Shock after Mechanical Thrombectomy for Acute Ischemic Stroke: A Point-of-Care Ultrasound Diagnosis

Govind Pandompatam, MD, and Stanley Bly, RVT, RDCS, *Springfield, Illinois*

INTRODUCTION

Acute ischemic stroke due to carotid artery dissection extending from type A aortic dissection is an uncommon but important etiology of stroke. It must be rapidly diagnosed and treated to prevent significant mortality. We present such a case of undifferentiated shock after mechanical thrombectomy for acute ischemic stroke that was promptly diagnosed with point-of-care ultrasound (POCUS).

CASE PRESENTATION

A 58-year-old man with a medical history of hypertension and tobacco abuse was found after having fallen down at home by a family member. Upon arrival of emergency medical services, the patient was awake but confused and was unable to move his left arm and leg. He was brought to a local emergency department, where urgent noncontrast computed tomography (CT) of the head showed no acute hemorrhage. The patient was last known to have been well 3 hours prior to arrival at the hospital. The National Institutes of Health Stroke Scale score was 19. Tissue plasminogen activator was given for suspected acute ischemic stroke. No further history was initially obtainable due to the patient's clinical status. Our stroke team was contacted from the local emergency room, and due to high suspicion for acute cerebral large vessel occlusion, the patient was flown to our hospital and taken directly to the catheterization suite for angiography and potential mechanical thrombectomy. During angiography, the right middle cerebral artery M2 and M3 branches were found to be occluded, and the patient underwent successful recanalization with resultant thrombolysis in cerebral infarction 2b flow. During angiography the right common carotid artery (R CCA) showed low flow and gravity stasis of contrast at the bifurcation to the internal carotid artery, with possible R CCA dissection (Figure 1). The neurointerventional team noted that the patient was hypotensive prior to starting the procedure, and he was started on low-dose phenylephrine.

The patient was brought to the intensive care unit postprocedurally on an escalating dose of phenylephrine at 250 μg/min. On physical exam the patient was awake and oriented to person, place, and time. Physical exam demonstrated left arm and leg hemiplegia and left gaze preference. Pertinent laboratory analysis revealed hemoglobin, 15.3 g/dL; international normalized ratio, 1.1; creatinine, 2.27 mg/dL; and blood glucose, 188 mg/dL.

Immediate POCUS exam was performed by the critical care team due to hypotension. A phased-array transducer (5-1 MHz) was used for thoracic and abdominal views, and a linear transducer (13-6 MHz) was used for superficial vascular views (Sonosite X-Porte Fujifilm ultrasound machine, Fujifilm, Tokyo, Japan). The parasternal long-axis view showed a dilated aortic root. Apical 4-chamber and subcostal views demonstrated pericardial effusion with right atrial diastolic collapse (Figure 2, Video 1), suggestive of tamponade physiology. The apical long-axis view showed mild aortic regurgitation (AR) judged by visual estimation of the color Doppler jet (Figure 3, Video 2). The aortic dissection flap was seen in the ascending aorta extending into the aortic arch in the suprasternal notch view and extending into the R CCA upon cervical vasculature evaluation (Figure 4, Video 3). The dissection flap was also seen continuing into the abdominal aorta (Figure 5, Video 4).

A CT angiography of the head and neck confirmed the findings of type A aortic dissection beginning at the aortic root, extending into the brachiocephalic artery and R CCA and distally into the abdominal aorta (Figure 6). Cardiothoracic surgery was emergently consulted; however, the patient refused surgery due to religious beliefs, despite being counseled regarding the extremely high mortality of disease without urgent intervention.

One hour later, the patient became somnolent and had worsening gaze deviation. POCUS exam of the right cervical superficial vasculature was repeated and now showed progressive thrombosis of the R CCA false lumen with true lumen flow compromise (Video 5). Progressive cerebral infarction was confirmed on repeat noncontrast head CT. The patient continued to deteriorate over the next 6 hours and passed away shortly thereafter.

DISCUSSION

Type A aortic dissection carries a mortality of 1%-2% per hour for the first 24 hours, and therefore rapid diagnosis and treatment are of paramount importance.[1,2] Transthoracic echocardiography may be useful in the acute initial setting, although the sensitivity may only be as high as 85%.[3] Transesophageal echocardiography and CT imaging have excellent diagnostic accuracy; however, transesophageal echocardiography may not be available at all hours at the bedside, and CT imaging requires transporting an often unstable patient. Transthoracic echocardiography, given its rapid availability and noninvasive nature, is a useful screening test for type A aortic dissection, especially if it involves the aortic root. Furthermore, it can add important information about LV systolic function, presence and

From the Department of Critical Care, HSHS St. John's Hospital (G.P.); and Department of Echocardiography, Prairie Cardiology (S.B.), Springfield, Illinois.

