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Innominate & Carotid Artery Intervention in High-Risk Patients

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Introduction

Revascularization of supra-aortic arterial disease (complicated peripheral artery disease) is usually elective and prophylactic to prevent initial or recurrent ischemic events. Surgical revascularization was once considered the treatment of choice [1]. Successful reports of percutaneous transluminal angioplasty (PTA) and stenting introduced endovascular treatment as an equal or possibly better than surgery option [2]. Each patient is unique, and the risk is multifactorial with both demographic and anatomic risk factors.

Several “high-risk” features are generally considered when treating carotid artery disease in these patients [3] (Table 1.1). Some of these features are also risk factors for innominate intervention.

The level of stenosis and/or occlusion, vessel tortuosity, amount of calcification, presence or absence of thrombus, concomitant vascular abnormalities, and comorbid conditions will also affect the risk with revascularization of the other supra-aortic vessels.

Although some authors may consider endovascular therapy the treatment of choice for innominate atherosclerotic disease, surgical therapy has been shown to be safe and effective [4]. During a period of almost 20 years from 1974 to 1993, Kieffer et al. revascularized surgically 148 patients with acceptable rates of complications, late mortality, long-term patency, freedom from neurologic events, and reoperation [4].

Table 1.1 High-risk features reported in the literature.

1) CAS in females
2) CAS in octogenarians
3) CAS with type II, type III, or bovine arch
4) Tortuous common carotid artery, angulated ICA, and/or distal ICA
5) Long lesions ≥ 15 mm
6) Ostial-centered lesions
7) Calcified arch and/or heavily calcified lesion
8) High-grade stenosis
9) Contralateral carotid occlusion
10) Presence of vertebral artery occlusion and/or stenosis
11) Patient with CKD

Innominate Interventions in High-Risk Patients

Catheter-based Therapy for An Innominate (Brachiocephalic) Stenosis

Step 1. Identification of the level of stenosis is the initial step. Computed tomography angiography (CTA) can be useful prior to an invasive procedure. This can allow for planning the interventional strategy and considering alternative forms of treatment. Additionally, CTA can be used to size the reference vessels.

When considering the choice of arterial access remember that catheter size is limited with radial access and the need to cross the stenosis is usually necessary from the radial or brachial approach. If intervention is planned, injections are against the direction of blood flow when working from the arm approach. I prefer the femoral approach to innominate stenoses.

Invasive angiography can be done with digital and/or subtraction angiography. A pigtail catheter is positioned in the ascending aorta proximal to the origin of the innominate artery. The angiography is performed in the 30° left anterior oblique (LAO) projection. Selective angiography is done with a Judkins right diagnostic catheter or guiding catheter (Figure 1.1a,b). Other diagnostic catheters can be used for selective angiography. The “working view” is the angulation that allows for delineation of the stenosis, any adjacent branches, and the ostium of the innominate. Road mapping may be useful but also take advantage of any vascular calcification as a point of reference.

Step 2. After the decision to intervene and baseline angiography has been performed, the innominate is engaged with an 8 Fr guide catheter. A different approach is to use a diagnostic catheter to engage the innominate artery, cross the stenosis with the appropriate wire, and introduce a 6 Fr sheath over the wire to the

