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Original Article

Significance of various scoring scales combined with CTA in predicting the clinical prognosis of acute ischemic stroke at ultra-early stage

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Abstract: *Objective:* The goal of this study was to investigate the significance of various scoring scales combined with computed tomography angiography (CTA) in predicting the clinical prognosis of acute ischemic stroke (AIS) at ultra-early stage. *Methods:* A total of 78 patients with AIS in the ultra-early stage admitted to our hospital from January 2017 to August 2010 were selected. All the patients that received CTA and were evaluated via stroke scales, including the National Institutes of Health Stroke Scale (NIHSS) score, the activities of daily living (ADL) scale, and the Rankin Scale (mRS) were adopted for evaluation. According to vascular stenosis assessment, patients were further divided into groups of mild (stenosis rate ≤ 29%), moderate (30% ≤ stenosis rate ≤ 69%), severe stenosis (70% ≤ stenosis rate ≤ 99%) and vascular occlusion (stenosis rate = 100%). In addition, based on whether the mRS score >2 points, the patients were divided into the good prognosis group (mRS score < 2 points) and the poor prognosis group (mRS score ≥ 2 points). *Results:* According to CTA, the rate of intracranial arteriostenosis was significantly higher than that of extra cranial arteriostenosis ($P < 0.05$). Before admission, patients with better prognosis (mRS score < 2 points) were determined with obviously lower NIHSS scores and Barthel indexes than those with poor prognosis (mRS score ≥ 2 points) ($P < 0.05$). Based on the Logistic regression analysis, the NIHSS score, Barthel index and vascular occlusion shown in CTA were independent predictive factors for the poor prognosis of patients ($P < 0.05$). Various scoring scales combined with CTA manifested that the area under the receiver operating characteristic (ROC) curve of the prognosis of patients was 0.953, with the sensitivity of 95.6% and the specificity of 91.5%. *Conclusion:* Various scoring scales combined with the CTA examination can not only precisely evaluate the severity of AIS in the ultra-early stage, but also effectively predict its prognosis, thus providing a scientific basis for the rational development of therapy.

Keywords: CTA, NIHSS, Rankin scale, Barthel index, acute ischemic stroke in the ultra-early stage

Introduction

Stroke is the most common cerebrovascular disease, and ischemic stroke (IS) takes up about three quarters of it [1]. Acute IS (AIS) refers to a disease with limited ischemic necrosis or softening of brain tissues triggered by disturbance of blood circulation in the brain, resulted from vascular stenosis or occlusion. The disease can cause a very high residual rate, recurrence rate and mortality rate, and it frequently occurs in the elderly population aged over 60 years old [2, 3]. Smoking and drinking, diabetes, hypertension, and atherosclerosis are primary risk factors for AIS [4]. Related statistics have revealed that the loss of labor to varying degrees was found among approximately 75% of surviving AIS patients [5]. After cerebral hemorrhage was excluded by cranial computed tomography (CT) examination, thrombolytic therapy in the ultra-early stage (within 6 h after onset) was critical for AIS patients [6]. CT angiography (CTA), characterized by a high image space, high-density resolution, and non-invasiveness during examination, greatly facilitates the diagnosis of AIS [7]. Currently, however, the prediction of the prognosis of AIS in the ultra-early stage has rarely been reported. In this study, AIS patients were evaluated by various scoring scales combined with CTA, in order to provide a basis for their treatment and prognosis prediction.

Table 1. General data of the study objects

Item	n = 78
Gender (male/female)	43/35
Average age (years old)	65.78 ± 7.54
Mean systolic blood pressure (mmHg)	140.21 ± 4.78
Mean diastolic blood pressure (mmHg)	81.63 ± 5.52
Cholesterol (mmol/L)	4.35 ± 0.63
Triglyceride (mmol/L)	1.37 ± 0.35
Low-density lipoprotein (mmol/L)	2.83 ± 0.47
High-density lipoprotein (mmol/L)	1.09 ± 0.26

Materials and methods

General data

A total of 78 patients with AIS in the ultra-early stage admitted and treated from January 2017 to May 2018 were randomly selected. Inclusion criteria: 1) patients who met the diagnostic criteria for AIS [8], 2) patients who were diagnosed within 6 hours after the clinical symptoms were observed, and 3) patients whose family members signed the informed consent and this clinical trial was approved by the Hospital Ethics Committee. Exclusion criteria: 1) patients with cerebral hemorrhage, or 2) patients whose vital signs were extremely unstable or those who could not cooperate with the examination. General data of patients is shown in **Table 1**.

