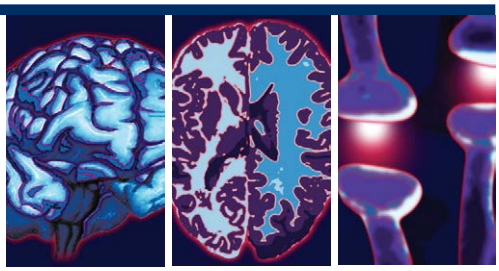
Case Report



Different Evaluations between Transcranial Doppler Ultrasonogrphy and Magnetic Resonance Imaging for the Ischemic Stroke

Lijuan Wang[1], Ying Chen[1], Limin Chen[1], Yingqi Xing[1,†]

ABSTRACT

Intracranial artery disease is the most common vascular lesion in stroke patients. The reasonable use of auxiliary examination is important. Herein, we describe a patient with a cerebral infarction. A transcranial Doppler ultrasound (TCD) indicated that the flow rate of the bilateral middle cerebral arteries, bilateral posterior cerebral arteries, and the right vertebral artery were low, but did not exhibit stenosis. Meanwhile, magnetic resonance angiography (MRA) indicated that the bilateral middle cerebral arteries and right vertebral artery exhibited severe stenosis. Owing to this inconsistency between the ultrasound and MRA, transcranial color coded duplex sonography (TCCS) was performed. TCCS indicated that the bilateral middle cerebral arteries, bilateral posterior cerebral arteries, and right vertebral artery exhibited low flow rate and no stenosis. Since the TCD and TCCS produced similar results, but were notably different than the results of MRA, we performed computed tomography angiography (CTA) and found that the bilateral middle cerebral arteries did not exhibit significant stenosis. Then, MRA re-examination indicated that the bilateral middle cerebral artery imaging was normal and that the right vertebral artery was thin. TCD combined with TCCS can improve accuracy of diagnosis. Proper examinations that are mutually complementary can increase the early diagnostic rate of vascular disease.

Keywords

Ischemic stroke, Arteriostenosis, Transcranial Cerebral Doppler, Magnetic resonance angiography, Computed tomography angiography

Introduction

Intracranial large-artery occlusive disease is a major vascular lesion in stroke patients [1]. Successful treatment depends on timely and accurate detection of the location and degree of vascular stenosis. To date, imaging examinations mainly include transcranial Doppler ultrasound (TCD) and carotid ultrasound, magnetic resonance angiography (MRA), computed tomography angiography (CTA), and digital subtraction angiography (DSA). With the development of diverse medical technologies, the diagnostic rate of vascular stenosis has steadily increased. Accordingly, the ease of detection of arteries with stenosis is improving. Nevertheless, the reasonable use of auxiliary examinations is important in order to determine the severity of the disease and to reduce the financial costs associated with medical care. Therefore, cerebral vasculature abnormalities must be carefully detected.

Case Description

A 49-year-old male was admitted with left limbs weakness for 3 days. The left upper limb could

[1]Department of Neurology, The First Hospital of Jilin University, Jilin, 130021, China

[†]Author for correspondence: Ying-qi Xing, The First Hospital of Jilin University, Xinmin Street 71, Changchun 130021, China, Tel: 86-158430637846; Fax: 0086-431-88782762; email: xingyq2009@sina.com

hold object and the left leg could walk arduously. He had a history of cerebral hemorrhage 3 years prior that was accompanies with left limbs numbness. The patient had no history of hypertension, diabetes, or coronary disease, and denied smoking and drinking.

Physical examination showed that the strength of the left leg was grade 4 and that the left limbs exhibited hypalgesia. His low density lipoprotein cholesterol level was 3.18mmol/L. Magnetic resonance imaging(MRI) was performed on June 20, 2014, and indicated the presence of acute infarctions within the right corona radiata and the left parietal lobe; previously documented multiple bilateral lacunar infarctions, and softening lesions in the pons and right basal ganglia with hemosiderosis and calcification **(Figure 1)**. TCD on June 20, 2014, indicated that the flow rate of the middle cerebral arteries, anterior cerebral arteries, posterior cerebral arteries, vertebral arteries, and basilar artery were low, but with the normal range **(Figure 2)**. Carotid ultrasound showed no abnormalities. The clinical diagnosis was cerebral infarction and hyperlipidemia. After admission, the patient was managed conservatively and treated with anti-platelet and lipid-lowering agents.

