IMAGING AND INTERVENTION

CASE REPORT IMAGING AND INTERVENTION 2022;2(2):23-26
DOI: 10.5152/iai.2023.22061

Early Balloon Angioplasty and Stenting Along with Aggressive Medical Management in Patients with Intracranial Stenosis Showing Watershed Pattern of Stroke

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Abstract

Most studies have focused on treatment options and timing without consideration of pathophysiology of stroke pattern in intracranial stenosis. Hypoperfusion stroke has different pathophysiology compared to embolic or perforator patterns of stroke, and the same approach to treatment may not work. Medical management alone may not be the best option for the treatment of hypoperfusion stroke, and these patients may benefit more from early stenting. Higher periprocedural risk in early percutaneous transluminal angioplasty and stenting can be seen in acutely symptomatic intracranial atherosclerotic stenosis as a result of plaque destabilization, while the risk of stroke recurrence may be higher in patients with watershed stroke treated with medical therapy alone. We report 4 patients who presented with symptomatic high-grade intracranial stenosis with imaging features of acute watershed infarction who underwent early percutaneous transluminal angioplasty and stenting. Although few studies have advocated early stenting, larger studies are needed to confirm the role of early angioplasty and stenting in acutely symptomatic patients with intracranial atherosclerotic stenosis presenting with hypoperfusion stroke.

Keywords: Angiography, balloon angioplasty, intracranial stenosis, neuroradiology, watershed infarct

Introduction

Intracranial stenosis accounts for 8%-10% of ischemic strokes globally, with greater prevalence in Asian population and African people.[1,2] Higher periprocedural risk in percutaneous transluminal angioplasty and stenting (PTAS) as shown in the Stenting and Aggressive Medical Management for Preventing Recurrent Stroke in Intracranial Stenosis (SAMMPRIS) trial resulted in aggressive medical therapy as the primary approach to the treatment for intracranial stenosis, despite somewhat suboptimal long-term outcomes with medical therapy alone.[3-5] Although many other subsequent studies have concurred with SAMPPRIS, a few studies have suggested otherwise.[3,5-8] Most studies have focused on treatment options and timing without consideration of the underlying variability in the pathophysiology of stroke in intracranial stenosis. Higher periprocedural risk in early PTAS may occur due to the risk of distal embolization in acutely symptomatic intracranial atherosclerotic stenosis (ICAS) as a result of plaque destabilization. However, this same assumption may not hold true for patients with high-grade intracranial stenosis who become acutely symptomatic due to hypoperfusion. Moreover, the risk of stroke recurrence may be higher in patients with watershed stroke treated with medical therapy alone.[9] We report 4 patients who presented with symptomatic high-grade intracranial stenosis with imaging features of acute watershed infarction, and PTAS was performed via transfemoral approach by a single operator without periprocedural complications or stroke recurrence on follow-up.

Case Presentations

Case 1

A 76-year-old diabetic and hypertensive patient presented to the emergency room with chief complaints of generalized weakness, slurred speech, and near syncope for 1 week which started after initiating amlodipine. Neurological exam was remarkable for left hemineglect to tactile and vision sensation. National Institutes of Health (NIH) stroke scale was 1. The patient did not receive tissue plasminogen activator as she came after 4.5 hours window period. She received aspirin 325 mg and atorvastatin 20 mg. Laboratories showed elevated creatinine, blood urea nitrogen, and alkaline phosphate and hyperlipidemia. Computed tomography (CT) of the head demonstrated transcortical hypodensity in the right parietooccipital location suspicious for an acute/subacute infarction which was confirmed by magnetic resonance imaging (MRI) as a cortical subacute watershed infarction (Figure 1). Magnetic

Cite this article as: *Raghuram K, Chaudhary RK. Early balloon angioplasty and stenting along with aggressive medical management in patients with intracranial stenosis showing watershed pattern of stroke. Imaging Interv. 2022;2(2):23-26.*

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Received: May 27, 2022 **Accepted:** November 1, 2022 **Publication Date:** April 7, 2023

