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Strategies to Approaching Lower Limb Occlusions

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Endovascular management of chronic total occlusions (CTO) can be challenging both from decision-making and technical perspectives. Successful treatment and management of a CTO requires the operator to have an understanding of the salient imaging findings, a thorough knowledge of the various technical challenges of the procedure, and comprehension of the importance and necessity of long-term clinical management. This article outlines a general approach to endovascular management of lower limb CTOs and discusses indications, techniques, potential complications, and therapeutic options of the procedure.
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Introduction

There is a significant amount of debate regarding the optimal treatment of infrainguinal chronic total occlusions (CTO). Although endovascular options can be complex in both clinical decision-making and technical skills, they represent an essential tool for the interventionalist. Bypass options remain a viable and effective treatment option for many lesions; however, endovascular options are being pursued as the initial option in many cases secondary to lower morbidity and mortality.[1] With continued advances in endovascular technology and the corresponding improving patency rates of next generation nitinol stents, drug-coated balloons (DCBs), drug-coated stents, and expanded polytetrafluoroethylene-covered self-expanding covered stents, there will be a continued push toward aggressive endovascular management of CTO. In most cases, however, the most difficult component of the procedure remains the initial passage of a guidewire beyond the occlusion.

Historically, when using conventional wire and catheter technique, success rates of treating CTOs have been moderate to poor, ranging from 40%-60%.[2] With the advent of the subintimal technique by Bolia et al,[3,4] the treatment of this difficult lesion enjoyed newfound optimism with technical success rates ranging from 80%-90%.[5] Since the introduction of subintimal recanalization, a new armamentarium of devices designed for this challenging endovascular territory has evolved. If the interventionalist expects to be successful in treating this patient population, there is a need to both define a treatment algorithm and be familiar with the full gamut of CTO techniques. The purpose of this article is to introduce the interventionalist to the management, evaluation, and treatment of CTO lesions with a focus on techniques of crossing the difficult CTO and therapy options after guidewire access is achieved.

Clinical Evaluation

A complete discussion regarding treatment considerations for endovascular therapy vs surgical bypass is beyond the scope of this article. However, it should be noted that a thorough clinical evaluation is necessary and consideration of bypass options should be made at time of initial workup. Frequent preprocedure testing may include non-invasive testing such as ankle brachial index, pulse volume recordings, toe brachial index, and transcutaneous oxygen measurements. In addition, imaging modalities such as duplex ultrasound, computed tomography angiography, and magnetic resonance angiography can provide a roadmap to assist in intervention planning. Important considerations when evaluating previous imaging include occlusion morphology, lesion length, potential targets for revascularization, degree of vascular calcification, and location of collateral vessels.[6]

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Before intervention, it would be prudent to have a thorough discussion with the patient regarding the potential outcome of endovascular revascularization and long-term expectations. Although some research argues no significant clinical difference in long-term outcomes between percutaneous and surgical revascularization in patients eligible for either bypass or endovascular technique, there remains a significant amount of controversy regarding treatment of long femoropopliteal occlusions.[7] As such, even though an increasing number of interventionalists will approach symptomatic femoropopliteal occlusive disease with a "percutaneous first" approach, more complex lesions will have a lower primary and primary-assisted patency rate.[8] Having a discussion with the patient about various endovascular and surgical options, including the likelihood and timeframe of reintervention, will benefit both the patient and the interventionalist with appropriate management of expectations.

Technique

The procedure is usually performed under moderate conscious sedation. Either an ipsilateral or contralateral common femoral artery approach may be used. In long-segment occlusions with preprocedure imaging (computed tomography angiography or previous angiogram) showing adequate inflow, an ipsilateral access may be beneficial to improve pushability and decrease required device length. Further, in presence of steep aortic bifurcations, prior endovascular aneurysm repair, prior aortobifemoral bypass graft, or bilateral common iliac stents, the contralateral up-and-over approach can be difficult or impossible. In addition, if preprocedure imaging demonstrates findings that may increase the likelihood of need for retrograde access (ie, long-segment occlusion with distal reconstitution of tibial vessels) than a sterile preparation of the affected foot and ankle is recommended.