The next day, MRA was performed, which indicated intermittent flow rate within the bilateral middle cerebral arteries and right vertebral artery, which led us to suspect that they were severely stenotic **(Figure 3)**. MRA examinations were performed using a1.5T (Avant; Siemens, Germany) scanner with three-dimension time-of-flight (3D-TOF). The imaging parameters were as follows: TR/TE = 23/7 ms; flip angle = 25.0°; FOV = 180 × 180 mm; FOV phase = 100%; slice thickness = 0.7mm; total acquisition time = 6:50 minutes; and reconstructed voxel size = 0.7 × 0.7 × 0.7mm. Due to the inconsistent results of the ultrasound and MRA, we performed transcranial color coded duplex sonography (TCCS), which indicated a low velocity, non-stenotic middle cerebral artery flow rate. Previously, the TCD and TCCS results were similar, but notably different than the results of MRA. CTA was performed 8 days following admission, which indicated that the bilateral middle cerebral arteries were relatively large and that the right vertebral artery

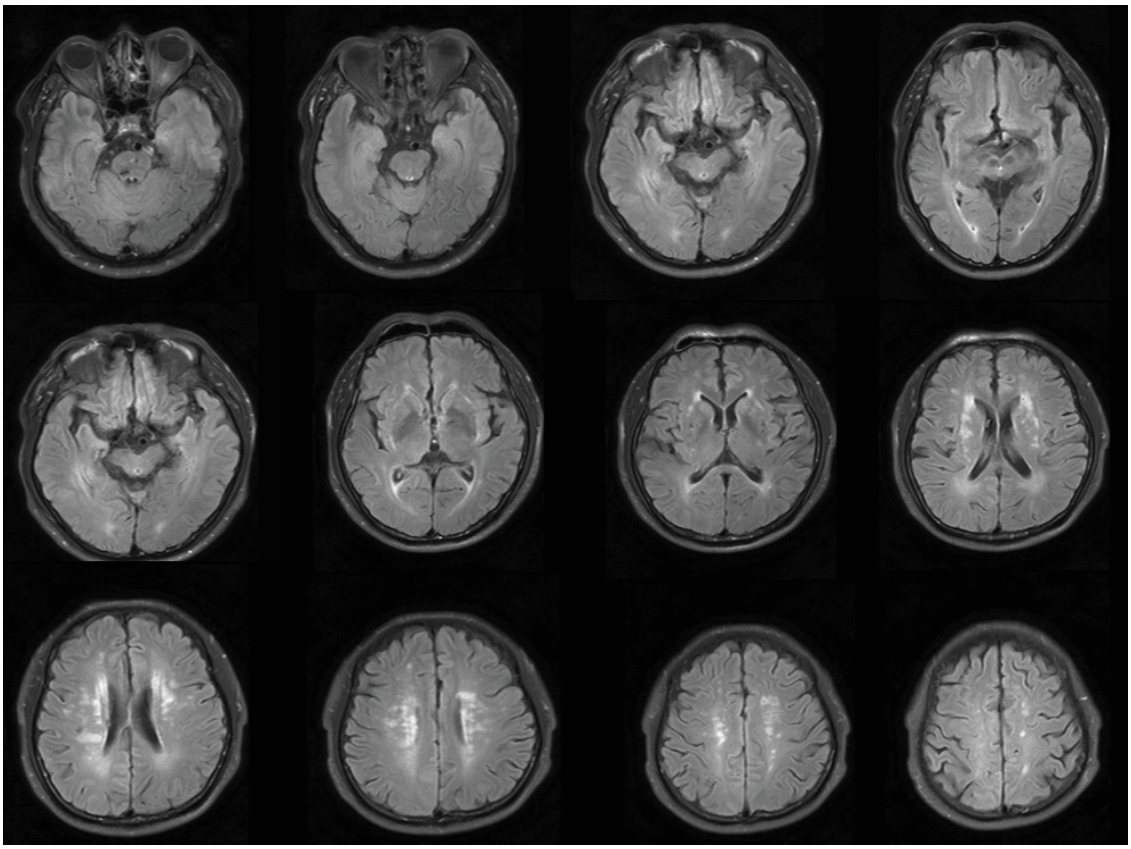


Figure 1: Magnetic resonance image showing acute infarctions within the right corona radiate and the left parietal lobe; previously documented multiple bilateral lacunar infarctions, and softening lesions in the pons and right basal ganglia with hemosiderosis and calcification.

