Long-Segment Arterial Occlusion: Percutaneous Transluminal Angioplasty

In cases of occlusion of the superficial femoral artery exceeding a length of 10 cm, accompanied by involvement of the popliteal artery and poor runoff, percutaneous transluminal angioplasty is unfavorable. However, when such advanced occlusive disease is present in patients for whom vascular surgery is not feasible, this technique can be of value by averting or at least postponing amputation. Percutaneous transluminal angioplasty was used to recanalize long segments (10–36 cm) of occluded or stenotic femoropopliteal arteries in 21 patients. Results were evaluated by means of pre- and postangioplasty arteriograms and measurements of pressure indices. The initial success rate was 76%; the success rate on 5–24 month follow-up was 67%. The long-term benefit can be improved by other measures, such as stopping cigarette smoking, exercise, long-term anticoagulation therapy, and early detection and treatment of restenosis.

Percutaneous transluminal angioplasty (PTA) has been widely applied to short segments (less than 10 cm) of arteries with occlusive lesions [1–10], but many radiologists have been reluctant to recanalize lesions of greater length because the reported initial and long-term success rates were low [11–15]. We discuss our experience with PTA for occlusions or stenoses 10–36 cm long in the femoropopliteal arteries of 21 patients who had end-stage peripheral atherosclerosis. None of these patients were candidates for arterial reconstruction.

Subjects and Methods

Twenty-one patients underwent percutaneous transluminal angioplasty. The patients ranged in age from 54 to 88 years (average, 72.2 years). There were 10 men and 11 women. Of these patients, 11 (52%) had diabetes mellitus, 12 (57%) had hypertension, and 12 (57%) had coronary artery disease (three of these had coronary artery bypass grafts). Of the 21 patients, 17 had gangrene, 19 had rest pain, four had undergone a contralateral major amputation, and four had contralateral bypass grafts. Eight of the patients were heavy smokers. In two patients, distal bypass grafts had failed. Of the 21 patients, 16 had long segments (10–36 cm) of complete arterial obstruction, and five had long segments (14–24 cm) of multiple stenoses with short segments (2–4 cm) of complete obstruction.

The technical aspects of PTA have been well described [9, 16, 17]. In performing PTA of a femoropopliteal occlusion, we prefer an approach through a contralateral rather than an ipsilateral femoral artery. However, we use antegrade femoral puncture on the ipsilateral side if tibiofibular lesions are present, if previous surgery was done on the contralateral groin, if the patient has extensive aortoiliac disease, or if the contralateral approach is not technically feasible.

In our series, an approach from the contralateral femoral artery for PTA was used in 12 patients, and an antegrade approach from the ipsilateral femoral artery was used in nine patients. Four of these nine patients were those with contralateral femoropopliteal bypass grafts, and five had severe aortoiliac artery disease.
Technical Considerations

Throughout the dilatation procedure, careful attention must be paid to the possibility of spasm. To prevent spasm [18–20] and thrombosis, we inject aqueous heparin (1,000 U) and Lidocaine (2 ml of 1% solution) and either Priscoline (25 mg) or Papaverine (30 mg) into the femoral artery before passing the guide wire through the segment of stenosis or occlusion. After passage of the catheter through the lesion, another 4,000 U of heparin is infused. During balloon inflation, we continue a slow infusion of heparinized saline (1,000 U of heparin in 500 ml of normal saline) through the catheter in order to maintain the circulation and prevent thrombosis distal to the temporary obstruction caused by the inflated balloon. If resistance to the catheter is encountered, additional Lidocaine and Papaverine or Priscoline are given immediately. For arterial spasm at the puncture site, we administer Lidocaine by local infiltration in the periarterial tissue and by injection into the external iliac artery proximal to the puncture site, just before the catheter is withdrawn.

