

CASE REPORT

PEER REVIEWED

Right Innominate Artery Endovascular Intervention and Concomitant Use of Carotid Embolic Protection Device via Single Radial Access

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Introduction

Stenosis of the subclavian and innominate arteries is a rare complication of peripheral arterial disease (PAD), with chronic occlusions occurring even less frequently. Risk factors for both PAD and stenosis of the subclavian and innominate arteries include cigarette smoking, diabetes mellitus, hypercholesterolemia, and hypertension.¹ The occurrence of innominate artery stenosis or occlusion is notably less prevalent compared with subclavian artery disease. Radiographic evidence reveals that innominate artery stenosis constitutes only a minor percentage, ranging from 2.5% to 4% of atherosclerotic lesions affecting the extracranial cerebral arteries. However, this encompasses primarily low-grade stenosis, which is likely asymptomatic.^{2,3} The precise frequency of symptomatic innominate artery disease remains uncertain. Nonetheless, observations suggest that up to 8% of individuals initially diagnosed with suspected subclavian steal syndrome may present with innominate artery lesions.⁴

Innominate artery disease exposes patients to the risk of various events affecting both the posterior fossa and hemispheric region, such as vertebrobasilar insufficiency, amaurosis fugax, and stroke.⁵ Numerous studies have illustrated that severe lesions in the innominate artery significantly disrupt the flow in the right vertebral artery compared with that in the right carotid artery.^{3,6} In cases of innominate artery occlusion, the flow is diverted from the basilar axis through the right vertebral artery into the subclavian artery, where it retrogradely enters the right common carotid artery and then moves cephalad.⁴ Doppler findings may reveal midsystolic decelerations and elevated ratios of peak systolic velocity between the left common carotid artery and the right common carotid artery in cases of innominate artery disease, although the severity of stenosis does not consistently correspond to these duplex findings.

Revascularization and stenting procedures performed on major arteries carry inherent risks of embolization, transient ischemic attack (TIA), or stroke. A study reported complications arising from embolic events in 2 patients who underwent percutaneous transluminal angioplasty and stenting of the subclavian artery, resulting in 1 TIA and 1 peripheral embolism.⁷ Both patients experienced full recovery, yet the gravity of such complications underscores the need for additional protective measures against embolism.^{7,8} The deployment of an embolic protection filter within the internal carotid artery (ICA) presents a viable solution to mitigate embolic risk in this artery without impeding the stenting process in the subclavian and innominate arteries.⁸⁻¹⁰

Case Report

A 70-year-old woman with a medical history notable for coronary artery disease, previous angioplasty of the right coronary artery, claudication in both arms, dyslipidemia, type 2 diabetes, hypertension, tobacco consumption, and severe peripheral vascular disease, which includes stents in both iliac arteries, renal artery, celiac artery, and superior mesenteric artery, as well as a past right carotid endarterectomy, and most recently, a left subclavian artery stent, presented with symptoms of pain, heaviness, and numbness in her right arm. A previous peripheral angiogram showed severe stenosis of the right innominate artery of 90%. This patient was eligible for revascularization due to her right upper extremity pain, heaviness, and numbness.¹¹

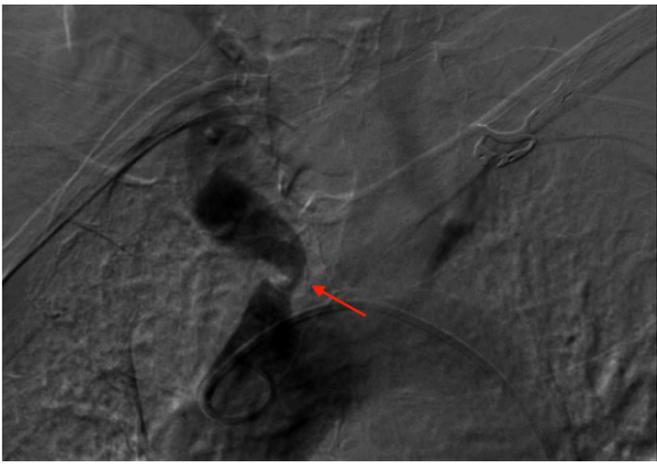


Figure 1. Aortogram showing right innominate artery stenosis (arrow).

in the right ICA through the radial access as it was the only route for delivering it to prevent entrapment of the filter if placed from the femoral route (**Figure 2**).



