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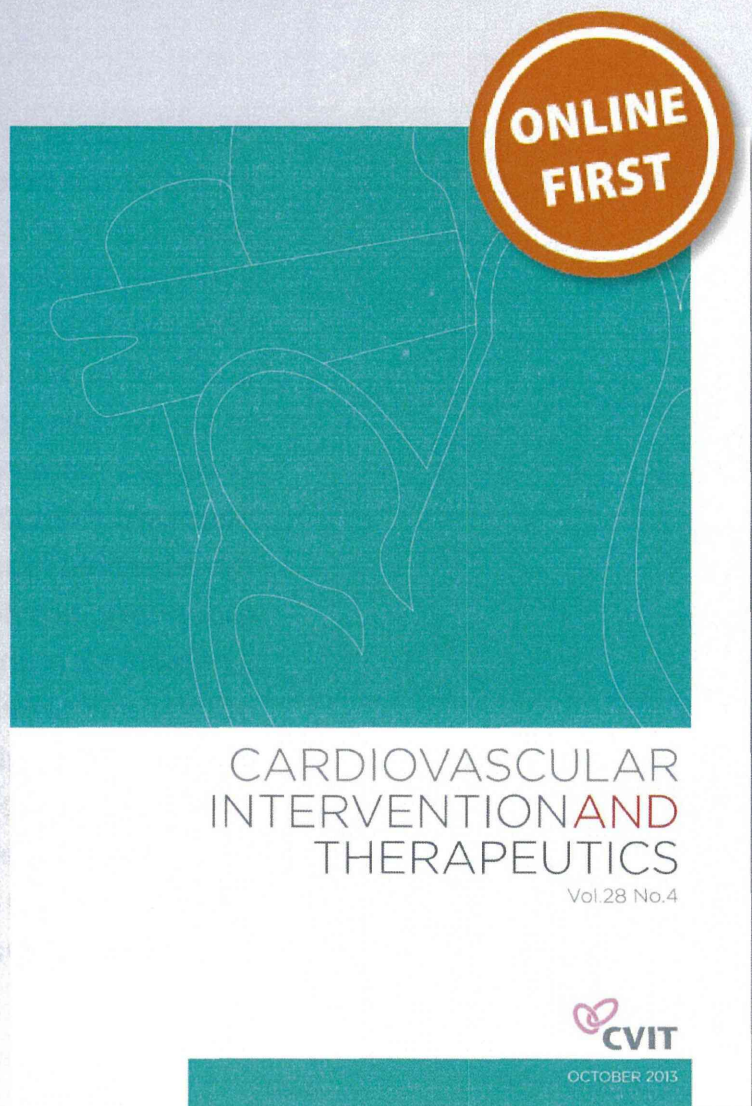
Endovascular recanalization of failed distal bypass in Buerger's disease

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CASE REPORT

Endovascular recanalization of failed distal bypass in Buerger's disease

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Abstract In the treatment of Buerger's disease, bypass surgery with the use of an autologous vein has served as a treatment option in cases in which distal target vessel has been available. However, failed bypass occlusion can result in a devastating clinical scenario. Herein, we report a successful endovascular revascularization of failed distal bypass graft as a last resort for a patient with Burger's disease with ischemic rest pain and extensive tissue loss.

Keywords Endovascular · Bypass ·
Thromboangiitis obliterans

Introduction

In the treatment of Buerger's disease, bypass surgery with the use of an autologous vein has served as a treatment option in cases in which distal target vessel has been available [1]. However, failed bypass occlusion can result

in a devastating clinical scenario. As recent endovascular technique and equipment have made a tremendous advancement during the last decade, endovascular revascularization of native vessel occlusion can be a viable option even in the setting of bypass occlusion [2, 3]. Depending on circumstances, occlusive bypass also might be able to benefit from contemporary endovascular therapy. Herein, we report a successful endovascular revascularization of failed distal bypass graft as a last resort for a patient with Burger's disease on the verge of limb loss.