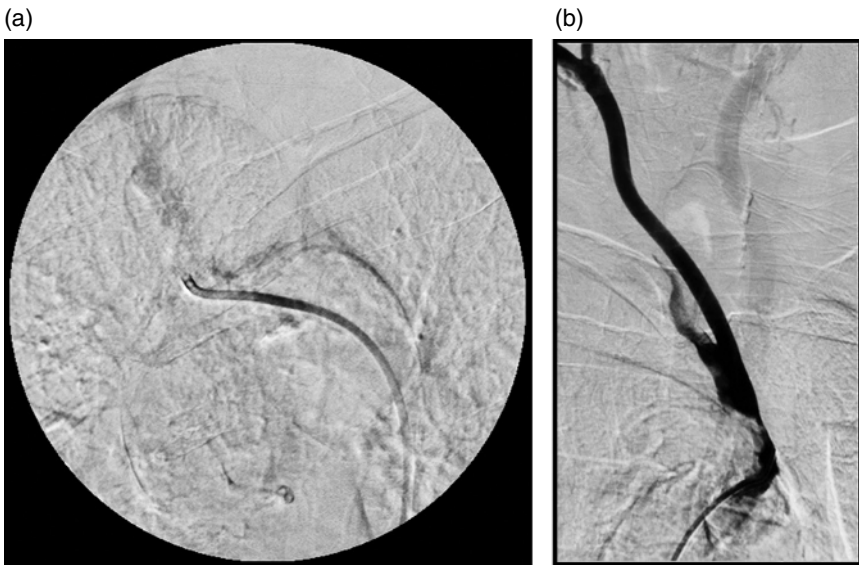


Figure 1.1 (a) Heavily calcified aorta and supra-aortic vessels. (b) Baseline innominate artery selective angiogram.

ostium of the innominate. Anticoagulation to achieve an activated clotting time (ACT) > 250 s is administered. Depending on the available balloons and stents, the appropriate wire (0.014–0.035 in.) is steered across the stenosis. The tip of the wire is passed into the subclavian artery. Wire tip can also be placed in the common or external carotid artery. Innominate artery PTA and stenting is usually performed without utilizing a distal embolic protection device (EPD). If you choose to use EPD, the necessary wire or filter can be positioned in the internal carotid artery. Horesh reported a case of innominate stenting with a covered stent and distal protection [5]. He emphasized the need to individualize patients and consider using embolic protection in high-risk patients. Hybrid procedures have been performed using balloon occlusion to trap embolic debris.

Step 3. Predilatation with a balloon is performed. The initial balloon is usually undersized but gives an idea of the ability to distend the lesion (Figure 1.2). The Shockwave Lithoplasty System (Medical Inc.) has been used to successfully treat severely calcified innominate stenosis prior to stenting [6]. This system has also been used in a hybrid operation [7]. Use the balloon inflation to help decide on stent sizing (diameter and length).

Step 4. Stent implantation is done after ensuring the correct position of the delivery system (Figure 1.3). If necessary, magnify the image to demonstrate the stent is appropriately placed. Remember, an undersized stent can be implanted so that

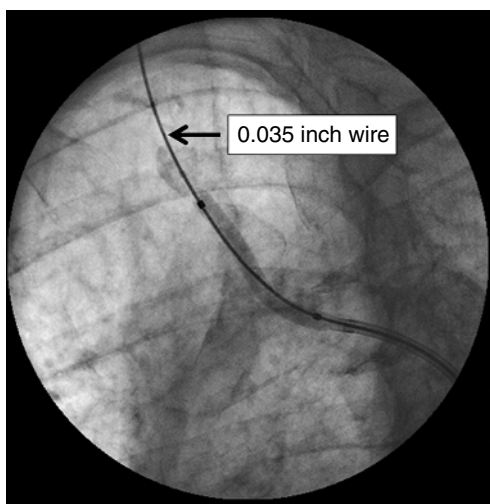


Figure 1.2 Predilatation with undersized balloon.



Figure 1.3 Stent in position at ostium of innominate.

the delivery sheath or catheter does not have to be “upsized.” A larger balloon (Figure 1.4) can subsequently be employed to adequately expand the stent without changing the sheath or catheter.

Step 5. Assessment of the poststent result is performed to determine stent apposition and size (Figure 1.5). If necessary, the stent can be postdilated with a larger balloon.

Step 6. After hemostasis the patient is usually monitored overnight and discharged the following day. Dual antiplatelet therapy is maintained for at least one month if there are no contraindications.

Figure 1.4 Larger balloon inflation.

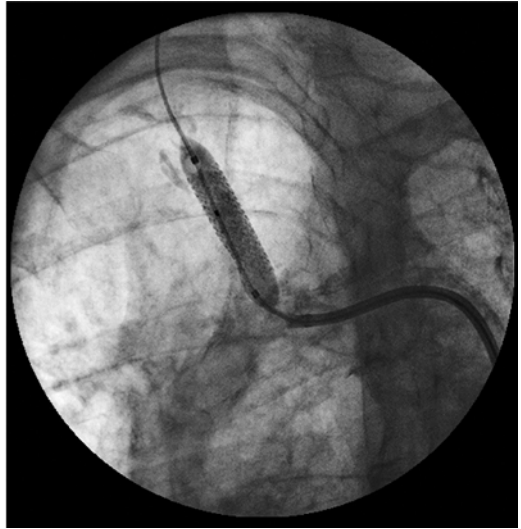


Figure 1.5 Final angiogram.