Methods

After the contraindications of all the patients were excluded, the metal objects were removed. Then the patients were subjected to the CTA examination via the Toshiba Aquilion One 320-row spiral CT machine (produced by Toshiba Co., Ltd., Japan). Parameters: 100 kV, automatic mA, contrast agents: Iopamiro (370 mg iodine/mL) (manufacturer: Patheon Italia S.P.A, Italy, sub-packaging: Shanghai Bracco Sine Co., Ltd., approval number: NMPH J20150090) and 25 mL 0.9% sodium chloride solution, injection flow rate: 5 mL/s, and scan mode: volume collection. The patients were required to take the supine position with hands on the head, and CT scanning was conducted on the patient's neck and head, ranging from the clavicle to the top of the skull. After scanning, the data were transmitted and imported into the Vitrea workstation provided by Toshiba for processing. Adaptive Iterative Dose Reduction 3 Dimension was adopted for reconstructing, and the images were read by two senior videographers with over 10 years of work experience via double-blind method.

Index evaluation

Vascular stenosis assessment [8]: The diameter of the most narrowed part of the vessel cross section (N) and that of the distal normal blood vessel (D) were measured, and the stenosis rate was calculated according to the related calculation formula: stenosis rate = (1-N/D) × 100%. Classification of stenosis degrees: 1) mild stenosis: stenosis rate ≤ 29%, 2) moderate stenosis: 30% ≤ stenosis rate ≤ 69%, 3) severe stenosis: 70% ≤ stenosis rate ≤ 99%, and 4) occlusion: stenosis rate = 100%.

Patients were evaluated using the National Institutes of Health Stroke Scale (NIHSS) score, the activities of daily living (ADL) scale and the Rankin Scale (mRS) before admission and after discharge [9, 10]. According to whether the mRS score >2 points, the patients were divided into the good prognosis group (mRS score < 2 points) and the poor prognosis group (mRS score ≥ 2 points).

Statistical methods

Statistical Product and Service Solutions 19.0 (SPSS Inc., Chicago, IL, USA) analysis software was adopted for statistical analysis. Measurement data are expressed as mean ± standard deviation ($\bar{x} \pm s$). *t* test was used for the intergroup comparison. Continuous data from multiple groups were analyzed by using one-way ANOVA, with the Tukey's post hoc test and detected using a *t*-test. Enumeration data are expressed as percentage and detected via the χ^2 test. The prognosis prediction was analyzed using the receiver operating characteristic (ROC) curve. *P*-values < 0.05 were considered statistically significant.

Results

CTA examination results of patients

There were 22 cases of mild stenosis (**Figure 1A**), 26 cases of moderate stenosis (**Figure 1B**), 21 cases of severe stenosis (**Figure 1C**), 8 cases of vascular occlusion (**Figure 1D**), indicating that the rate of intracranial arteriosteno-

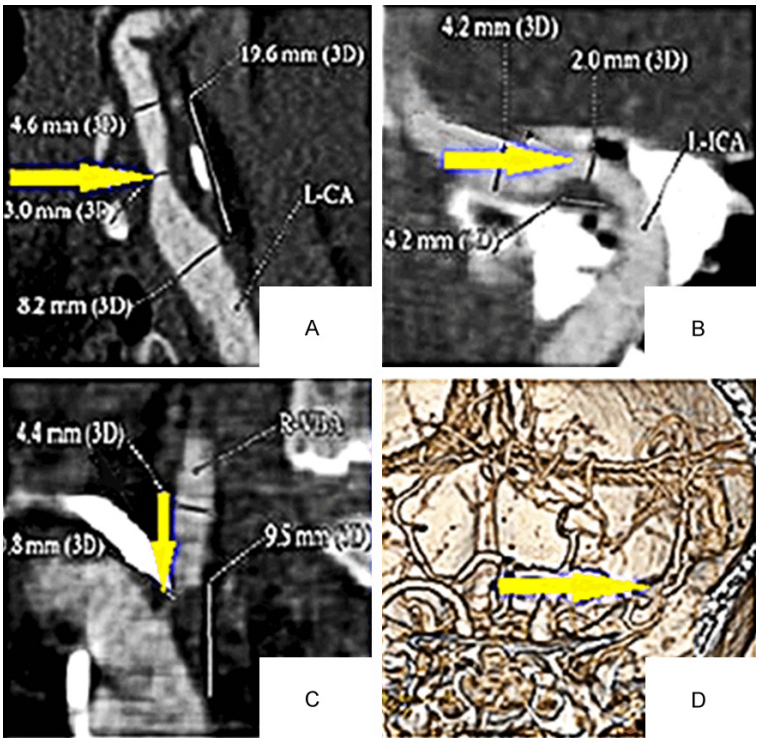

Figure 1. A. Mild vascular stenosis. B. Moderate vascular stenosis. C. Severe vascular stenosis. D. Vascular occlusion.

