Cryoplasty, Cutting Balloon, and AngioSculpt

Novel technologies for endovascular management of infrapopliteal disease.

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Each year, critical limb ischemia (CLI) remains a paramount issue in those patients undergoing amputation. Typically involving two, and more often all three infrapopliteal vessels, it has become the purview of the endovascular specialist. Single-vessel infrapopliteal disease is often asymptomatic or may present with claudication but without ischemic ulceration. These patients are usually treated medically. However, in patients with CLI, the infrapopliteal disease is usually multilevel, multisegmented, and frequently involves the superficial femoral artery (SFA), popliteal, and the infrapopliteal vessels. It is for these patients that endovascular intervention has been reserved.

Chronic CLI carries a 20% 1-year mortality rate. Physiologically, CLI manifests when there are two or more levels of distal arterial tree occlusion or hemodynamically significant stenosis. These multiple levels of obstruction decrease the effectiveness of collateral supply and the systolic driving force in the periphery. Driving pressure is decreased in the distal arterioles, and then is raised in the distal venules, due to inactivity and stasis. This reduces pressure gradient across the capillary bed, resulting in ischemia and ultimately in progressive tissue death if uncorrected.[1] The best patient outcomes are achieved when the diagnosis and appropriate treatment for CLI are not delayed. Definitive diagnostic imaging studies, such as arteriography, ultrasound Doppler, CTA, or MRI, provide the detailed information needed

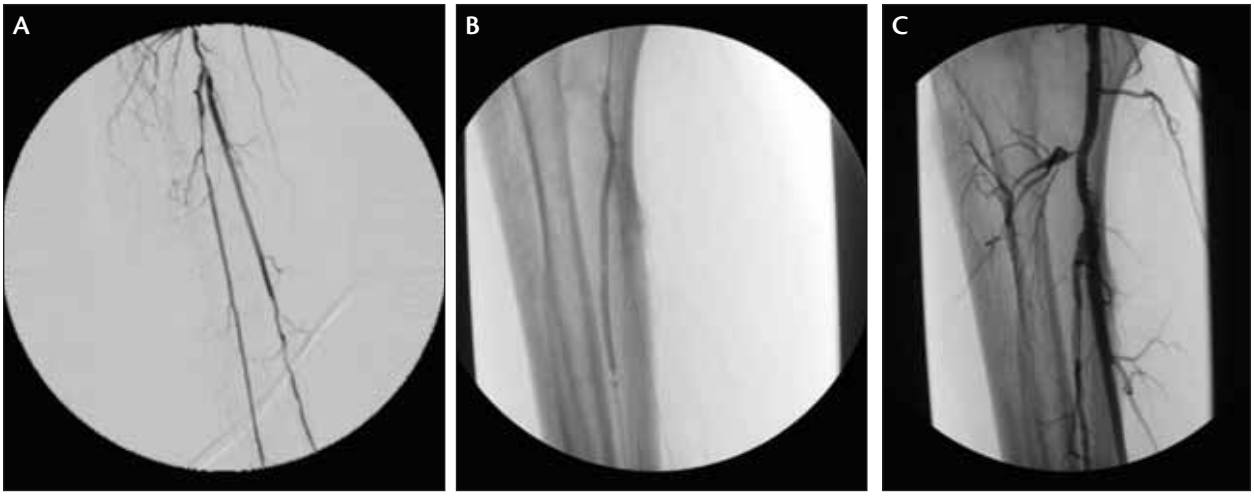

Figure 1. Infrapopliteal angiogram showing totally occluded anterior tibial artery, severe tibioperoneal trunk disease and severe diffuse peroneal artery disease (A). Balloon angioplasty of the peroneal artery (B). Final result (C).