Carotid Artery Intervention in High-Risk Patients

Endovascular Treatment of A Carotid Stenosis

Left common carotid artery stenoses are treated endovascularly similarly to innominate artery stenoses. Distal embolic protection is not used routinely. There are endovascular, hybrid, and surgical alternatives.

Transcarotid artery revascularization (TCAR) offers alternative to both carotid endarterectomy (CEA) and carotid artery stenting (CAS) which are done via a transfemoral approach.

CAS can be performed with distal embolic protection and/or flow reversal. Distal embolic protection is the most commonly used choice. It is readily available and technically easier to deploy. However, it is not the best choice for tortuous common and/or internal carotid arteries, heavily calcified vessels, and “string signs.” Distal protection devices require crossing the diseased segment without protection compared to proximal protection where this is not necessary. Additionally, if anatomy warrants, CEA can be the treatment of choice.

Catheter-based Therapy for Carotid Stenosis

Step 1. Arterial access is obtained for distal embolic protection and flow reversal cases. Distal EPD can be done via femoral, radial, or brachial access. Flow reversal, because of the larger diameter sheath required, is performed via the femoral artery route. Access is obtained with ultrasound guidance or using anatomic landmarks. Femoral angiography is usually performed at the initiation of the case to document the appropriateness of the access and to plan for use of a closure device (Figure 1.6).

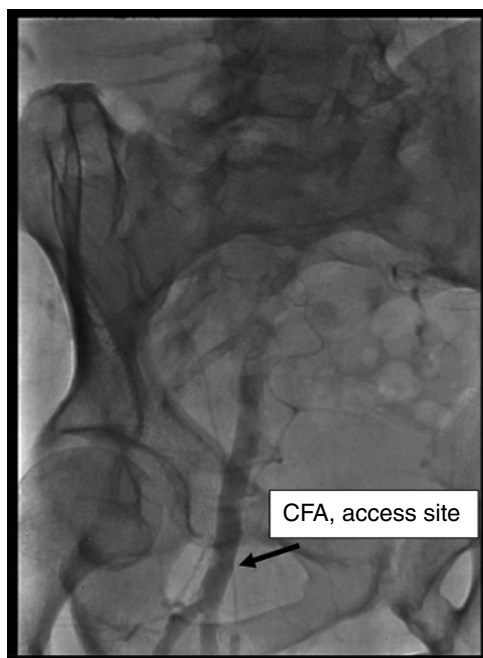
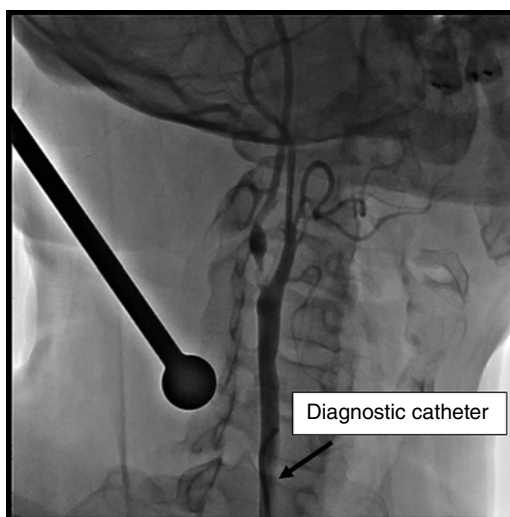


Figure 1.6 Femoral artery access.

Figure 1.7 Baseline selective angiography with reference object.



Step 2. Selective carotid angiography (Figure 1.7) of the culprit vessel is performed with a diagnostic catheter. The best angle to visualize the lesion is chosen. Quantitative angiography is done. This can be with a reference object placed at the level of the lesion or with online software. Of note, angiography of all the arch and intracranial vessels is performed prior to intervention. This can be done during the CAS procedure or at an earlier date. Other imaging modalities (CTA or MRI) can be done prior to the CAS. Imaging of the intracranial circulation is necessary in the event that the rare occurrence of neurorescue is needed and it is necessary to document the baseline anatomy.