sisis was markedly higher than that of extra cranial arteriostenosis ($P < 0.05$) (**Table 2**).

Scores of patients with different prognoses in various scales before and after admission

The NIHSS score and Barthel index of the patients with good prognosis before and after admission were significantly lower than those of patients with poor prognosis ($P < 0.05$) (**Table 3**).

Analysis of predictive factors for the poor prognosis of patients

Logistic regression analysis revealed that the NIHSS score [odds ratio (OR) = 1.935, $P = 0.006$], vascular occlusion shown via CTA (OR = 1.817, $P = 0.007$) and the Barthel index (OR = 1.846, P = 0.013) were independent predictive factors for the poor prognosis of patients (**Table 4**).

Prediction of the prognosis of patients via various scales combined with CTA

The area under the ROC curve of the prognosis of patients was 0.953, with the sensitivity of 95.6% and the specificity of 91.5% (**Figure 2**).

Discussion

AIS refers to the condition that under the influence of multiple factors, the arterial blood perfusion is insufficient or the blood supply is restricted in the patient's regional brain tissues, so that they are subjected to disintegration and necrosis in the case where nutrients and oxygen are not delivered in time [11]. The pathogenesis of AIS is the damage to intracranial and extracranial arteries as well as arterial endothelium caused by a variety of factors. This leads to vascular stenosis and atherosclerotic plaques, which affects the normal supply of blood and oxygen in brain tissues, thus resulting in tissue necrosis [12]. An epidemiological survey has manifested that AIS frequently occurs in the elderly population, and its incidence rate shows an uptrend and a younger trend [13]. Clinically, AIS is primarily treated with anticoagulation, thrombolysis, antiplatelet, neuroprotective treatment and surgical treatment. However, the prognosis of most patients is poor, for the disease repeatedly occurs in over half of the patients until they die, and most of the survivors lose their ADL [14]. It has been confirmed by many scholars and clinical studies that if AIS patients are treated in the ultra-early stage, the prognosis will be significantly improved. Detection and treatment of AIS in the ultra-early stage, therefore, is of great importance.

As the imaging technique develops, the CTA technique has been gradually widely used in clinical practice, especially in the diagnosis of cardiovascular and cerebrovascular diseases [15]. CTA has such advantages of rapidness, non-invasiveness and less related complications, and it is economical and less restrictive than other imaging techniques [16]. CTA results in this study demonstrated that among 78 AIS patients, there were 22 cases of mild vascular stenosis, 26 cases of moderate vascular steno-

Table 2. Comparison of vascular stenosis in patients [n (%)]

Group	n	Mild stenosis	Moderate stenosis	Severe stenosis	Vascular occlusion
Intracranial arteriostenosis	56	17 (30.16)	18 (32.14)	13 (23.21)	8 (14.29)
Extracranial arteriostenosis	22	5 (22.73)	8 (36.36)	9 (40.91)	0 (0.00)
χ^2					27.923
P					< 0.001

Table 3. Scores of patients with different prognoses in various scales before and after admission

Group	n	Time	NIHSS score	Barthel index
Good prognosis group	48	At admission	8.18 ± 1.24#	59.18 ± 3.43#
		At discharge	3.63 ± 1.13*,#	82.63 ± 3.62*,#
Poor prognosis group	30	At admission	11.57 ± 1.45	40.57 ± 3.56
		At discharge	6.74 ± 1.32*	68.34 ± 3.64*

Note: *$P < 0.05$ vs. at admission, and #$P < 0.05$ vs. poor prognosis group.