Keywords: Point-of-care ultrasound, Type A aortic dissection, Carotid artery dissection

Conflicts of Interest: None.

Correspondence: Govind Pandompatam, MD, HSHS St. John's Hospital, 800 East Carpenter Street, Springfield, Illinois 62769 (E-mail: *govind@ualberta.ca*).

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2468-6441

https://doi.org/10.1016/j.case.2022.04.014

VIDEO HIGHLIGHTS

Video 1: Apical 4-chamber and subcostal views demonstrating cardiac tamponade. The *arrow* demonstrates right atrial collapse. Imaging was obtained with a phased-array transducer (5-1 MHz).

Video 2: Apical long-axis view showing mild AR associated with type A aortic dissection (dissection flap not clearly seen in this view). Imaging was obtained with a phased-array transducer (5-1 MHz).

Video 3: The pulsating R CCA seen with dissection flap in the middle of the vessel separating true and false lumens. The right internal jugular vein is seen overlying the R CCA. Superficial cervical vasculature POCUS exam was done with a linear ultrasound transducer (13-6 MHz).

Video 4: Aortic dissection flap is seen extending into the abdominal aorta, first seen in short-axis view and then in the longitudinal view. Imaging was obtained with a phased-array transducer (5-1 MHz).

Video 5: Right CCA imaged 1 hour after initial presentation showing progressive thrombosis of the false lumen of the dissected vessel, leaving a narrow true lumen with severely compromised blood flow as imaged with color Doppler. Superficial cervical vasculature POCUS exam was done with a linear ultrasound transducer (13-6 MHz).

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Figure 1 Angiography demonstrates R CCA low flow and gravity stasis of contrast at the bifurcation of the internal carotid artery with possible dissection *(arrows)*.

severity of associated AR, and pericardial effusion/cardiac tamponade as seen in our case.[3] Cardiac tamponade is well known as one of most common causes of death in type A aortic dissection, and thus it is vital to screen suspected cases with rapid bedside POCUS.

POCUS exams for type A aortic dissection at the bedside can be performed by clinicians faster than ordering a formal transthoracic echocardiography in many circumstances. POCUS protocols, which include detection of an intimal flap, ascending aorta dilatation, aortic valve regurgitation, and cardiac tamponade, have been shown to be feasible by noncardiology emergency providers.[4] Combining standard thoracic views with abdominal aortic views may further improve sensitivity for type A aortic dissection detection on POCUS exam.[5] In an emergency room study, diagnosis of type A aortic dissection with POCUS was achieved faster with less misdiagnosis than in a standard group without POCUS.[6]

Carotid extension of type A aortic dissection is a well-known complication, with the R CCA most frequently involved. Strokes in type A aortic dissections may be seen in up to 6%-16% of cases.[7] In cases of isolated extracranial carotid artery dissections, thrombolytics are deemed safe and recommended; however, thrombolytics are contraindicated if underlying aortic arch dissection is suspected.[8] Unfortunately, our patient did not have clear clinical signs of chest or back pain to suggest aortic dissection and was given thrombolytics prior to transfer for mechanical thrombectomy. The importance of clinical clues and history prior to thrombolysis for acute ischemic stroke is vital to avoid potentially catastrophic complications, although this may be particularly difficult in a neurologically compromised patient.

We have started performing a rapid cardiac and cervical vasculature POCUS exam on our acute stroke patients, occasionally diagnosing cases of carotid artery dissection and commonly diagnosing other embolic and thrombotic stroke etiologies like carotid stenosis and left ventricular thrombus. Evaluating the aortic root and cervical vasculature can be done quickly in most patients and may be especially important if CT angiography of the neck is not available prior to thrombolytic administration to evaluate for underlying aortic dissection. In a recent study POCUS exam with a handheld device in the acute phase of ischemic stroke detected sources of embolism accurately, and findings were in agreement with standard transthoracic echocardiography examination in 128 of 130 patients (98%).[9] The majority of patients had diagnostic images, and less than 10% of patients were excluded due to poor thoracic windows.