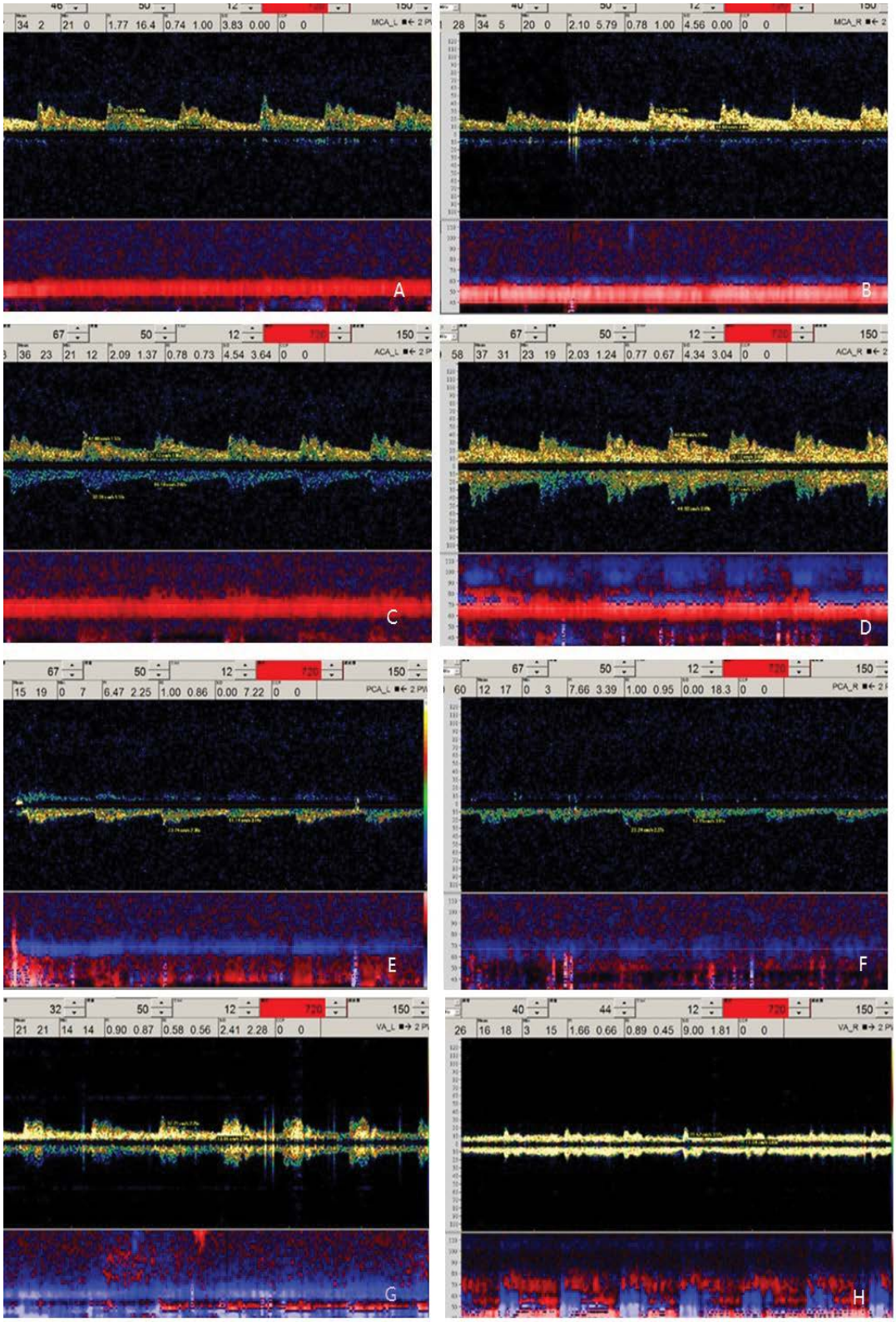


Figure 2: Transcranial Doppler ultrasound indicated that the flow rate of the middle cerebral arteries, anterior cerebral arteries, posterior cerebral arteries, vertebral arteries and basilar artery, were the low, but with the normal range). A:the velocity of left middle cerebral artery: 39/18cm/s; B: the velocity of the right middle cerebral artery: 38/18cm/s; C: the velocity of the left anterior cerebral artery:32/16cm/s; D: the velocity of the right anterior cerebral artery: 44/20cm/s; E: the velocity of the left posterior cerebral artery:23/11cm/s; F: the velocity of the right posterior cerebral artery:22/11cm/s; G: the velocity of the left vertebral artery:32/13cm/s; H: the velocity of the right vertebral artery:20/10cm/s.

was slightly thin (Figure 4). Both arteries did not exhibit significant stenosis. Then, MRA re-examination was performed on June 29, 2014, which indicated normal bilateral middle cerebral arteries imaging were normal and a thin right vertebral artery (Figure 5). Therefore, the results of the TCD and TCCS that were validated by the CTA were correct.

Discussion

The reasonable use of auxiliary examination is important in order to determine the severity of disease. This report showed different evaluations between TCD and MRA in an ischemic stroke patient. The change in MRA results between the two measurements may have been caused by the setting of machine parameters or a defect in the MRA equipment itself. Some factors can affect signal losses that occur in MRI [2] and MRA [3]. A previous report similarly found that CTA underestimated stenosis, that MRA overestimated it, and that Doppler produced results within the range of these modalities [4]. Currently, DSA is still the gold standard for vascular diagnosis.