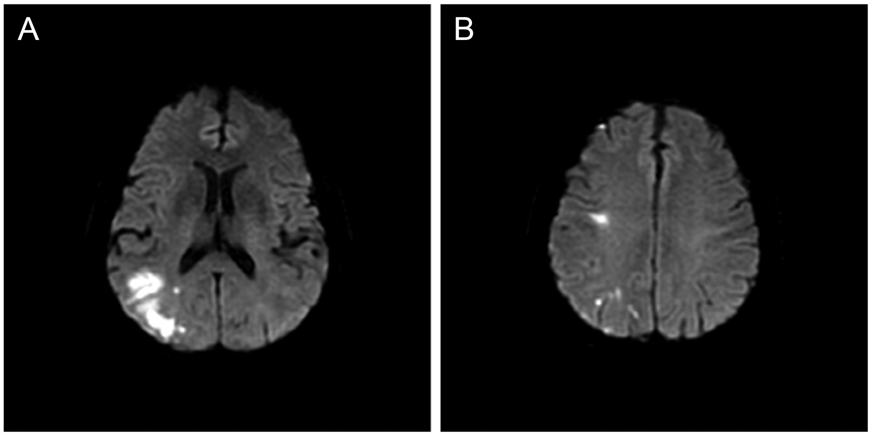

Figure 1. (A-B) Diffusion weighted images (DWI) image demonstrates acute watershed infarction on right side.

resonance angiography (MRA) of the head and neck was performed, which demonstrated focal moderate to severe stenosis of the right petrocavernous Internal carotid artery (ICA) junction with attenuated flow in the distal right cavernous and supraclinoid right ICA (Figure 2). Limited cerebral angiogram was performed the same day which demonstrated a 70%-80% stenosis of the right ICA at the petrocavernous junction (Figure 3). The patient underwent angioplasty and stenting the next day with a Herculink Elite 4 × 12 mm balloon-mounted stent in the right petrocavernous junction. Marked improvement in caliber was noted, with only 25% residual stenosis (Figure 4). Pre-procedural P2Y12 reaction units (PRU) was 249 following which clopidogrel 300 mg loading dose was given followed by clopidogrel 150 mg. Post-procedural PRU was 221 which was higher than our target PRU of <200. Heparin and clopidogrel were stopped, prasugrel tablet 10 mg was started, and the patient was discharged on aspirin and prasugrel. Follow-up MRA of head and neck 9 months after angioplasty demonstrated no significant narrowing (Figure 5). The patient had no recurrence of transient ischemic attack (TIA) or acute stroke during 17 months follow-up.

Case 2

A 66-year-old heavy smoker, diabetic, and hypertensive patient with prior stenting for coronary artery disease presented to the emergency room with sudden onset of left hemianopsia almost 24 hours after the onset of symptom. NIH stroke scale was 1. CT of the head showed remote left and subacute right occipital infarcts. Aspirin and statin was started. Laboratory reports were unremarkable. Echocardiogram obtained demonstrated diastolic dysfunction. Computed tomography angiography (CTA) of the head showed an 80% stenosis in the V4 segment of the left dominant vertebral artery as well as moderate left petrous ICA stenosis and 70% left carotid bulb stenosis. Repeat CT of the head after 2 days showed evolving likely subacute right occipital lobe and splenium of corpus callosum infarcts. He was started on dual antiplatelet therapy. He underwent a catheter angiogram the next day, which demonstrated a small right vertebral artery, nearly 80% left vertebral artery

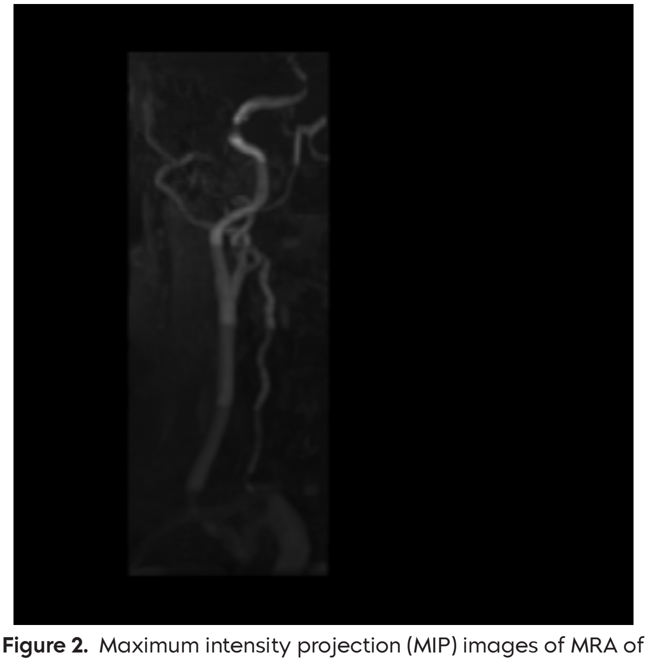

Figure 2. Maximum intensity projection (MIP) images of MRA of the brain demonstrate focal moderate to severe stenosis of the right distal cervical ICA just proximal to the petrous segment.