POCUS exams are arguably most useful for the patient with undifferentiated shock. Integrative protocols have become standard in the initial triage of critically ill patients, systematically evaluating the heart, lungs, arterial and venous vasculature, and abdomen to rapidly diagnose common etiologies of shock. The RUSH exam (Rapid Ultrasound in Shock) is one useful step-by-step algorithm that has been shown to be fast and accurate.[10,11] Advanced critical care POCUS including cardiac hemodynamics, spectral Doppler, and evaluation of valvular disease is now gaining ground in critical care units and is becoming available to multidisciplinary medical teams. The recently developed Special Competence in Critical Care Echocardiography examination offered by the National Board of Echocardiography incorporates many aspects of POCUS

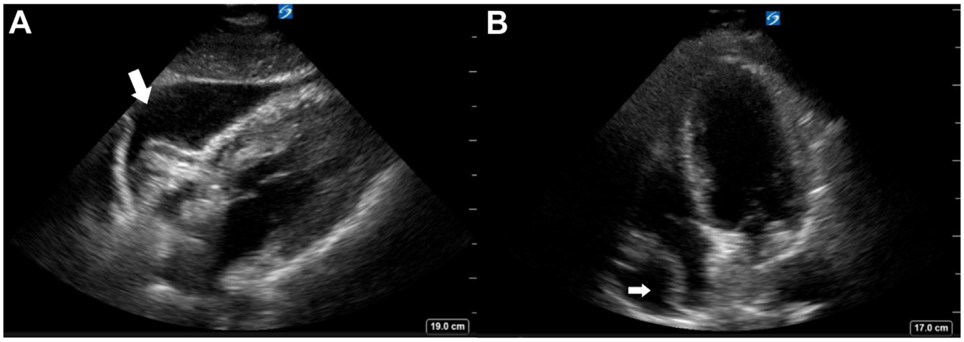

Figure 2 Subcostal view **(A)** and apical 4-chamber view **(B)** showing pericardial effusion with right atrial diastolic collapse *(arrows)*.

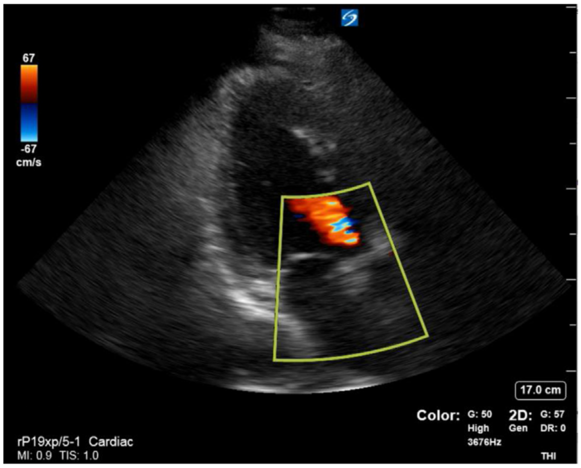

Figure 3 Apical long-axis view showing mild AR by visual estimation of the color Doppler jet.

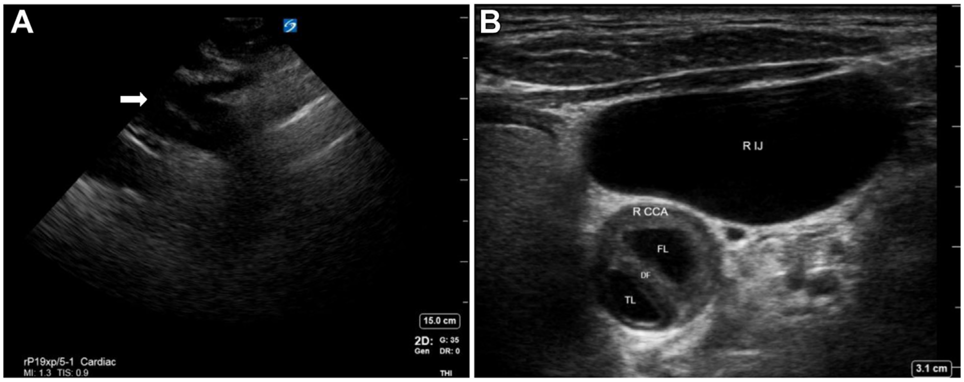

Figure 4 Dissection flap is seen in the **(A)** aortic arch in the suprasternal notch view *(arrow)* and **(B)** extending into the R CCA, with smaller true lumen (TL) and larger false lumen (FL) separated by the dissection flap (DF). Thrombus lines the wall of the false lumen. Overlying the R CCA is the right internal jugular vein (R IJ).

in critically ill patients and is a step in the right direction to ensuring the quality and future expansion of POCUS use. POCUS has become an effective extension of the physical exam for the bedside clinician, providing an immediate window into the pathology at hand. However, despite the enthusiasm for POCUS, clinicians must be cognizant that POCUS does not replace a formal ultrasound evaluation. A negative POCUS result often still needs to be followed by a formal ultrasound examination to confirm findings and guide treatment.