to plan revascularization therapy. Patients with ischemic ulcers or gangrene usually have ankle pressure (AP) of <50 mm Hg or toe pressure (TP) of <30 mm Hg. Healing requires an inflammatory response and additional perfusion above that required for supporting intact skin and underlying tissues. The AP and TP levels needed for healing are, therefore, higher than the pressures found in ischemic pain at rest. Transcutaneous oxygen tension measurement (critical level <30 mm Hg) and skin perfusion pressure measurement (critical level <30 mm Hg) are useful methods to evaluate the microcirculation.[2]

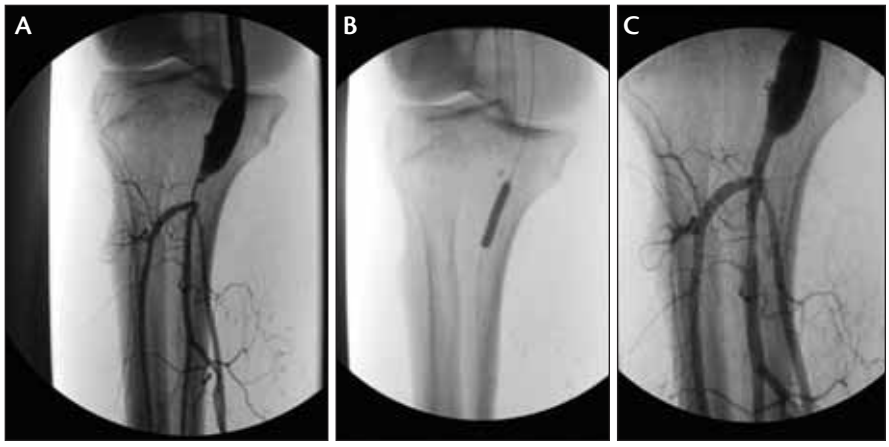

Figure 2. Severe stenosis of the proximal anterior tibial artery. Note the occluded SFA stent and the patent distal femoropopliteal bypass graft (A). Cutting Balloon angioplasty (B). Final result after Cutting Balloon angioplasty (C).

MEDICAL THERAPY

Medical therapy for CLI consists of medications including pentoxifilin.[3] Vasodilator prostaglandins PGE1, iloprost have been studied in patients with CLI who are poor candidates for revascularization.[4] In addition, the following therapies are being evaluated, including autologous granulocyte colony-stimulating factor. Angiogenic growth factors (ie, VEGF,[5,6] 5FGF-4,[7] intermittent pneumatic compression,[8] and rheopheresis[9]) are currently being evaluated. Prostanoids are the best-studied class of drugs for such applications, but their use is still investigational in the US. Although other medical approaches, such as the use of other vasoactive agents, drugs that treat claudication, or gene-induced angiogenesis, may prove useful, they have not yet demonstrated roles in the treatment of patients with CLI. Depending on the extent of the lesions, transluminal angioplasty of infrapopliteal artery stenoses and occlusions is considered as an effective and safe therapeutic modality to avoid limb loss in diabetics with critical ischemia.[10] Adjunctive medical therapy, such as aggressive platelet antagonists, statins and angiotensin-enzyme inhibitors, is paramount in this cohort of patients. After intervention, routine noninvasive surveillance with Doppler scanning has been recommended by some experts.[11]

SURGICAL THERAPY

Surgical bypass to the infrainguinal and infrapopliteal segments with saphenous vein bypass grafts has a 66% 5-year patency rate and an 80% to 90% limb salvage rate. However, in the absence of adequate venous conduits, the prosthetic patency rate falls to <50%.[12] Advances have been made in the surgical management of CLI; however, open surgical procedures are still associated with significant perioperative complications, including an operative mortality rate of 1.3% to 6%[13] and wound infection, as well as myocardial infarction. Dense calcification and absence of suitable distal targets often make a surgical option less viable.

