The diagnostic value of combined TCD and CTA in intracranial arterial stenosis

Susan Andrew[1, a], Ichiro Yamamoto[1, b, *],

[1]Japan Medical Association,2-28-16 Honkomagome, Bunkyo-ku, Tokyo 113-8621, Japan
a.susanandrew_99_245111@yahoo.com, b.yamamoto_20080109@163.com
***Corresponding Author**

Abstract: To investigate the clinical diagnostic value of computed tomographic angiography (CTA)and transcranial Doppler (TCD)used separately and in combination for intracranial arterial stenosis. Methods: A total of 47 patients diagnosed with acute ischemic stroke at the Second Affiliated Hospital of Qiqihar Medical University from June 2015 to June 2016 were selected as the study subjects. All patients underwent both TCD and CTA examinations, followed by digital subtraction angiography (DSA). Results: Using DSA as the gold standard, the results of TCD and CTA were evaluated. Among the 47 patients, a total of 67 intracranial arterial stenoses were detected by DSA.TCD identified 53 stenoses, CTA identified 52 stenoses, and the combined diagnosis of CTA and TCD identified 64 stenoses. The combined diagnosis of CTA and TCD was significantly higher than that of a single examination method.($X^2 = 8.152, P = 0.004; X^2 = 9.241, P = 0.002$).Conclusion: The combined diagnosis of intracranial arterial stenosis using TCD and CTA can avoid missed diagnoses and provides a reliable basis for clinical decision-making, offering an objective foundation for further clinical treatment.

Keywords: Transcranial Doppler Ultrasound, Computed Tomographic Angiography, Intracranial Arterial Stenosis

1. Introduction

In clinical diagnostic practice, patients with acute cerebral infarction caused by intracranial arterial stenosis and occlusion, despite having similar symptoms, exhibit significant differences in prognosis. This is determined by the risk factors for stroke [1], but the most critical factor is the varying degrees of vascular stenosis and collateral circulation compensation. In 1982, transcranial Doppler ultrasound (transcranial Doppler, TCD) was invented, utilizing the characteristics of low-frequency ultrasound waves. It is a non-invasive and cost-effective method and has become the preferred screening examination [2]. However, since TCD requires examination through the temporal bone, in previous studies, researchers excluded results with poor temporal bone penetration, leading to significant bias. In contrast, this study included all stroke patients. With the advancement of technology, medical imaging equipment has made rapid progress. Multi-slice spiral CT has been widely introduced into clinical hospitals, and computed tomographic angiography (CTA)has gradually gained recognition from clinicians for its ability to observe intracranial arterial stenosis [3]. This paper retrospectively analyzes the medical history data of 67 patients with intracranial arterial stenosis to assess the diagnostic value of TCD and CTA used separately and in combination for intracranial arterial stenosis.

2. Materials and Methods

2.1. Study subjects

A total of 47 patients diagnosed with acute ischemic stroke at the Second Affiliated Hospital of Qiqihar Medical University from June 2015 to June 2016 were selected as the study subjects. The group included 27 males and 20 females, with a mean age of 68.7 years (range,42–73 years). All patients were admitted for examination and treatment within one week after the onset of symptoms. Each patient underwent both

https://doi.org/10.62852/csa/2025/177

transcranial Doppler (TCD)and computed tomographic angiography (CTA) examinations, followed by digital subtraction angiography (DSA). DSA was used as the gold standard for comparison.

2.2. Methods

2.2.1. TCD examination

The TCD examination was performed using a standardized rapid protocol, taking approximately 15 minutes. A 2 MHz probe was routinely used to detect intracranial arterial stenosis and changes in various blood flow signals. The bilateral middle cerebral arteries (MCA), posterior cerebral arteries (PCA), anterior cerebral arteries (ACA), vertebral arteries (VA), and basilar artery (BA)were examined in all patients. For each artery examined, the mean blood flow velocity (V m), systolic peak flow velocity (Vs), pulsatility index (PI), and spectral waveform were measured.

2.2.2. CTA examination

A Toshiba AQUILION 64-slice spiral CT scanner was used for the examination. Patients were instructed to keep their heads still during the procedure. After a non-contrast scan, an iodinated contrast agent (Iopromide, Ultravist 370) was injected via the antecubital vein at a rate of 3.5–4 ml/s using a high-pressure injector, with a total volume of 80 ml. The scanning range extended from the aortic arch to the top of the skull. The scanner settings included a rotation speed of 0.38 seconds per rotation, a pitch of 0. 984, a slice thickness of 0.625 mm, and a slice spacing of 0.625 mm. The tube voltage was set at 120 kV, and the tube current was 300 mA. All data were transferred to a workstation for subtraction processing and image reconstruction.

2.2.3. DSA examination

Digital subtraction angiography (DSA)was performed using a Philips FD-20 suspended digital C-arm to identify the locations of intracranial arterial stenosis.

2.3. Statistical Analysis

All data were analyzed using the statistical software SPSS 18.0. The chi-square(χ^2) test was employed, and a p-value of less than 0.05 was considered to indicate a statistically significant difference.

3. Results

Using the results of DSA as the gold standard, the findings of TCD and CTA were evaluated. Among the 47 patients, a total of 67 intracranial arterial stenoses were detected by DSA.TCD identified 53 stenoses (Figure 1), CTA identified 52 stenoses (Figures 2 and 3), and the combined diagnosis of TCD and CTA identified 64 stenoses. The combined diagnostic approach was significantly higher than TCD ($X^2 = 8.152, P = 0.004, P < 0.05$), is also higher than CTA ($X^2 = 9.241, P = 0.002, P < 0.05$).

Figure 1The patient is a 56-year-old female with reversed systolic blood flow direction and normal diastolic blood flow direction in the middle cerebral artery.