Step 3. Heparin is administered to achieve an ACT greater than 250s. A sheath, guide catheter, or neuroprotection device is exchanged over a stiff wire (exchange length 0.035 in. Amplatz wire). The tip is placed in the common carotid artery. During the exchange procedure, the tip of the wire is positioned in the common carotid or external carotid artery. For the flow reversal case, it is necessary to place the stiff wire in the external carotid artery (ECA) through the diagnostic catheter (Figure 1.8) before the exchange procedure.

Step 4. This is where the proximal and distal protection significantly differ. With distal protection, a device is passed through the lesion into the internal carotid artery (Figure 1.9). The EPD is deployed. Balloon predilatation (Figures 1.10) is usually done with a smaller than the reference vessel sized balloon (generally 2.5–3 mm). A stent is deployed (Figure 1.11) and usually postdilatation is skipped. Completion angiography is done (Figure 1.12) along with the intracranial images. Hemostasis can be obtained with a closure device of choice. Generally, these patients are observed in the hospital overnight.



Figure 1.8 Angiogram through a diagnostic catheter in the external carotid artery before exchange.



Figure 1.9 EPD positioned in the internal carotid artery.

Figure 1.10 Predilatation with distal embolic protection.



Figure 1.11 Retrieval of the EPD.





Figure 1.12 Final angiogram after stenting.

When flow reversal is used, it follows the instructions for use with the Medtronic Mo.Ma device. The ECA balloon is inflated in the proximal segment (Figure 1.13). The common carotid balloon is inflated and the stenting is performed (Figures 1.14–1.16) with flow reversal at the end of the procedure prior to reestablishing antegrade flow. Operator should have all equipment ready to insert. I encourage “loading” the balloon and wire in the catheter before starting the proximal occlusion to minimize the occlusion time. Completion angiography, hemostasis, and postoperative care are as above with distal embolic protection.

Conclusions

The operator must carefully consider if revascularization is indicated in the patient with supra-aortic atherosclerosis. Revascularization is usually performed prophylactically to prevent ischemic events. The risk must be considered compared to the potential benefits. Knowledge of alternative revascularization strategies is paramount before undertaking these procedures.

Figure 1.13 Mo.Ma device with ECA balloon inflated.



Figure 1.14 Stent and postdilatation.





Figure 1.15 ECA balloon deflated with proximal balloon inflated.

Figure 1.16 Final angiogram.



References

- 1 Sullivan, T.M., Gray, B.H., Bacharach, J.M. et al. (1998). Angioplasty and primary stenting of the subclavian, innominate and common carotid arteries in 83 patients. *J. Vasc. Surg.* 28: 1059–1065.
- 2 Motarjeme, A. (1996). Percutaneous transluminal angioplasty of supra-aortic vessels. *J. Endovasc. Surg.* 3: 171–181.
- 3 Elewa, M.K. (2019). *Carotid Artery Stenting in High-Risk Patients for Stenting, Carotid Artery - Gender and Health* (ed. R. Rezzani and L.F. Rodella). IntechOpen. <https://doi.org/10.5772/intechopen.82019>.

- 4 Kieffer, E., Sabatier, J., Koskas, F., and Bahnini, A. (1995). Atherosclerotic innominate artery occlusive disease: early and long-term results of surgical reconstruction. *J. Vasc. Surg.* 21: 326–337.
- 5 Horesh, L. (2010). Endovascular management of an embolizing innominate artery stenosis: Evaluation of distal protection devices and covered stents. *Endovascular Today* 36–40.
- 6 Tripolino, C., Grillo, P., Tassone, E.J. et al. (2019). A case of critical calcified innominate artery stenosis successfully treated with the Shockwave Lithoplasty. *Clin. Med. Insights Case Rep.* 12: 1–3.
- 7 Mordasini, P., Gralla, J., Do, D.D. et al. (2011). Stenting of symptomatic high-grade innominate artery stenosis: technique and follow-up. *AJNR Am. J. Neuroradiol.* 32: 1726–1731.