In our early experience with PTA, we occasionally had difficulty in withdrawing the balloon catheter. This difficulty, caused by spasm of the artery at the puncture site, resulted in wrinkling and compression of the balloon as it was withdrawn and made the distal end of the balloon appear like a partially opened umbrella. It was thus impossible to remove the catheter without rupture of the balloon or a significant increase in the size of the arteriostomy. After relieving the spasm with Lidocaine and intraarterial vasodilators, we advanced the tip of the catheter deep into the common iliac artery and relieved the "partially opened umbrella" inversion by inflating and deflating the balloon. We were then able to withdraw the catheter without difficulty.

The catheter has a tendency to buckle in the aorta when a contralateral femoral approach is used [21]. We have found that arterial spasm may be a factor in this buckling phenomenon, and that control of spasm often leads to successful recanalization with the contralateral approach.

Our usual procedure for femoropopliteal lesions is to begin dilatation with the most distal part of the lesion and proceed proximally. In some cases, however, the catheter may not pass through the entire length of the obstruction or stenosis. In this instance, angioplasty of the more proximal lesion should be carried out first [21] so that the catheter can be advanced more distally.

Occasionally, despite successful advancement of the guide wire below the occluded arterial segment, the rigidity of the lesion may prevent passage of the catheter. For such instances, Guntrzig and Kumpe [16] recommended the use of a "stiffening cannula." We prefer the Lunderquist Exchange Guide Wire [22], which is constructed of solid steel with a soft, flexible tip welded to its distal part. Its firmness exerts sufficient force on the catheter to overcome resistance in the occluded artery. With the contralateral femoral approach, the Wilson variable stiffness guide wire also may be used for rigid lesions.

After PTA, intravenous heparin (1,000 U/hr) is continued for 3 days, the dose being adjusted so that the partial thromboplastin time remains at about twice the control value. Patients are maintained on long-term Coumadin or aspirin therapy. If a patient has gangrene or ulceration of the diseased foot or leg, we give antibiotics 1 day before and several days after PTA, depending on the severity of the infection.

Results

Dilatation was successful in 18 (86%) of the 21 cases, as evaluated by means of improved postdilatation angiograms (table 1). In two of the 18 patients, dilatation was achieved, but reocclusion occurred within 1 week. Thus, the overall initial success rate was 16 (76%) of 21 cases. In five cases (24%) PTA was unsuccessful, and amputation was required within 1 month.

Of the 16 patients successfully recanalized initially by PTA, seven (44%) developed recurring stenosis or occlusion 2–12 months later. Repeat PTA was successful in all seven cases (fig. 1). One of these patients developed a distal obstruction, however, and underwent a below-the-knee amputation 4 months after the second PTA (9 months after the initial PTA). In another case, recanalization of a previously obstructed peroneal artery developed spontaneously 6 months after repeated PTA. When the proximal stenosis recurred, the patient underwent a successful femoroperoneal bypass graft.

Thus, 15 (71%) of 21 limbs had been salvaged after 5–24 months of follow-up. During this interval, the patency rate for arteries that had been successfully recanalized was 88% (14 of the 16 patients). The overall success rate for PTA at follow-up was therefore 67% (14 of 21 patients). Three patients have died, one at 2 months, one at 4 months, and another at 9 months after PTA. All three of these patients had patent arteries at the time of death.

The complications of PTA have been discussed [11, 17–19]. We encountered four hematomas at the puncture site, two of which required surgical evacuation (table 2). In two patients, arterial perforation occurred, but was without clinical consequences. One patient had significant arterial spasm, and in one patient distal emboli were seen on a postdilatation arteriogram (fig. 2). Worsening of ischemia was not observed in any of these patients.

Discussion

We consider preventing and treating spasm during and after PTA to be of crucial importance for the successful
PTA FOR LONG-SEGMENT OCCLUSION

Fig. 1.—66-year-old man had 2 month history of rest pain and nonhealing ulcers of right leg and foot. He had diabetes mellitus and hypertension and had undergone coronary artery bypass grafts for coronary artery disease. A, Before PTA: 19 cm segment of complete obstruction of distal superficial femoral artery (arrows). Proximal popliteal artery stenotic, and right anterior tibial and posterior tibial arteries completely obstructed. Fibular artery reconstituted 5 cm distal to origin. B, After recanalization: Superficial femoral artery (arrows) and popliteal artery patent; better collateral circulation to leg. Symptoms were relieved and ulcers healed. Ankle/brachial systolic pressure index, not recordable before PTA, increased to 0.51. C, Reocclusion of superficial femoral artery at 5 months, with return of symptoms of rest pain and gangrene of right third toe. D, After redilatation: Occlusion recanalized. Ankle/brachial systolic pressure index increased from 0.17 before redilatation to 0.65 after redilatation. After PTA, patient underwent successful amputation of distal phalanx of right third toe. He was symptomfree 9 months after redilatation.