CONCLUSION

POCUS in our acute stroke patient rapidly expedited the diagnosis and treatment plan for acute type A aortic dissection with carotid

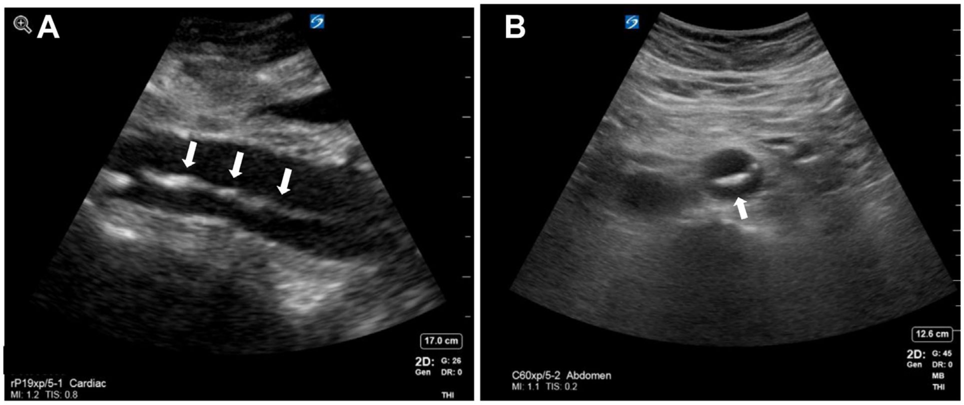

Figure 5 Extension of dissection flap into the abdominal aorta as seen in **(A)** long-axis *(arrows)* and **(B)** short-axis *(arrow)* views.

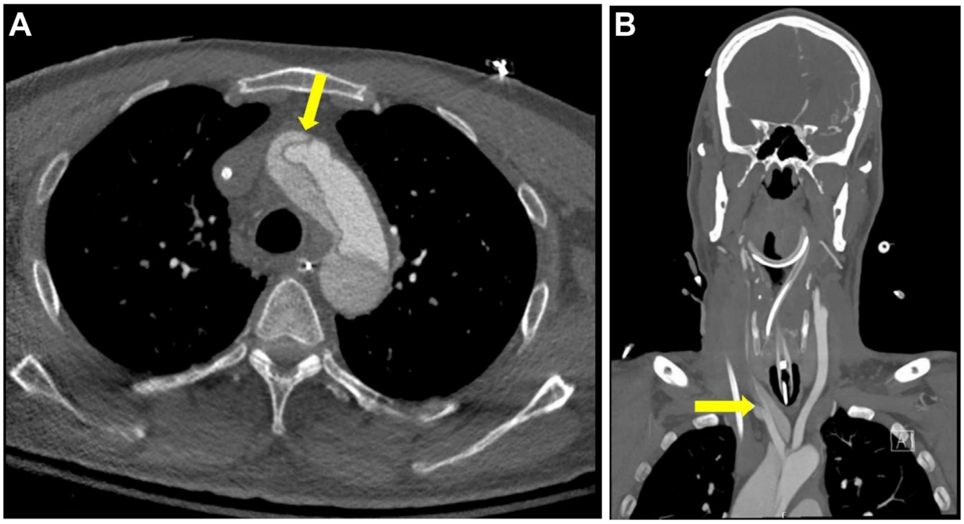

Figure 6 Computed tomography angiography showing type A dissection extending across the aortic arch and into the takeoff of the brachiocephalic artery in **(A)** axial views *(arrow)* and further into the R CCA in **(B)** coronal views *(arrow)*.

extension. As POCUS proliferates in medicine and handheld devices increase in quality and number, we are optimistic that POCUS can contribute significantly to the care of critically ill patients.

SUPPLEMENTARY DATA

Supplementary data to this article can be found online at https://doi.org/10.1016/j.case.2022.04.014.

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