> "It is of utmost importance that these patients be followed up postprocedure with a multidisciplinary approach . . . "

The severity of the CLI imposes a multidisciplinary approach. A delay in managing this condition increases the risk of amputation significantly. For most patients, a revascularization procedure, surgical or endovascular, can be considered, because the aim of the treatment is to restore an arterial flux to permit wound healing and relieve pain. Whenever choice is available, endovascular techniques are preferred, because this option is less invasive, it can be done without general anesthesia, and has a reported lower short-term complication rate. The choice between two techniques is never simple and imposes the intervention of a multidisciplinary staff composed of vascular specialists, vascular surgeons, and interventional radiologists. The aim of the medical treatment, while waiting for the revascularization, is to control the pain and the infection, prevent progression of the lesions, and optimize respiratory and cardiac functions.

ENDOVASCULAR MANAGEMENT

Invasive management of CLI is directed at re-establishing perfusion and local wound care, including avoiding pressure to the affected limbs, control of infection/osteomyelitis, and debridement. The success of infrapopliteal intervention is not measured by long-term patency, but rather by wound healing, pain relief, and amputation-free survival. Important variables predicting success include the number of vascular levels that are obstructed, the patency of the plantar arch, the amount of tissue destruction, the need for debridement or skin grafting, the potential conduit (eg, venous) available, associated comorbidities, and the nutritional status of the patient because tissue healing requires significant caloric intake.[14]

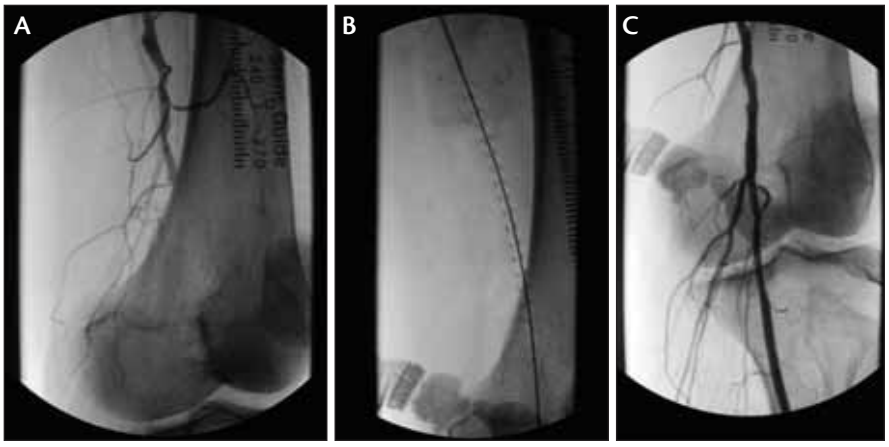

Figure 3. Total occlusion of distal SFA (A). Cryoplasty of distal SFA/popliteal artery (B). Final result after Cryoplasty (C).

The recently published Bypass versus Angioplasty in Severe Ischemia of the Leg (BASIL) trial demonstrated that amputation-free survival at 1 year was similar with percutaneous therapy when compared with surgery.[15] The same trial also demonstrated that a percutaneous approach was associated with lower 30-day mortality and morbidity rates. There is no doubt that the infrapopliteal arena is a hostile environment for the endovascular specialist. These vessels are typically densely calcified with long segments of disease that can be either occluded or reveal multiple stenosis. They are typically small, ranging from 2.5 mm to 3.5 mm in diameter and frequently have a compromised microvascular run-off as noted by decreased transcutaneous oxygen tension measurement in these patients. The inflow vessels (ie, the iliac, superficial femoral, and popliteal arteries) usually have concomitant stenosis, which may alter the hemodynamic and flow dynamics of these vessels. This imposing anatomy is seen in the setting of associated comorbidities, such as diabetes, renal failure, low cardiac output, and impaired wound healing, compounding the technical demands in revascularizing these patients.