Case

A 60-year-old man with a 20-year history of Buerger's disease was referred to our hospital for the treatment of an unhealing tissue loss and serious pain of the left foot after the occlusion of femoral-anterior tibial bypass using vein graft (Fig. 1a, b). The bypass executed 3 years ago had been occlusive for 12 months. According to a previous surgical report, surgical thrombectomy had also been attempted at the same time of bypass procedure. Due to the worsening of resting foot pain at night, he had been obliged to sleep in the dependent position, causing venous ulcer as well. Baseline angiography via an ipsilateral common femoral approach with a 4-Fr long sheath identified tapered occlusion of distal bypass graft as well as flush occlusion of femoropopliteal artery (Fig. 2a). We attempted recanalization of the tapered occlusion of bypass graft because of the less likely to cross the occlusive native vessel with endovascular adhesion. The 0.014 in. hydrophilic soft guidewire (Cruise, Asahi Intecc Co, Nagoya, Japan) supported by 4-Fr JR catheter negotiated the occlusive lesion to enter the microchannel (Fig. 2b), and then a step-by-step approach of the naturally formed guidewire loop supported

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Fig. 1 **a** A 60-year-old man with an unhealing tissue loss and serious pain of the left foot of 12 month after the occlusion of 3-year-old distal bypass graft. **b** The ischemic tissue loss complicated by venous ulcer

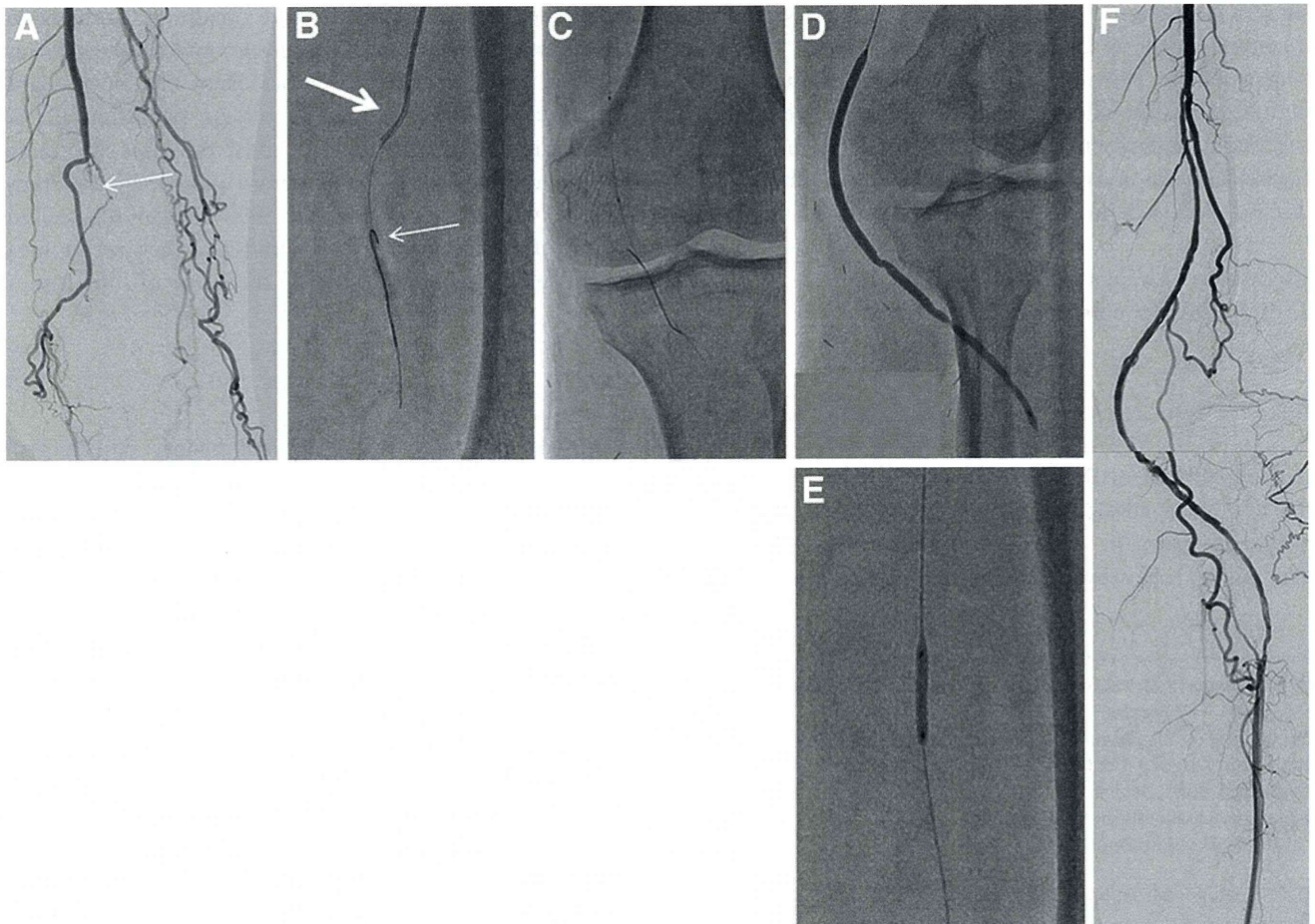
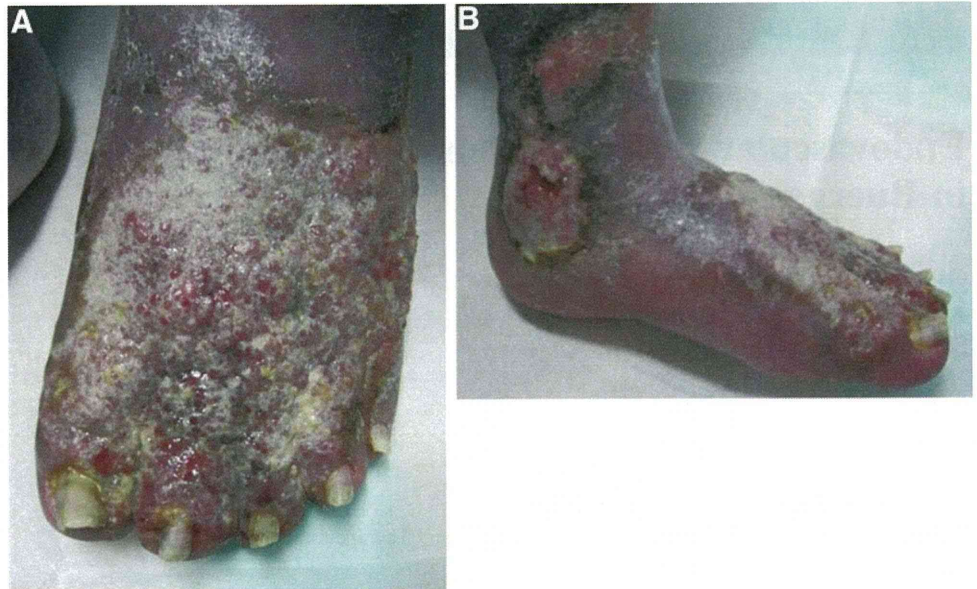