DSA with good spatial resolution can not only provide cerebrovascular hemodynamic data, but also display the arteries and veins according to time sequence. It can distinguish the direction of flow and have an irreplaceable role in endovascular intervention. However, it is expensive, time-consuming, and invasive. MRA, which is a noninvasive and rapid auxiliary imaging modality, is more widely used in the clinical setting. It also has disadvantages, such as signal loss and lack of appropriateness for bedside use. There are many reasons for the signal loss, which is largely related to the state of blood flow. The complex and saturation effects related to vascular stenosis or its distal blood flow can result in signal loss since MRA is not sufficiently sensitive to display slow blood flow. TCD is good at not only identifying stenosis of intracranial vasculature, but also evaluating the collateral circulation. Current applications of TCD include intraoperative monitoring, auto-regulatory testing and cerebral microembolismdetection [5]. In our report, TCD was used to accurately assess the arteries. TCD is simple, noninvasive, relatively easy, repeatable, and low cost. It can be used as a primary screening method and can be paired to subsequent testing for vascular diseases. TCD, when combined with TCCS, can significantly improve the accuracy of the diagnosis of stenosis. When the TCD examination prompts a positive result, MRA and CTA can be selected. In general, MRA is the preferred examination modality since it does not require the use of contrast agents and costs less than CTA. However, our results show that CTA, rather than MRA should be used if TCD indicates a low velocity of intracranial arteries so as to prevent an overestimation of the degree of stenosis or false positives. Clinicians should become familiar with the advantages and disadvantages of auxiliary examinations so that they may be familiar with and apply a wide range of imaging techniques.