Figures 2 and 3The patient is a 46-year-old male with severe stenosis of the right middle cerebral artery.

https://doi.org/10.62852/csa/2025/177

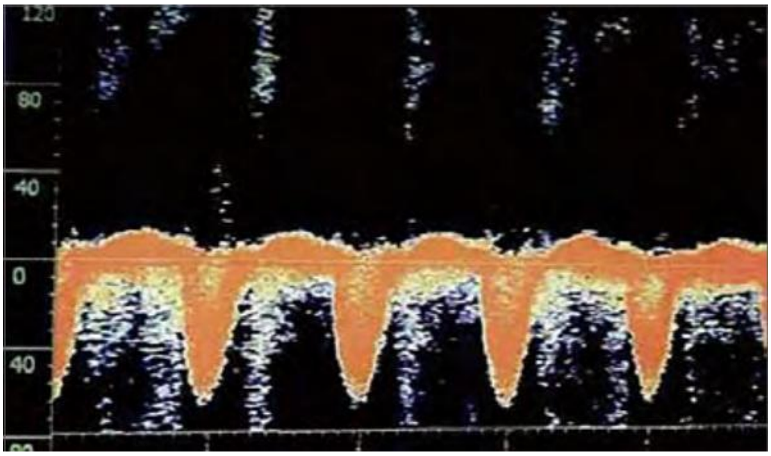

Figure 1. Reversed blood flow in the middle cerebral artery.

Figure 2

Figure 3

4. Discussion

In China, the incidence of stroke caused by intracranial arterial stenosis is increasing year by year. Digital subtraction angiography (DSA)is considered the gold standard for diagnosing intracranial arterial stenosis [4]. However, its use as the primary diagnostic method is limited due to high radiation exposure and high examination costs. Transcranial Doppler (TCD)has become the preferred clinical examination method for intracranial vascular stenosis because it is non-invasive and cost-effective. However, the detection rate of TCD has always been low due to the thickness of the temporal bone in some patients, which affects the examination results, and the high operator dependence [5]. The combined use of computed tomographic

https://doi.org/10.62852/csa/2025/177

angiography (CTA)has significantly improved the detection rate and provided accurate information for clinical prognosis assessment.

The combined diagnosis of TCD and CTA holds significant value in assessing stenosis of the middle cerebral artery. TCD can detect increased blood flow velocity and a coarse Doppler signal in the stenotic segment, with more severe stenosis correlating to higher velocities and rougher signals [6]. However, TCD cannot evaluate intracranial blood flow or accurately locate the stenosis, and it may lead to misdiagnosis of occluded vessels by clinicians, necessitating extra caution. This is where CTA results come into play, as CTA can visualize the exact location of stenosis and aid clinicians in making accurate judgments. TCD also has the capability to detect microemboli; a strong signal in microemboli detection suggests that the plaque in the stenotic segment is unstable [7], which is highly likely to cause cerebral infarction and warrants close attention from clinicians. Some studies have reported that TCD underestimates the degree of middle cerebral artery stenosis compared to CTA, possibly due to the long interval (2 weeks) between the two examinations [8]. During this period, emboli may undergo fibrinolysis or displacement, leading to discrepancies in results. To avoid this, the interval between the two examinations in this study was shortened to within 3 days. The discrepancy may also be related to the complex anatomy of intracranial arteries, which increases the difficulty of detection. TCD examination can use multiplanar reconstruction to understand whether the stenosis is caused by tumor compression and whether soft or hard plaques have formed at the stenotic site.

5. Conclusion

In summary, the combination of TCD and CTA provides clinicians with valuable information, such as the location of intracranial arterial stenosis, the stability of plaques, and hemodynamic data. This integrated approach is beneficial for early assessment of stroke risk by clinicians and offers an objective basis for further clinical treatment.

6. References

[1] Xing Ying qi, Zhang Jie. Issues and Causes in the Clinical Application of Transcranial Doppler and Carotid Color Doppler Ultrasound[J]. Chinese Journal of Stroke,2014,9(3):171-182.

[2] Xu Ping, Xiao Bo, Xiang Xu Lin, et al. Correlation Analysis of TCD and Stroke Prognosis[J]. Chinese Journal of Practical Nervous Diseases,2013,16(11):15-16.

[3] Tao Zhong Hai, Zhang Qing Xiu, Fu Jia liang, et al. Application Value of TCD Combined with DSA in the Evaluation of Intracranial Vessels in Watershed Infarction[J]. Chinese Journal of Neurology, 2015,14(1):33-36.

[4] Wang Yanlin, Li Yun Hua. Clinical Value of TCD and MRA in the Diagnosis of Intracranial Arterial Occlusion or Stenosis[J].2013,20(5):313-314.

[5] Chen Li, Mo Xuean, Chen Ya, et al. Comparative Analysis of TCD and CTA in Evaluating Arterial Occlusion in Acute Cerebral Infarction Patients[J].2013,39(6):359-361.

[6] Wang Liying, Li Yanjun, Zhong Zhenya. Comparative Study on the Diagnostic Value of 64-Slice CT, CTA, and 1.5T MRA in Middle Cerebral Artery Stenosis[J].2012,33(6):707-709.

[7] Fan Xiaodong. Clinical Value Assessment of CTA, TCD, and DSA in Symptomatic Intracranial Arterial Stenosis[J]. Chinese Modern Doctor,2013,51(8):74-75.

[8] Luo Qiu Yun. Application of 64-Slice Spiral CT and DSA in the Study of Ischemic Cerebrovascular Disease[J]. Practical Clinical Medicine,2010,11(10):85-86.

https://doi.org/10.62852/csa/2025/177