Fig. 2 **a** Baseline angiography showing the tapered occlusion of vein bypass graft (*arrow*). **b** Negotiation of 0.014 in. hydrophilic guidewire (*small arrow*) supported 4-Fr JR catheter (*large arrow*) with the occlusive bypass. **c** A step-by-step advancement of 0.014 in. hydrophilic guidewire with a loop configuration supported by over-the-wire

balloon catheter. **d** Serial dilatation of occlusive vein bypass graft with $4.0 \times 150 \text{ mm}^2$ balloon catheter. **e** The resistant lesion to conventional balloon angioplasty was dilated with $2.5 \times 15 \text{ mm}^2$ cutting balloon catheter. **f** Final angiography showing the excellent revascularization of bypass graft

Fig. 3 a, b Tissue loss completely cured after 3 months



by over-the-wire balloon was made. The guidewire was intraluminally advanced within the collapsed occlusive vein bypass graft with relatively small amount of thrombus, and the occlusive bypass graft was successfully crossed without the subintimal tracking and distal re-entry (Fig. 2c). Then, we serially dilated the occlusive lesion with $2.0 \times 40 \text{ mm}^2$ balloon catheter and $4.0 \times 150 \text{ mm}^2$ balloon catheter (Fig. 2d). The resistant lesion to conventional balloon angioplasty was dilated with $2.5 \times 15 \text{ mm}^2$ cutting balloon catheter (Fig. 2e). Final angiography demonstrated the excellent revival of bypass graft without any evidence of distal embolization (Fig. 2f). He was relieved from serious foot pain immediately after the revascularization, and the skin perfusion pressure increased to 49/45 mmHg (dorsum/plantar foot), suggesting the high likelihood of wound healing [4]. With the assistance of a devoted wound care, complete wound healing was achieved at 3 months (Fig. 3a, b). This clinical benefit has been sustained for 12 months although repeat intervention was required for hemodynamically significant restenosis 7 months later.