Conclusion

TCD combined with TCCS can improve diagnostic accuracy in patients with cerebral

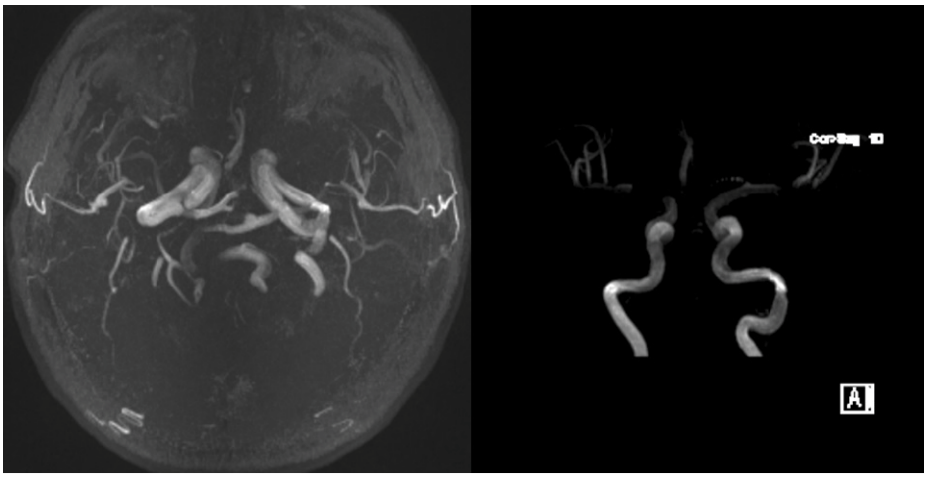


Figure 3: Magnetic resonance angiography indicated that the bilateral middle cerebral arteries and right vertebral artery exhibited intermittent flow rate, which was suggestive of severe stenosis.

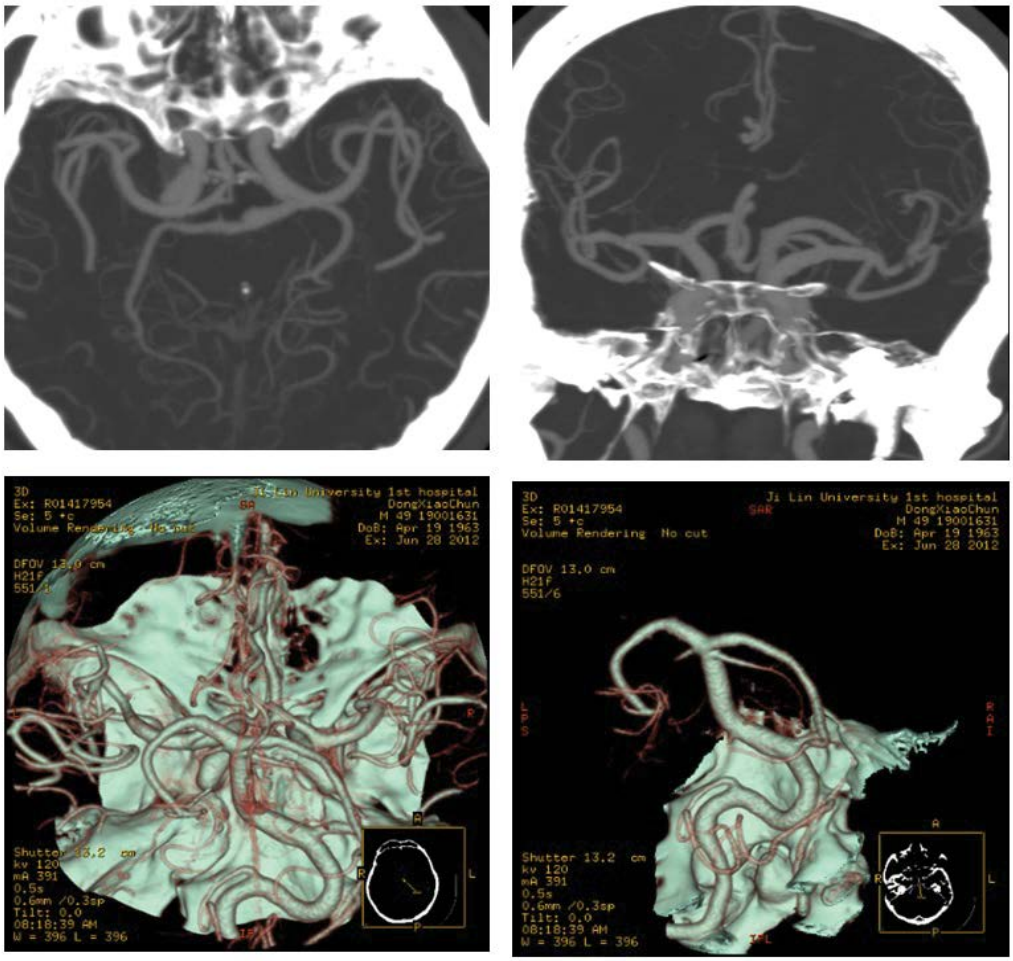


Figure 4: Computed tomography angiography indicated relatively large bilateral middle cerebral arteries and a modestly thin right vertebral artery. omputed tomography angiography indicated relatively large bilateral middle cerebral arteries and a modestly thin right vertebral artery.

