

# Subintimal Angioplasty for the Management of Chronic Total Occlusions

Subintimal angioplasty is an effective tool for the management of long-segment chronic total occlusions, particularly in higher Rutherford category patients.

BY LARRY HORESH, MD

Chronic total occlusions of the femoro-popliteal segments or infrapopliteal vessels are encountered more frequently with increasing patient longevity, bringing critical limb ischemia (CLI) to greater clinical attention. Surgical revascularization has been well documented for achieving limb salvage; however, the morbidity and mortality rate in this patient cohort can be significant.<sup>1</sup> Endovascular therapy has been shown to be equivalent to surgical revascularization in achieving limb salvage with a favorable patient survival.<sup>2,3</sup> Bolia first described subintimal angioplasty and has outlined its main purposes for the treatment of chronic limb ischemia.<sup>4-6</sup> The value of subintimal angioplasty in limb salvage, and even comparison to bypass grafting, suggests that subintimal angioplasty may be a good first-line approach to long-segment occlusions in CLI and higher Rutherford category patients who are at above average risk for surgery.<sup>7,8</sup>

Bolia has described the subintimal angioplasty technique.<sup>9</sup> This article describes the various techniques for subintimal angioplasty in more difficult applications used for 23 limbs in 20 patients for long-segment chronic total occlusion over the initial 9-month period the technique was started by a single operator. Indications primarily consisted of CLI (14 Rutherford category 5, four Rutherford category 4 and 5 for severe limiting claudication). Technical success was achieved in all cases. Four patients had flush occlusions, three patients had failed femoropopliteal bypass grafts, and only three patients required stent placement.

Initiating the subintimal plane can easily be performed at occluded stumps or at the level of a large shelf-like plaque by pointing a catheter eccentrically away from the midline lumen. At times, a stiffer catheter (braided JR4, C.R. Bard Inc., Murray Hill, NJ, or other catheters) can be used, or heavy-duty straight wires such as the Newton wire (Boston Scientific

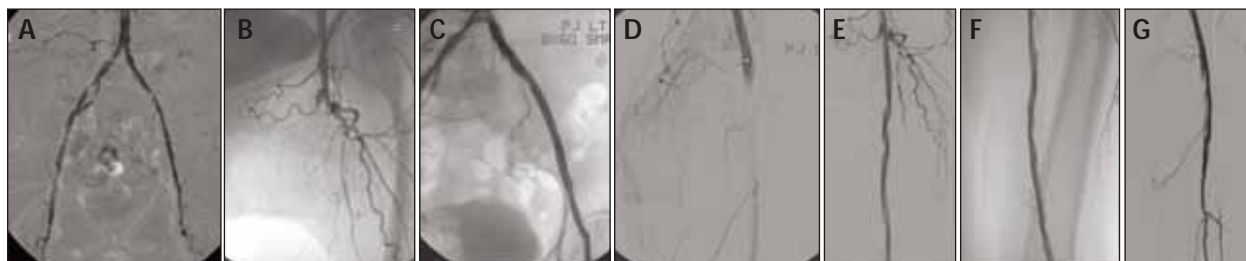


Figure 1. Diffuse vascular calcifications with more focal high-grade left external iliac artery stenosis. Flush occlusion of the left superficial femoral artery (SFA) (A,B). Correction of focal left external iliac artery stenosis with placement of a Smart stent (Cordis Corporation, a Johnson & Johnson company, Miami, FL) (C). Subintimal channel with .035-inch Spectranetics support catheter (Spectranetics Corporation, Colorado Springs, CO) in the subintimal plane (D). Final subintimal recanalized left SFA demonstrating a widely patent SFA, popliteal artery, and proximal trifurcation (E-G).



Figure 2. Occlusion of the popliteal artery at the knee joint level, with distal reconstitution of the posterior tibial artery near the ankle and of the peroneal artery in the distal calf (A,B). The proximal fibrous portion of the occlusion required a Smart nitinol stent. The rest of the subintimal angioplasty to the posterior tibial artery demonstrates rapid antegrade flow (C-E).

Corporation, Natick, MA) can be used to initiate the subintimal plane. Once the subintimal plane is entered, a Glidewire (Terumo Corporation, distributed by Boston Scientific Corporation) is passed, forming a loop. The loop is preserved, and re-entry often can occur effortlessly, with the loop entering the expected location of healthier artery distally. If re-entry is not achieved at the desired level, small contrast injections may show small “holes” in the intima communicating with the true lumen, allowing lower-profile torqueable wires to be passed through these holes achieving true lumen entry.