Discussion

As of today, no established therapy exists except for complete discontinuation of cigarette smoking which reduces Buerger's disease progression. Distal bypass using autogenous saphenous vein has been considered as one of treatment options if the patient has severe symptom and a reasonable outflow. According to previous enthusiastic vascular specialists, 7.4–17.4 % of Buerger's disease patients required bypass procedure [5, 6]. However, the patency rates of bypass graft are suboptimal because even

experts reported that primary and secondary patency rates were 48.8 and 62.5 % at 5 years, and 43.0 and 56.3 % at 10 years, respectively [7]. Despite advances in surgical techniques and effective postoperative surveillance, bypass graft occlusion in Buerger's disease still occurs at a relatively consistent rate over time worldwide. In the treatment of failed bypass, endovascular revascularization of native vessel occlusion could be one of contemporary treatment options [2, 3]. In this case, underlying severe adhesion in native vessel related to previous surgical procedure limited negotiation of the occlusion in the native vessel. Thus, the occlusion of vein graft was the only candidate for endovascular revascularization.

Although there are increasing opportunities to endovascularly treat nonatherosclerotic diseases in the field of interventional vascular medicine [8], one of the most technical challenges for endovascular therapy is the passage of a guidewire across the occlusive lesion. The proliferative crossing techniques have emerged in the field of native vessel chronic total occlusion intervention [9]. In this case, the 0.014 in. hydrophilic soft guidewire's exploring of micro channel at the ostial bypass and subsequent blunt advancement with a loop configuration by 0.014 in. hydrophilic soft guidewire facilitated the successful crossing of the occlusive bypass. This finding suggests that bypass graft also can enjoy from crossing techniques of native vessel chronic total occlusion. Although the balloon dilatation of occlusive bypass graft can cause the risk of thrombus embolization, no visible distal embolization was observed. Given that this case is late failure of vein bypass graft, no angiographically relevant embolization is possible due to the preceding stenosis from intimal hyperplasia and shrinkage of vein graft with relatively small amount of thrombus. However, just in case

of significant distal embolization, catheter-based aspiration or balloon maceration of the thrombus could be considered. Also, the liberal usage of dedicated devices such as percutaneous mechanical thrombectomy might be able to reduce the thrombus load in the treatment of peripheral bypass occlusion [10].

According to Carlson et al. [11], balloon angioplasty for stenotic infrainguinal venous bypass graft on atherosclerotic patients basis was acceptable because primary patency rates were 74.2, 62.7 and 58.2 % at 6, 12 and 24 months, respectively, and cumulative assisted vein bypass graft patency rates were 87.0, 83.2, and 78.9 %, respectively. However, although this case required repeat intervention 6 months later, no data are available regarding the initial and long-term outcomes of endovascular therapy for occlusion of venous bypass graft in Buerger's disease patients. Therefore, further investigation needs to be undertaken.

In conclusion, this case demonstrates that bypass recanalization could represent an additional treatment option for bypass occlusion even in patients with Buerger's disease.

Conflict of interest Nothing to report.

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◆ CASE REPORT ◆

Subintimal Angioplasty of Lengthy Femorotibial Total Occlusion in Buerger's Disease

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Purpose: To report successful subintimal angioplasty of a lengthy femorotibial occlusion in a patient with Buerger's disease, with wound healing and limb salvage.

Case Report: A 38-year-old female heavy smoker was referred to our hospital for treatment of extensive infectious tissue loss, with severe foot pain 1 month after early failure of a distal bypass graft. Angiography revealed total occlusion in the femoropopliteal and infrapopliteal arteries. Endovascular recanalization was attempted in order to establish "straight-line flow" to the foot on the verge of limb loss. The subintimal angioplasty technique with a 0.014-inch hydrophilic guidewire facilitated successful crossing of the occlusive femoropopliteal and posterior tibial arteries. The lesions were serially dilated (standard and cutting balloons). Angiography demonstrated antegrade flow to the foot without flow-limiting dissection, and the serious pain dramatically disappeared. Complete wound healing was observed 5 months after initial revascularization with the assistance of repeat angioplasty for restenosis.

Conclusion: Contemporary endovascular therapy using the subintimal angioplasty technique could represent a viable option for Buerger's disease.

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Key words: thromboangiitis obliterans, Buerger's disease, catheter-based treatment, subintimal angioplasty, femoropopliteal segment, tibial arteries, chronic total occlusion

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Little has progressed in the treatment of thromboangiitis obliterans since Dr. Winiwarter first described a strange form of endarteritis and endophlebitis with foot gangrene in 1879.¹ This disorder, named after Leo Buerger in 1908,² has yet to benefit from contemporary endovascular therapy. There has been rapid growth in endovascular therapy for atherosclerotic disease worldwide, particularly chronic total occlusions (CTO). Here, we

describe successful subintimal angioplasty of a lengthy femorotibial arterial occlusion due to Buerger's disease that presented with extensive infectious tissue loss.