Fig. 2.—72-year-old man had history of hypertension and one-half block left calf claudication which had recently progressed to severe rest pain of left foot. A, Before PTA: 36 cm complete obstruction (arrows) of left superficial femoral artery with poor distal runoff. B, After PTA: Superficial femoral artery successfully recanalized. Emboli in popliteal and deep femoral arteries (arrows). Ankle/brachial systolic pressure index rose from 0.15 before PTA to 0.33 and 0.51 1 week and 2 months after angio-plasty, respectively. Patient had immediate relief of rest pain and warm, hyperemic foot.

<table>
<thead>
<tr>
<th>Complication</th>
<th>No. Patients</th>
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<tr>
<td>Hematoma and bleeding from the puncture site</td>
<td>4</td>
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<tr>
<td>Distal embolization</td>
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<tr>
<td>Spasm of the arteries</td>
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<td>Perforation of the artery by guide wire</td>
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Note.—Eight of 28 PTAs had complications; two required surgery.

recanalization of long segments of occluded vessels. Mechanical stimulation of an artery by manipulation of a guide wire or catheter can induce significant spasm [18], especially in small and medium-sized muscular arteries such as the popliteal arteries or tibial vessels [19]. This spasm can be prevented or minimized by administration of local anesthetics at the puncture site [19] and by intraarterial infusion of Lidocaine and Priscoline before insertion of the guide wire or catheter [20]. Because of the propensity for spasm, puncture of the superficial femoral artery and insertion of the guide wire below the level of the knee should be avoided, if possible.

In our series, seven of the eight heavy smokers developed reocclusion within 1 week to 7 months after PTA. In contrast, only two of 10 nonsmokers developed reocclusion at 5–24 month follow-up. Schmidtke et al. [12] reported on a 5 year follow-up of patency rates after PTA. The arteries of about 45% of their patients who had discontinued smoking were still patent, as opposed to no more than 18.8% and 14.3% for cigarette and pipe/cigar smokers, respectively. Therefore, patients should stop smoking in order to benefit maximally from PTA [12, 19, 23].

Muscular exercise strongly promotes collateral blood flow. Through muscular exercise, such collaterals may become large enough to maintain a sufficient circulation in the leg even if the femoral or popliteal artery later is reoccluded by progressive atherosclerosis [11, 24]. In our experience, long-term anticoagulation therapy has also improved the success of PTA. Zeitler [25] has reported that recanalized
femoropopliteal arteries remained patent for up to 30 months in 80% of patients given anticoagulants, whereas the patency rate was only 40% in patients not given such therapy.

The best results of PTA can be expected after dilatation of a simple, short segment of stenosis of the iliac, femoral, or popliteal arteries [26–28]. In patients with diffuse, multiple stenoses or a long segment (more than 10 cm) of complete obstruction and poor distal runoff, successful PTA is technically difficult to achieve, and the long-term results are relatively poor [12–14, 16]. However, a high percentage of limbs threatened with amputation can be salvaged. The long-term benefits of PTA for long segments have not yet been clearly established, and restenosis is a significant problem. However, this procedure can be repeated, if necessary, as in seven of our cases. Restenosis usually occurs over only a short segment if it can be detected early, even though the originally dilated segment may have been more than 10 cm long. Therefore, we strongly suggest that frequent and objective follow-up evaluations are crucial for these patients. If ankle pressure indices decrease and symptoms return, prompt repeat arteriography and PTA of the restenosing lesion should be carried out.

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REFERENCES