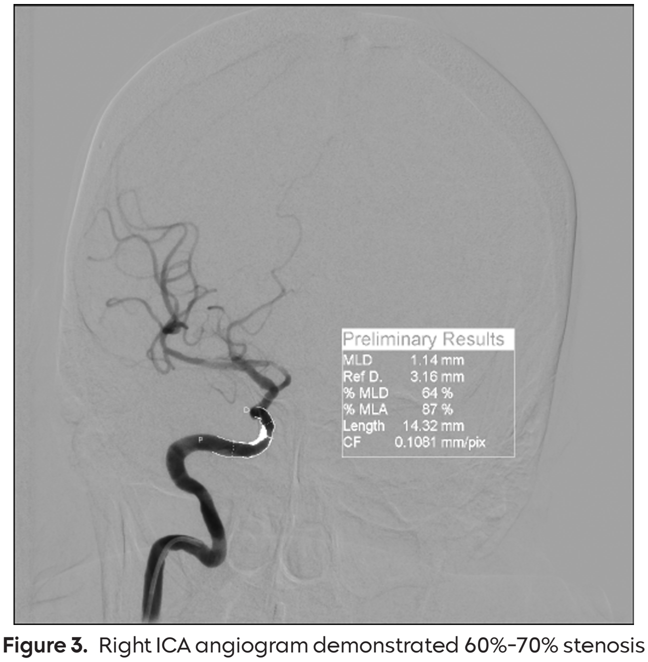

Figure 3. Right ICA angiogram demonstrated 60%-70% stenosis at the petrocavernous junction.

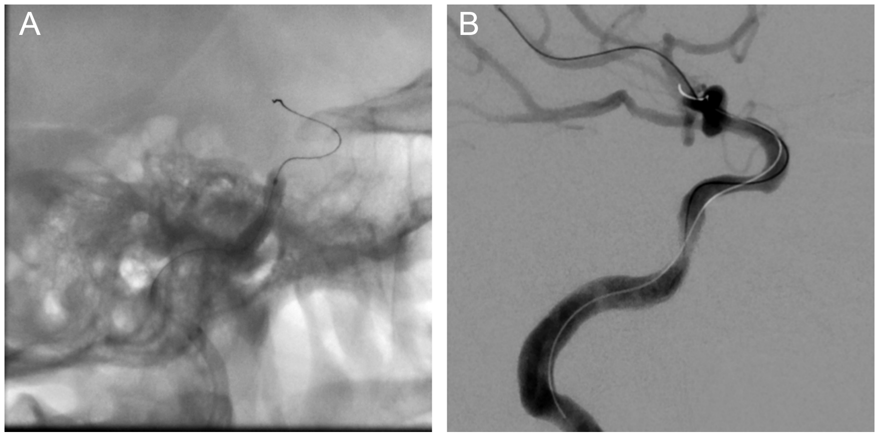

Figure 4. (A) Right ICA angioplasty with balloon inflated in the region of stenosis. (B) Right ICA with improved stenosis and flow post angioplasty and stenting.

stenosis, and a 70% left ICA stenosis. Angioplasty and stenting was planned the next day. A 4 × 18 mm balloon-mounted Vision stent was placed across the stenosis in the left vertebral artery. Additional angioplasty was performed with satisfactory dilatation of the stent. The patient did well and was discharged on aspirin 81 mg and clopidogrel 75 mg daily for 3 months. The patient had no symptoms of TIA or acute stroke during 3 months follow-up.

Case 3

A 73-year-old male with diabetes, hypertension, hyperlipidemia, and past history of stroke came to the emergency room 5 hours after left facial droop and slurring of speech. Patient was on atorvastatin, baby aspirin, clopidogrel, amlodipine, hydrochlorothiazide, and oral hypoglycemic agents. The patient's blood pressure was 171/74 and heart rate was 60. Neurological examination was unremarkable except for left facial droop. Computed tomography of the head did not demonstrate any significant abnormality. Laboratory results showed a high random blood glucose level. CTA of the head was obtained the next day, which demonstrated a short-segment 70%-80% stenosis of the proximal basilar artery. MRI of brain did not show diffusion restriction. Initial cerebral angiogram performed 2 days after presentation demonstrated approximately 70%-80% stenosis of the basilar artery as well as 50% left V4 vertebral artery stenosis. Angioplasty and stenting of the left distal vertebral artery and the basilar artery were performed using a 2.5 × 15 mm Gateway balloon and a 4 × 15 mm Wingspan stent. Only minimal residual 10%-20% stenosis of the vessel was identified at the end of the procedure. The patient was discharged on dual antiplatelet therapy along with antihypertensive and antihyerlipidemic agents and drugs for glucose control. Follow-up at 15 months showed no recurrence of acute stoke or TIA.

Figure 5. Follow-up MRA MIP images at 9 months do not show evidence of restenosis.