CASE REPORT

A 38-year-old female heavy smoker without other atherosclerotic risk factors was referred to our hospital for the treatment of extensive

The authors declare no association with any individual, company, or organization having a vested interest in the subject matter/products mentioned in this article.

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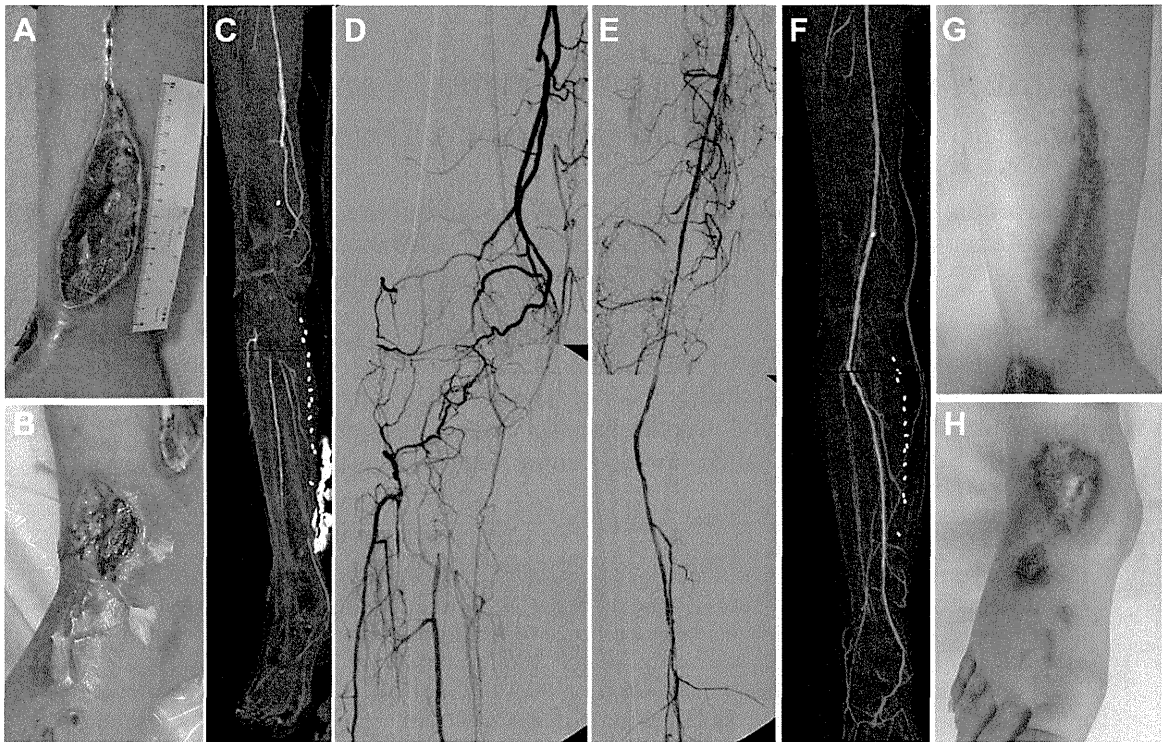


Figure ♦ A 38-year-old woman with infectious gangrene and extensive tissue loss on the (A) inside of the lower leg and (B) dorsum of the foot after early distal bypass failure. (C) CTA showing long total occlusion of the femoropopliteal segment, the proximal and mid segments in the posterior tibial artery, the tibioperoneal trunk, and the anterior tibial artery. (D) Angiography showing total occlusion of the femoropopliteal artery with collateral vessels. Final angiography (E) and (F) follow-up CTA showing the straight-line flow to the foot from the femoral to posterior tibial arteries. (G) Complete wound healing of the medial lower leg defect at 1 month; (H) the dorsal wound completely healed 5 months later.

infectious lower leg and foot wounds (Figure, A,B) with severe pain 1 month after early failure of a distal bypass graft. The bypass graft had been performed at another hospital for the treatment of Buerger's disease with progressive intermittent claudication and angiographically extensive occlusion in the femoropopliteal and infrapopliteal segments.

On admission, pulses of the dorsalis pedis and posterior tibial arteries were not palpable. The right ankle-brachial index was not available because of severe foot pain. Also, skin perfusion pressure (SPP) in the right foot was 13/8 mmHg (dorsum/plantar foot). The wound culture identified multiple bacterial infections, but rheumatologic and serologic investigations had proven negative. Duplex ultrasonography and computed tomographic angiography (CTA) revealed bilateral noncalcified total occlusions in the femoropopliteal

and infrapopliteal segments, with a spastic proximal femoral artery (Figure, C). There was no evidence of embolic sources or other nonatherosclerotic disorders (e.g., popliteal artery entrapment syndrome and cystic adventitia). Differential diagnosis confirmed Buerger's disease.