## CASE STUDIES

### Case 1

A 48-year-old woman with a 60 pack-year history of cigarette smoking had undergone two previous coronary bypass operations. The last operation was performed 6 months prior to this case. The inferior aspect of her left leg saphenous vein graft harvest site failed to heal and had deepened and worsened. She had undergone left femoral-popliteal bypass 7 years previously, which failed early. Arteriography demonstrated that she had diffuse vascular calcifications but with more focal stenosis of the left external iliac artery corrected with angioplasty and stenting (Figure 1). She had a flush occlusion of the left SFA, with the bypass stump apparent. The popliteal artery reconstituted at Hunter's canal with a two-vessel runoff.

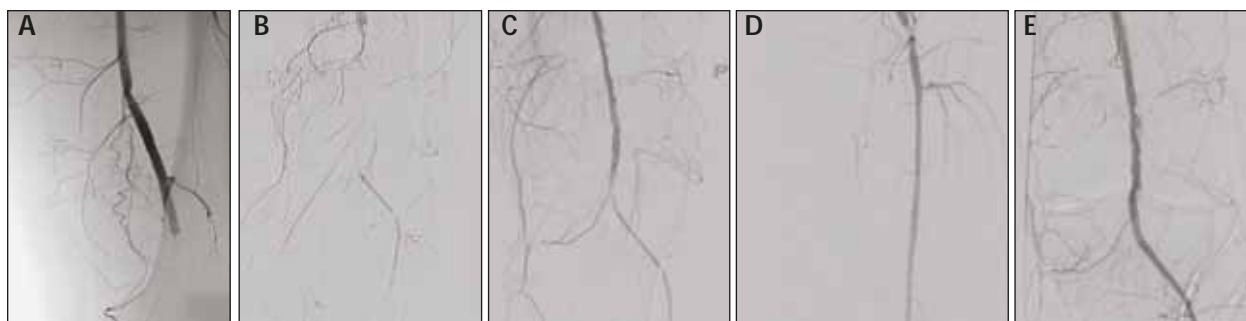
She underwent left external iliac artery stent-assisted angioplasty and subintimal recanalization of the left SFA. A 6-F Balkin sheath (Cook Incorporated, Bloomington, IN) was placed over the bifurcation into the left common femoral artery. A relatively stiff braided JR4 catheter was placed in the common femoral artery and, with use of a Newton wire, the area between the bypass stump and profunda was vigorous-

ly probed entering the SFA. The JR4 catheter was then advanced into the superior SFA and exchanged for a Glidewire, which was advanced with a loop to the location of expected “healthy” popliteal artery. The loop, however, did not enter the popliteal artery. Contrast injection demonstrated a trickle of contrast entering the popliteal artery in an antegrade fashion. A torqueable Choice PT Extra Support (Boston Scientific Corporation) was then advanced across this intimal “hole” into the popliteal artery, and standard percutaneous transluminal angioplasty with a 5-mm X 8-cm Meditech Ultra-thin SDS balloon (Boston Scientific Corporation) was performed, achieving patency. The patient's wound rapidly healed in a 4-week period.

### Case 2

A 78-year-old man had diabetes mellitus and significant coronary arterial disease with recent myocardial infarction presenting with a nonhealing, 2-cm wound on the right third toe. Angiography demonstrated occlusion of the popliteal artery above the knee joint level, with reconstitution of the posterior tibial artery at the ankle and of the peroneal artery in the distal calf (Figure 2).

He underwent subintimal recanalization to the posterior tibial artery. An antegrade approach was selected for all long-segment infrapopliteal occlusions. A braided JR4 catheter was placed at the occlusion eccentrically, and a Glidewire was utilized to start the subintimal plane forming a loop with the JR4 catheter advanced over to the tibioperoneal trunk location. The JR4 catheter was pointed toward the posterior tibial artery, and this area was probed with a Glidewire entering the subintimal channel in the posterior tibial artery. A .035-inch Spectranetics support catheter was required for the stiff subintimal plane in the posterior tibial artery. A Glidewire was still utilized to dissect this plane; how-