Figure 2. Carotid angiogram showing an Emboshield filter (NAV6, Abbott Cardiovascular) in the right internal carotid artery (arrow).



Figure 4. Aortogram post stent placement with distal malapposition.

Endovascular intervention has evolved as the treatment of choice for innominate artery stenosis due to the increasing complications of various surgical bypass options, including increasing morbidity and mortality due to complications such as chylothorax, acute arterial thrombosis, pneumothorax, pleural effusion, lymphatic fistulae, phrenic nerve palsy, and Horner syndrome.¹⁰

Considering the patient's comorbidities, an endovascular approach was the safest approach. Dual access was achieved using a 6F sheath in the right radial artery and another 6F sheath in the right femoral artery; an aortogram was then conducted showing severe stenosis in the right innominate artery (**Figure 1**). A carotid angiogram was performed, revealing a vessel size measuring 6 to 7 mm. We advanced a BareWire guidewire (Abbott Cardiovascular) and proceeded with the successful deployment of an Emboshield NAV6 filter (Abbott Cardiovascular)

We planned to proceed with the case using femoral access for better support delivering the stent. Unfortunately, attempts to cross antegrade from the groin were unsuccessful, despite multiple efforts and the utilization of various catheters (JR4, IM, AR-1).



Figure 3. Deploying the stent in the right innominate artery.

We upgraded the femoral sheath to a long sheath and planned to snare wire from the radial sheath and have more support; however, the patient became bradycardic and hypotensive, and despite improvement with atropine, we aborted further intervention from femoral access.

At this moment we elected to proceed with endovascular intervention through the radial access. Via right radial access, a long Runthrough

wire (Terumo Interventional Systems) crossed the stenosis into the distal aorta, and we upgraded the sheath to 7F over both wires (BareWire and long Runthrough). We exchanged the long Runthrough wire with a Glidewire Advantage (Terumo Interventional Systems) via a TrailBlazer support catheter (Medtronic). We predilated with an 8-mm balloon and then an 8-mm x 29-mm Omnilink balloon-expandable stent (Abbott Cardiovascular) was successfully placed in the right innominate artery and deployed (**Figure 3**). Next, a pigtail catheter was advanced through the groin and angiography was performed, showing an under-expanded and malapposed mid to distal area of the stent (**Figure 4**), which was post-dilated with a 14-mm x 10-mm Armada balloon (Abbott Cardiovascular) (**Figure 5**), after which the filter was removed and a final aortogram showed good results with better apposition without complications (**Figure 6**).

Follow-up

During a follow-up appointment 1 month later, the patient reported no dizziness, fainting, or near-fainting episodes, TIA, or stroke-like symptoms. Her right arm heaviness and numbness were resolved completely and she had a strong radial pulse bilaterally. A carotid and subclavian Doppler examination was scheduled for 6 months post-procedure to assess the condition of the stent. This showed multiphasic waveforms in both subclavian arteries with mild disease in the right carotid artery and the previous left subclavian stent without any elevated velocities or evidence of stenosis in the right innominate or subclavian arteries. (**Figure 7**).

Discussion

Our findings underscore two significant technical considerations in subclavian/innominate intervention that hold relevance for interventional and endovascular practitioners. First, the potential for using a single radial access to provide both embolic protection and deliver treatment, and second, the implementation of embolic protection devices aimed at mitigating the risk of neurological complications.



Figure 5. Post-dilation with a 14 x 10 mm Armada balloon (Abbott Cardiovascular).

treated for subclavian occlusions, with an average follow-up period of 19.4 months.¹³



Figure 6. Final aortogram.

We had planned to upgrade the access sheath to a long, more supportive sheath via femoral access, but had to abort this approach as the patient had a significant vagal response when the long sheath was being placed.