Once arterial access has been achieved, a complete diagnostic arteriogram is performed. Careful attention to imaging technique is vital so that adequate assessment of lesion length, distal target, and runoff vessels may be performed. When the decision to intervene has been made, an appropriate dose of intravenous or intra-arterial heparin is administered to achieve a target-activated clotting time of greater than 250 seconds.

True Lumen Approach

Antegrade true lumen recanalization should be attempted using conventional wire and catheter techniques. Given that some interventionalists believe that intraluminal recanalization carries many advantages, there has been a significant amount of technological innovation in crossing wires, support catheters, and true lumen–crossing devices. When compared to subintimal technique, some advantages include potential lower procedural costs and less risk of losing side branch patency secondary to long-segment dissection. This latter point is of particular importance when addressing lesions involving the distal popliteal artery and trifurcation of runoff arteries. An additional advantage is maintaining the option to use a wide variety of atherectomy devices to increase luminal gain. Some of the disadvantages of adopting an intraluminal recanalization only strategy include increased procedural time, lower success rate, and theoretical increased risk of distal embolization.

True lumen–crossing wires include a variety of 0.035-in, 0.018-in, and 0.014-in hydrophilic tip wires. Such wires use a hydrophilic coating to aid in navigation through the "microchannels" that are found in CTOs. An example of hydrophilic wires commonly used for CTO crossing include Glidwire, Glidewire Advantage (Terumo, Tokyo, Japan), Hi-Torque (Abbott, Abbott Park, IL), V-14 and V-18 ControlWire Guidewire (Boston Scientific, Marlborough, MA), SV 0.018 (Cordis, Fremont, CA), Nitrex (Covidien, Plymouth, MN), and Roadrunner (Cook, Bloomington, IN). Weighted tip CTO wires are specialty wires designed to maintain true lumen crossing. Many designs offer increasing tip loads (12-30 g) for control and a range of pushability. Examples of weighted tip wires include Victory (Boston Scientific), Treasure (Asahi, Tokyo, Japan), Connect (Abbott), and Approach (Cook).

In addition to the array of available crossing wires, there are a large number of true lumen support catheters in the market. Such catheters offer flexible, braided catheter shaft with hydrophilic coating and a variety of straight and angled low-profile tips. Such features allow for increased support and pushability, the list of these specialty catheters include CXI (Cook), Trailblazer (Covidien), Quick-cross (Spectranetics, Colorado Springs, CO), Rubicon 14 (Boston Scientific), and Navicross (Terumo, Tokyo, Japan).

In addition to the available crossing wires and catheters, there are a number of true lumen–crossing devices that increase chances for intraluminal wire access across a CTO. The exact mechanism differs between manufacturers but the general method is blunt dissection for boring through the CTO with enough force to get through the occlusion but not enough to go outside the vessel. Options include the Crosser (Bard, Tempe, AZ), which uses a nitinol core wire to transmit mechanical vibration (via a separate generator) to the metal tip of the catheter at up to 20,000 cycles per second. This 5-F device is available in over-the-wire and monorail configurations on a 0.014-in platform. The Wildcat and Kittycat (Avinger, Redwood City, CA) feature a rotatable tip with sloped wedges that is manually activated to corkscrew through the CTO. A related product, the Ocelot (Avinger), uses a similar crossing mechanism but offers the advantage of real-time intravascular imaging guidance through use of optical coherence tomography. Other options include the Truepath (Boston Scientific), which offers the advantage of a 0.018-in rotating diamond-coated shapeable tip powered by an included control unit and no separate capital equipment purchase. Lastly, the Frontrunner (Cordis) features an actuating distal tip that creates blunt microdissection to create a channel through the CTO.