**Figure 3.** The popliteal artery is occluded above the knee, with collateral reconstitution of the proximal variant anterior tibial artery. The anterior tibial artery further distally is occluded, with no dorsalis pedis in the foot; however, collaterals supplying the plantar arteries and dorsal arch were noted (A,B). Initially, the subintimal channel did not directly communicate with the anterior tibial artery; however, with a JR4 catheter placed at the origin of the anterior tibial artery, a Glidewire was advanced across the intima into the anterior tibial artery (C-E).

ever, as with other infrapopliteal trifurcation subintimal dissections, care is taken to avoid a large loop and often the loop is removed from the Glidewire. Eventually, a relatively healthy portion of the posterior tibial artery was entered. Standard angioplasty with a 2.5-mm Symmetry (Boston Scientific Corporation) balloon was performed in steps in the posterior tibial artery, and 5-mm angioplasty was performed in the popliteal artery. The rigid superior fibrous cap required a 6-mm X 4-cm Smart stent to achieve adequate patency. A palpable pulse was achieved and maintained without other intervention until healing occurred in a 4-month period.

### Case 3

A 52-year-old woman had large embolic events to her left middle cerebral artery and left popliteal artery with distal emboli in the runoff vessels (Figure 3). She presented with strict contraindication for thrombolytic therapy. Attempts at Angiojet thrombectomy (Possis Medical Inc, Minneapolis, MN) were unsuccessful. A subintimal plane was created into the variant high anterior tibial artery takeoff. The subintimal recanalization provided limb salvage and allowed the patient to pursue rehabilitation, moving her past her acute event. A JR4 catheter was placed eccentrically at the occlusion, and a Glidewire was passed into the occluded tibioperoneal trunk. The JR4 catheter was then pulled back to the anterior tibial origin, as demonstrated by roadmap images, and a Glidewire was advanced in the anterior tibial artery. After the JR4 catheter was advanced into the true lumen anterior tibial artery origin, the Glidewire was exchanged for a V-18 (Boston Scientific Corporation), and support wire and standard angioplasty was performed. A Smart stent was required at the superior edge to stabilize thrombus at this location.

### DISCUSSION

Subintimal angioplasty was first used in 1987 and gained popularity, initially in Europe.<sup>10</sup> The technique was adopted a decade later by US centers, with reports appearing from the departments of surgery and radiology at Montefiore Medical Center.<sup>11</sup> More recently, various cases with the use of re-entry catheters have been described in the US experience.<sup>12</sup> Many US endovascular specialists have been reluctant to adopt the technique given the counterintuitive nature of starting a subintimal plane intentionally for fear of being unable to gain re-entry. The technique, however, is relatively easy and inexpensive because it does not rely on stents or various atherectomy devices. In fact, the success of re-entry can be better than intentional true lumen passage for long-segment CTOs.

Subintimal angioplasty is technically successful in 70% to 90% of cases, as described in the literature. Limb salvage is achieved in approximately 80% to 90% of patients, and clinical worsening has rarely been described. Primary patency rates range from 60% to 80% at 6 months and 60% to 70% at 12 months.<sup>13-15</sup> In this patient series, secondary interventions were quick and easy, with wire passage readily into the prior subintimal plane achieving overall excellent secondary patency at 1 year. The approach does not interrupt bypass options and may, in fact, preserve options better than stent placement, which may lead to a greater loss of collaterals upon occlusion, making more distal reconstructions necessary. Often, after a subintimal infrainguinal plane is created, new collaterals are observed, and it is likely that multiple tiny “holes” are present in the subintimal channel supplying greater collaterals. When the subintimal channels start to fail, often portions with collaterals remain patent, and overall perfusion benefit may substantially exceed even patency rates.<sup>15-17</sup>

## CONCLUSION

Endovascular therapy is replacing surgical revascularization in the management of CLI without compromising limb salvage or subsequent vascular intervention. CLI patients represent a subset of patients with high mortality rates similar to myocardial infarction and stroke patients. The mortality risks of infrapopliteal surgical revascularization can approach the risks of abdominal aortic surgery. An initial endovascular approach achieves limb salvage rates equivalent to surgical bypass. Subintimal angioplasty is a relatively easy technique to master and can be applied to long-length occlusions as a first-line treatment option for CLI. Subintimal angioplasty should be in the armamentarium of all endovascular specialists. ■

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