Urgent revascularization was required for pain reduction, as well as wound healing and limb salvage. In addition to warfarin, antiplatelet and vasodilator agents were administered prior to the procedure. Angiography (Figure, D) via a 4-F sheath placed antegrade at the ipsilateral common femoral artery demonstrated total occlusion of the femoropopliteal, anterior tibial, tibioperoneal trunk, peroneal, and posterior tibial arteries, whereas only the distal posterior tibial artery was preserved.

Endovascular recanalization was attempted in order to establish a straight-line flow to the foot. A total of 7000 units of heparin were given intra-arterially. A 0.014-inch CTO dedicated guidewire was advanced into the occluded femoral artery supported by a 4-F multipurpose catheter. Further navigation in the middle popliteal artery using the traditional technique failed to advance the wire the below the knee; the 0.014-inch floppy guidewire then strayed into the branch of the popliteal artery. Through the Y-connector of 4-F multipurpose catheter, a second 0.014-inch looped hydrophilic guidewire was carefully advanced via a subintimal technique along the occluded popliteal and posterior tibial arteries. The diseased segments were serially dilated with 2.0 to 2.5-mm by 40 to 100-mm balloons; the resistant lesion required the use of a 2.5×15-mm cutting balloon. Guidewire-induced vasospasm was unresolved despite the selective intra-arterial administration of isosbide dinitrate. Final angiography demonstrated the establishment of antegrade flow to the foot without flow-limiting dissection (Figure, E).

The severe pain dramatically disappeared. Medical treatment including both antiplatelet and anticoagulation therapies continued after the procedure. The SPP increased to 65/31 mmHg (dorsum/plantar foot), suggesting a high likelihood of wound healing.³ CT 3 days after the procedure (Figure, F) clearly demonstrated straight-line flow to the foot maintained without vasospasm, which was confirmed by angiography 2 weeks later. Liberal debridement and intravenous administration of optimal antibiotics facilitated complete wound healing on the medial lower leg 1 month later (Figure, G); the dorsal wound healed 5 months later (Figure, H) after repeat angioplasty for restenosis. The patient recovered uneventfully during 8 months of follow-up.

DISCUSSION

Thromboangiitis obliterans is a nonatherosclerotic disease with no or minimal atheromas but segmental vascular inflammation and vasospastic phenomena in the small and medium-sized arteries and veins of the

upper and lower extremities.⁴ The clinical diagnosis of Buerger's disease can be challenging. According to vascular experts specializing in this disease, diagnostic criteria are age <45 years; current or recent smoking history; the presence of distal extremity ischemia; exclusion of autoimmune diseases, hypercoagulable states, and diabetes mellitus; exclusion of a proximal source of emboli; and arteriographic findings consistent with the disease in the clinically involved and noninvolved limbs.⁴ In our patient, all these criteria were met except the typical angiographic findings of corkscrew collateral vessels. However, this angiographic pattern has been described as suggestive of Buerger's disease, but not pathognomonic.^{5,6} The process of differential diagnosis also ruled out other nonatherosclerotic diseases; thus, we believed that this patient had Buerger's disease.

Despite the relative young age of patients with Buerger's disease, the prevalence of major amputation is 4.4% to 11.8%, with minor amputations necessary in 16.7% to 39.5% of those afflicted.⁷ This catastrophic vascular disease is more common in the developing countries of Asia, the Middle East, and Eastern Europe. Thus, there is likely to be an increasing number of patients with critical limb ischemia due to Buerger's disease worldwide. However, no established remedy exists for Buerger's disease other than discontinuation of cigarette smoking to prevent disease progression and avoid major amputation.

With today's sophisticated endovascular technology and decades of experience in the endovascular treatment of atherosclerotic disease, catheter-based solutions may open a new dimension to Buerger's disease treatment. The subintimal angioplasty technique has become quite popular for the treatment of atherosclerotic CTOs in the lower limb.⁸⁻¹³ As shown in this case, subintimal angioplasty with a 0.014-inch guidewire was able to safely and rapidly traverse the entire occlusive lesion extending over the knee joint in the setting of nonatherosclerotic Buerger's disease, although the management of coexistent guidewire-induced vasospasm and underlying thrombus might be required.