Case 4

An 80-year-old diabetic and hypertensive gentleman presented to the emergency room with the chief complaint of difficulty in identifying numbers, objects, and making sense of written language. He was taking insulin, lisinopril, atorvastatin, metoprolol, and aspirin. His blood pressure was 169/108 and pulse rate was 114. NIH stroke scale was 0. On neurological exam, the symptoms were most consistent with visual agnosia and alexia. His laboratory reports were unremarkable except for random blood sugar of 280 mg/dL and alkaline phosphatase 187 U/L. CT of the head demonstrated transcortical hypodensities in the left parietooccipital lobes and left frontal lobe. MRI of brain confirmed acute/subacute watershed infarction. Intravenous tissue plaminogen activator was not initiated due to delay in patient arrival greater than 4.5 hours of symptom onset, and NIH stroke scale was 0. CTA of the head was performed after 2 days, which demonstrated focal 70% stenosis of the left M1 middle cerebral artery (MCA) trunk just proximal to bifurcation. Angiography was performed followed by angioplasty of the MCA stenosis with a Gateway 2.5 × 15 mm balloon. A stent was not placed as the patient would not be able to be prescribed dual antiplatelet therapy as he was concurrently diagnosed with rectal cancer and was scheduled for curative surgery. The angioplasty resulted in improvement in caliber of the left MCA stenosis with a residual stenosis close to 40% but without significant flow limitation. The patient was discharged on atorvastatin and aspirin. The patient had no new symptoms over a 13-month follow-up period.

Discussion

In our small group of acutely symptomatic patients with a watershed pattern of infarction, early stenting was able to be undertaken safely. In our study, 3 patients underwent endovascular treatment within 1 week of onset of symptoms and 1 underwent stenting within 2 weeks of onset of symptoms.

The SAMMPRIS trial showed a 30-day stroke recurrence rate of 14.7% in PTAS versus only 5.8% in the aggressive medical management group favoring medical management over PTAS, which was further supported by other studies including meta-analyses.[1,5,8] However, some non-randomized studies have shown that PTAS is still a viable option for the treatment of patients with intracranial stenosis with better short- as well as long-term outcomes.[3,6] Addressing the mechanism of initial stroke is important to determine the risk of recurrent stroke and the effectiveness of therapy.[1] Hypoperfusion is the main mechanism suggested for watershed infarction, while acute plaque destabilization plays an important role in embolic and perforator patterns of stroke.[9] It seems logical that aggressive medical management can help in plaque stabilization and prevent future embolization, but the same argument may not hold true for hypoperfusion strokes which have a different mechanism. Lesion stability has been suggested to be a more important predictor of outcome of PTAS than the degree of stenosis in ICAS. This was further supported by significantly lower risk of stroke recurrence over 2 years in patients with hypoperfusion stroke who underwent stenting compared to those patients with non-hypoperfusion strokes similar to subgroup analysis of the SAMMPRIS trial. However, the difference did not reach a significance level.[10,11] Distinguishing types of strokes in practice may not always be easy, and vessel wall imaging using high-resolution MRI could help in the characterization of atherosclerotic stenosis.[12,13]

In a small study by us (n = 39), more than half (4 out of 7) of the patients with watershed infarction had recurrent stroke, while none of the patients with an embolic pattern had stroke recurrence when treated with medical management alone.[9] In fact in our current study as well, 2 patients developed watershed stroke when they were already on medical management. One-year results of the Chinese multicenter prospective registry (NCT01968122) comparing outcomes of tailored stenting of patients with symptomatic ICAS and poor collaterals have suggested that hypoperfusion strokes may benefit more from recanalization than other patterns of stroke, but the details are not available.[14] In a retrospective study (n = 68), stenting of severely stenosed (70%-99%) symptomatic ICAS patients with watershed type of infarction or TIA resulted in a low 30-day complication rate of approximately 4.4%, much lower than that of the SAMMPRIS trial, but the patients in the study underwent stenting only after 2 weeks of aggressive medical management.[15]

Conclusion

The literature to support patient stratification in intracranial atherosclerotic disease using the mechanism of stroke is sparse. In our a small case series, early intervention with PTAS was able to be undertaken safely in patients with severe ICAS and a hypoperfusion pattern of stroke. Larger studies are needed to validate this observation.

Informed Consent: Written informed consent was obtained from all patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – R.K.; Design – R.K.; Supervision – R.K.; Funding – None; Materials – R.K., R.C.; Data Collection and/or Processing – R.C.; Analysis and/or Interpretation – R.C., R.K.; Literature Review – R.C.; Writing – R.C.; Critical Review – R.K.

Declaration of Interests: The authors have no conflict of interest to declare.

Funding: This study received no funding.

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