Endovascular treatment of atherosclerotic popliteal artery disease based on dynamic angiography findings

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ABSTRACT

Objective: To evaluate efficacy, safety, and midterm patency of endovascular treatment of obstructive popliteal artery (PA) disease.

Methods: A retrospective evaluation of patients with atherosclerotic PA disease who underwent percutaneous transluminal balloon angioplasty and provisional stent, based on both conventional and dynamic angiographies, was conducted from June 2011 to June 2014. Forty-three patients were included in the study, and most patients had limited surgical revascularization options. Demographic characteristics, angiographic findings, interventional data, complications, vessel patency, limb salvage rates, and survival rates were analyzed.

Results: The median lesion length was 5 cm with 72.1% having total occlusions. The second popliteal segment (P2) was involved most frequently (60.5%, n = 26). Critical limb ischemia was present in 69.8%. The technical success rate was 92.9% (42/43 limbs), with 29 cases requiring adjunctive nitinol stents after balloon angioplasty (47.6% based on conventional angiography, 21.4% based on dynamic angiography, and 4.8% additional stents based on dynamic angiography). Complications included thromboembolism (2.3%), perforation (2.3%), pseudoaneurysm (2.3%), and myocardial infarction (2.3%). Stent fracture was present in three cases (7.1%) during the mean follow-up period of 18.3 months. The baseline ankle-brachial index significantly improved after the intervention, from 0.49 ± 0.11 to 0.92 ± 0.14 ($P < .01$). The Rutherford-Becker class decreased from 3.95 ± 0.76 to 1.76 ± 0.95 ($P < .01$) at 12 months. The 1-year primary, primary-assisted, and secondary patency rates were 75.2% ± 6.8%, 82.4% ± 6.0%, and 89.9% ± 4.8%, respectively. The limb salvage and amputation-free survival rates at 12 months were 91.6% and 87.0%, respectively.

Conclusions: Balloon angioplasty with a provisional stent based on dynamic angiography is a feasible, safe, and effective therapy for patients with obstructive PA disease. Although the occurrence of stent fracture is still inevitable, patients with critical limb ischemia who have limited surgical options may get more benefits from the endovascular treatment of PA obstructive diseases. (J Vasc Surg 2016;■:1-9.)

Endovascular interventions for femoropopliteal lesions of claudication and critical limb ischemia (CLI) have been widely used in the past decade.[1-3] Recently, advances in endovascular techniques have led to a more aggressive approach to the treatment peripheral artery disease (PAD). In fact, they have been considered by many centers as the first-line therapeutic modality for patients with complicated cases, including femoropopliteal chronic total occlusions (CTOs) and TransAtlantic Inter-Society Consensus II classification C and D lesions.[4-6] The latest data from studies on nitinol stent placement in long femoropopliteal lesions have indicated encouraging primary patency rates of 70% to 80% at 12 months.[7,8]

Despite the positive results of endovascular interventions for femoropopliteal lesions, limited data are available on isolated popliteal artery (PA) obstructive diseases. The PA, unlike the superficial femoral artery, presents unique characteristics, including extreme mobility between the proximal and distal fixation points and the biomechanical forces resulting from repetitive motion.[9] Thus, the PA is traditionally considered a no-stent zone, and stent placement is only reserved for suboptimal results after percutaneous transluminal angioplasty (PTA), such as significant recoil, flow-limiting dissection, or significant residual stenosis.[10]

The purpose of this study was to evaluate the clinical outcomes with the use of the nitinol stent in the management of isolated PA lesions in patients with PAD. To derive morphologic changes of the PA during knee flexion, dynamic angiography (knee flexion at 90°) was performed in all the patients.

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METHODS

Study group. Institutional review board approval was obtained for this study. The study comprised a retrospective review of a prospectively maintained database of Shanghai Ninth People's Hospital from June 2011 through June 2014. Forty-three consecutive patients with PAD and PA obstructive lesions who had undergone endovascular treatment were identified. Those patients considered poor surgical candidates based on (1) lack of suitable autogenous conduit for distal bypass (n = 9); (2) absence of good distal bypass target vessels (n = 10); (3) elderly patients with multiple comorbidities such as congestive heart failure, symptomatic coronary artery disease, myocardial infraction, or stroke that would make them high risk for general anesthesia (n = 21); and (4) limited life expectancy such as end-stage cancer (n = 3). The exclusion criteria included simultaneous upstream (femoral and/or iliac artery) associated procedure, acute limb ischemia, severe renal insufficiency (glomerular filtration rate <30 mL/min), contraindication to contrast media, and endovascular intervention for aneurysm, compression, or traumatic injury of the PA. Before treatment, all the patients were evaluated by using the ankle-brachial index (ABI), duplex ultrasound (DUS), and computed tomography-angiography to define the severity of ischemia and the location of lesions and to plan the revascularization strategy.