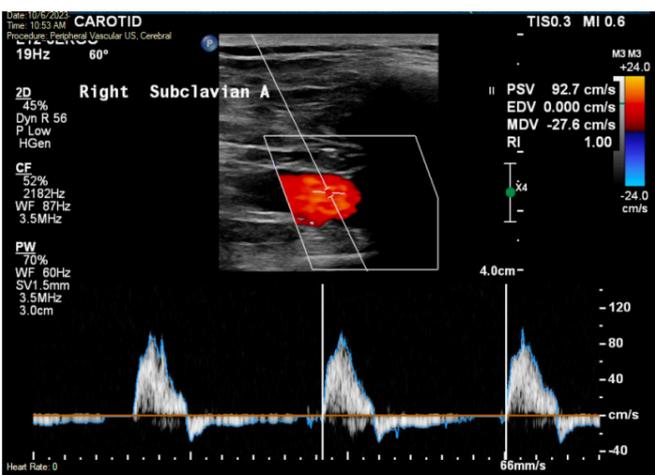


Figure 7. Doppler of right subclavian artery showing multiphasic waveforms without any elevated velocities or evidence of stenosis.

We believe, as highlighted in this case, that radial access is a useful and valuable tool when femoral access fails in endovascular procedures involving innominate arteries. ■

Affiliations and Disclosures

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The indications prompting revascularization in cases of innominate artery occlusion are associated with upper extremity ischemia with arm claudication, upper extremity ischemia, vertebrobasilar insufficiency, or subclavian steal syndrome.^{12,13} Transthoracic and extrathoracic bypass surgeries are associated with significant mortality rates and complications. The mortality rates associated with transthoracic open surgery for innominate artery disease range from 3% to 16%,^{14,15} with perioperative stroke rates reaching up to 6%.¹⁶ Therefore, endovascular procedures are now regarded as the primary treatment approach for lesions in the supra-aortic trunk.¹⁷⁻¹⁹ The success rates of the endovascular approach are reported as 100% in stenosis and approximately 90% in instances of complete occlusion.²⁰

In our case, embolic protection was employed as a preventive measure owing to the patient's severe PAD, which posed a heightened risk of embolization during the procedure. Additionally, stenting of the innominate artery poses a potential risk of embolization to the carotid artery. The incidence of strokes post-innominate artery stenting varies from 2% to 11%. Angle et al observed aphasia in 1 out of 21 patients (4.7%) following subclavian artery angioplasty, and Beck et al reported a 1% rate of neurological complications in 423 subclavian procedures.²¹ Martinez et al found 1 case of restenosis among 17 patients

Reports documenting the use of embolic protection devices during revascularization of severe stenosed or occluded vessels are rare. Those that utilize this technique describe deployment of a balloon in the ICA or vertebral artery, clamping of the carotid artery during surgical exposure, or use of modern embolic protection devices.^{8,22,23} Modern embolic protection techniques are superior to the others due to their flexibility and ease of navigation. In contrast to balloon angioplasty, they do not require flushing or aspiration of the proximal vessel, and they are also considerably less invasive than clamping of the carotid artery during surgical exposure.⁸ Such devices have been utilized more frequently in carotid artery stenting and are thought to reduce the risk of stroke.^{21,24,25} However, with their increasing ease of use, they can be utilized in both the carotid and vertebral arteries to revascularize the major vessels.⁸

Difficulties navigating a tortuous aortic arch has been documented in the literature, with various techniques suggested to add more support via femoral access.^{26,27}

This case adds additional support to the role radial access plays in bailing out peripheral endovascular procedures when femoral access is not readily available. Radial access is an important alternative access in such interventions, and our case clearly highlights how it can be safely utilized to deliver both stenting and embolic protection at the same time.^{28,29}

Conclusion

Managing innominate artery disease via radial access by utilizing a single radial access for both embolic protection and treatment delivery presents a viable alternative when femoral access is not feasible. Furthermore, the integration of embolic protection devices may offer added benefits for patients with severe PAD, helping to reduce the likelihood of neurological complications.

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