiovasc Disord. 2017; 17: 154.

24. Mi D, Wang Y, Wang Y, Liu L. Insulin resistance is an independent risk factor for early neurological deterioration in non-diabetic patients with acute ischemic stroke. Neurol Sci. 2020. 41: 1467-1473.

25. Yu Z, Lin L, Jiang Y, Chin I, Wang X, Li X, et al. Recombinant FGF21 Protects Against Blood-Brain Barrier Leakage Through Nrf2 Upregulation in Type 2 Diabetes Mice. Mol Neurobiol. 2019; 56: 2314-2327.