Treatment. All endovascular procedures were performed in the interventional angiography suite by experienced vascular surgeons, using the Innova 3100IQ angiography system (General Electric Company, Fairfield, Conn). Access was obtained through a 6F sheath via the ipsilateral femoral approach in most of the patients or the contralateral femoral approach in obese patients. The patient was fully heparinized to maintain an activated coagulation time of >250 seconds after sheath insertion. Intraluminal recanalization was attempted primarily with conversion to the subintimal approach if this failed. The above-knee lesions were primarily recanalized with a 0.035-in hydrophilic guide wire (Terumo Medical Corporation, Somerset, NJ) and a 4F or 5F support catheter. Hydrophilic 0.018- or 0.014-in guide wires (Boston Scientific Corporation, Natick, Mass), and matching support catheters were used typically to cross the below-knee lesions. Distal retrograde access and subintimal arterial flossing with antegrade-retrograde intervention were used in cases of failed reentry in the optimal true lumen or failed passage to the lesions. Once lesions were crossed, PTA (ClearStream Technologies Ltd, Wexford, Ireland) was subsequently performed with 3- to 6-mm-diameter balloons, same size depending on the reference artery. Balloon inflation times varied from 120 to 180 seconds at 8 to 14 atm.

Conventional angiography (anteroposterior view with knee extension) and dynamic angiography (single lateral view with knee flexion at 90°) were performed after PTA. The dynamic angiography allowed us to (1) detect the significant obstruction that was not visible on conventional angiography (Fig 1); (2) identify the further aggravated obstructions, with less than 30% residual stenosis/recoil on conventional angiography (Fig 1); and (3) detect morphology changes of the PA because of the presence of a stent (Fig 2). Stents were placed in cases of flow-limiting dissection and/or more than 30% residual stenosis/recoil in either conventional or dynamic angiography. Three types of self-expanding nitinol stents were used in the present study, including Protégé Everflex (ev3 Inc, Plymouth, Minn) and LifeStent (Bard Peripheral Vascular Inc, Tempe, Ariz) for the P1 and P2 segments, and Xpert (Abbott Vascular, St. Paul, Minn) for the P3 segment. The choice of nitinol stents was based on the operator's preference, and the diameters were typically oversized by approximately 10% compared with the normal reference vessel. The results were confirmed by both using conventional and dynamic angiographies. At least one run-off vessel to the foot would be preserved with or without additional endovascular intervention.

All patients provided written informed consent before treatment. The ABI was evaluated before discharge. After the operation, all patients received dual antiplatelet therapy with aspirin and clopidogrel for at least 4 weeks, with aspirin continued indefinitely.

Definitions. Lesions were assigned to the PA segments, which were defined as follows: the first popliteal segment (P1), extending from the adductor hiatus to the superior border of the femoral condyle; the second popliteal segment (P2), extending from the superior border of the femoral condyle to the joint line; and the third popliteal segment (P3), extending from the joint line to the bifurcation of the anterior tibial artery and tibioperoneal trunk. Technical success was defined as recanalization of the PA lesions with residual stenosis of <30% on both conventional and dynamic angiographies.

Follow-up. Patient demographic characteristics, interventional detail, technical success rates, and complications were recorded. Potential risk factors such as symptoms, CTO, lesion length, number of runoff artery, location of the stent, and stent fracture were also included. Follow-up visits and DUS were scheduled at 1, 3, and 6 months, and then at 3-to 6-month intervals thereafter. Significant stenosis on DUS was defined as a ratio >2.5 (peak systolic velocity at the lesion/peak systolic velocity proximal to the lesion). Patients with hemodynamic evidence of restenosis or reocclusion based on DUS underwent repeat endovascular intervention. Data on cumulative patency, limb salvage, and amputation-free survival rates were obtained from office databases and telephone contacts.