Table 4. Logistic regression analysis of predictive factors for the poor prognosis of patients

Factor	β	Standard error	Wald	OR	95% confidence interval	*P*
Vascular occlusion shown in CTA	0.847	0.675	5.423	1.817	1.106-3.854	0.007
NIHSS score	0.685	0.803	6.427	1.935	0.896-2.542	0.006
Barthel index	0.805	0.496	5.298	1.846	1.025-2.973	0.013

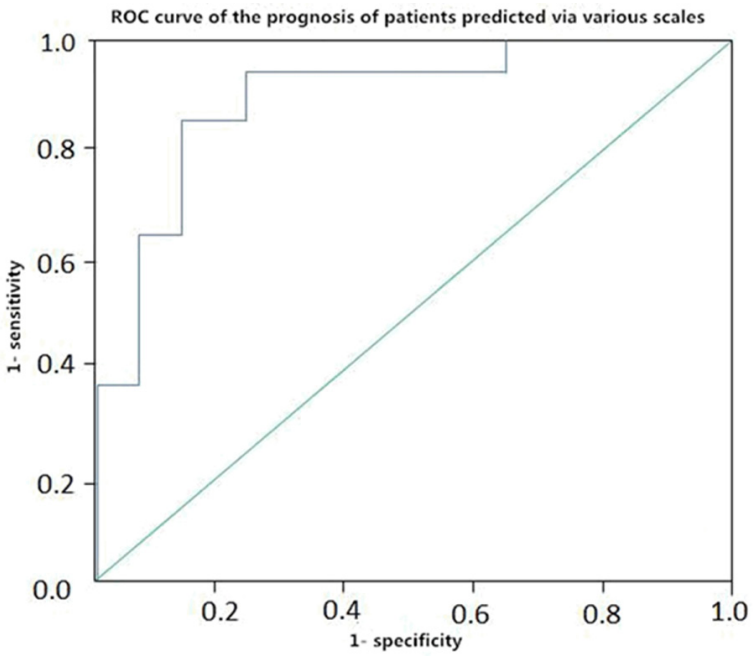

Figure 2. ROC curve of the prognosis of patients predicted via various scales combined with CTA.

sis, 21 cases of severe vascular stenosis and 8 cases of vascular occlusion, and the rate of intracranial arteriostenosis was markedly was higher than that of extracranial arteriostenosis. It has been verified by a great number of studies in China and foreign countries that AIS is mainly caused by intracranial arteriostenosis. CTA examination can accurately indicate the degree of intracranial and extracranial stenosis since it is seldom affected by the blood flow velocity of the patient.

As the clinical treatment and research on AIS advances, different types of scales evaluating the patients' disease has formed, including the NIHSS, ADL and mRS for prognosis evaluation [17]. The NIHSS, proposed by scholars in the late 1980s in the USA, has become a mainstream scoring scale for cerebrovascular diseases, which reveals neurological deficits in patients through evaluating the upper and lower limb movements, consciousness, eye movement, vision, mutual aid, facial paralysis, sensation, dysarthria, language and neglect of patients with AIS [18]. ADL scores patients from 10 aspects, including up and down stairs, bathing, eating, dressing, groom-

ing, urination, defecation, walking 45 meters on the ground and bed and chair transfer, in which the Barthel index usually reflects ADL of patients, objectively and accurately evaluating the prognosis of patients [19]. According to the results of this study, the NIHSS score and Barthel index in patients with good prognosis were significantly lower than those in patients with poor prognosis before and after admission ($P < 0.05$), suggesting that the NIHSS score and Barthel index can not only objectively and accurately evaluate the severity of AIS patients, but also effectively reflect the rehabilitation of patients treated after treatment with time. Therefore, it can be used to accurately determine the prognosis of patients combined with the mRS score, which has a high clinical value.

As a non-invasive examination method, CTA identifies the degree of vascular stenosis and accurately determines intracranial plaques as well as the nature of plaques as well, which exerts a crucial effect in the diagnosis and treatment of AIS [20]. The results of this study illustrate that various scales combined with CTA for prognosis prediction present very high sensitivity and specificity. CTA examination for AIS was inevitably affected by a variety of factors, so that the imaging performance is unobvious, which inevitably results in inaccurate judgment. By combining with various scoring scales and taking advantage of each other, CTA can objectively and accurately evaluate the patient's disease, which provides leads for the prevention of the occurrence and development of cerebral infarction.

Conclusion

In conclusion, CTA examination combined with various scales in the evaluation of AIS in the ultra-early stage can not only provide important cerebrovascular information about the patients' disease, but also facilitates the assessment of various scales, indicating a high clinical application value.

Disclosure of conflict of interest

None.

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