ANGIOPLASTY

Several nonrandomized prospective and retrospective reviews have shown that the technical success of angioplasty ranges from 86% to 95%,[16-18] with a clinical success rate as high as 95%. These contrast to the poor overall survival of these patients. Survival rates of 75%, 49%, and 33% have been reported for 1, 3, and 5 years, respectively.[16-18] The results from the BASIL trial, although not exclusively infrapopliteal showed that balloon angioplasty was not significantly different from bypass surgery in preventing amputation, but that angioplasty was superior to bypass surgery on secondary endpoints such as the length of hospital stay (Figure 1). In select patients with long diffuse stenosis, balloon angioplasty may provide a durable result, culminating in wound healing and amputation-free survival.

Because of the aforementioned hostile environment, plain-old balloon angioplasty is frequently faced with inadequate dilatation of the densely fibrotic and calcified stenosis. Two variations on the same theme have become available: Cutting Balloon (Boston Scientific Corporation, Natick, MA) and AngioSculpt (Angioscore, Inc., Freemont, CA).

CUTTING BALLOON

The Cutting Balloon was originally introduced for coronary intervention. Given the similar diameter of coronaries and infrapopliteal vessels, it was a logical extension. This balloon has microsurgical blades, called *atherotomes*, mounted to its surface to score the lesion, allowing the noncompliant balloon to dilate the stenosis gently (Figure 2). A 1-year limb salvage rate of 85.9% was reported by Ansel in 73 patients undergoing peripheral interventions utilizing a Cutting Balloon, with a low adjunctive stenting rate of 20% for severe dissection and inadequate dilatation.[19] The Cutting Balloon has also been reported to be superior to plain-old balloon angioplasty in peripheral arterial bypass graft stenosis.[20]

AngioSculpt recently received FDA-marketing clearance for balloon dilatation of lesions in the

infrapopliteal arteries. The limited but encouraging data from Europe in a 43-patient nonrandomized registry from five separate institutions showed an 89.3% success rate with no need for adjunct therapy. No perforations were reported, and minor dissections were noted at 10.7%.

CRYOPLASTY

Another balloon therapy that is gaining wider acceptance for infrapopliteal revascularization is balloon Cryoplasty. In addition to mechanical dilatation, it also serves as a pathway to the introduction of cryotherapy. The PolarCath Peripheral Dilatation System (Boston Scientific) uses nitrous oxide to fill an angioplasty balloon to approximately 8 atm, cooling its surface to -10°C. As it is inflated, the cold surface of the balloon cools the vascular lesion, which exerts both mechanical and biological effects that may help prevent restenosis (Figure 3). Biologically, cooling promotes an apoptotic environment, which reduces excessive thickening of the new layer of smooth muscle cells after angioplasty, and in turn, reducing restenosis.

The interim results at 6 months of the ongoing Below-The-Knee Chill (BTK Chill) trial showed a 6% amputation rate. This cohort consisted of patients with hypertension (85%), diabetes (67.7%), and a history of smoking (72.6%). Concomitant carotid artery disease was seen in 70.1% of this cohort. Patients' symptoms ranged from skin discoloration (76.4%) to gangrene (36.8%). The group as a whole had an anticipated amputation rate of 24.7%. The acute technical success rate of 97% and 93% amputation-free survival rate was noted at the end of 6 months.[21] In a conversation with Tony Das, MD, he noted that this amputation-free survival appears to have been maintained at 85% by 365 days.[22] For infrapopliteal disease, routine balloon angioplasty in its various forms can be utilized as the first mode of therapy, reserving stents for suboptimal results or flow-limiting dissections.

SUMMARY

The interventional management of infrapopliteal disease has become highly differentiated in the last 2 decades. Currently, with the availability of multiple modalities, such as Cutting Balloon and Cryoplasty, limb salvage can be achieved in a larger percentage of patients. Newer, high-tech modalities have been introduced, but to date, none have shown superiority to balloon dilation. It is of utmost importance that these patients be followed up postprocedure with a multidisciplinary approach with input from a vascular surgeon, podiatrist, internist, and/or infectious disease specialist, along with a wound-care team. Aggressive medical therapy along with surveillance of these patients with duplex scanning is recommended. ■

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