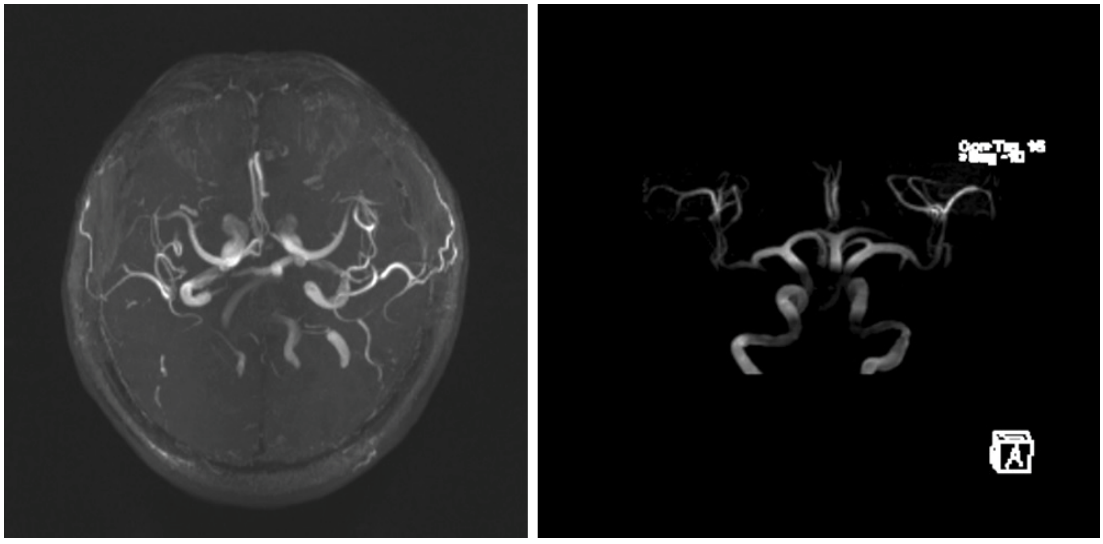


Figure 5: Magnetic resonance angiography re-examination indicated that the bilateral middle cerebral artery was normal and that the right vertebral artery was thin.

vasculature events. Our results suggest that CTA, rather than MRA, should be performed in patients in whom TCD indicate slow velocity of the intracranial arteries. This will help prevent an over-estimation of the degree of stenosis or false positives. Using a variety of auxiliary examinations with mutual complementarity can readily increase the early diagnostic rate of vascular diseases.

Competing Interests

None declared

References

1. Wong KS, Li H, Chan YL, *et al.* Use of transcranial doppler ultrasound to predict outcome in patients with intracranial large-artery occlusive disease. *Stroke* 31(11), 2641-2647 (2000).
2. Gatenby J, McCauley T, Gore J. Mechanisms of signal loss in magnetic resonance imaging of stenoses. *Medical. Physics* 20(4), 1049-1057 (1993).
3. Urchuk SN, Plewes DB. Mechanisms of flow-induced signal loss in Mr Angiography. *J. Magn Reson. Imaging* 2(4), 453-462 (1992).
4. Patel S, Collie D, Wardlaw J, *et al.* Outcome, observer reliability, and patient preferences if cta, mra, or doppler ultrasound were used, individually or together, instead of digital subtraction angiography before carotid endarterectomy. *J. Neurol. Neurosurg. Psychiatry* 73(1), 21-28 (2002).
5. Naqvi J, Yap KH, Ahmad G, *et al.* Transcranial doppler ultrasound: A review of the physical principles and major applications in critical care. *Int. J. Vasc. Med* 629(1), 378 (2013).