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Case Report

Late Result of Dorsal Pedal Artery Bypass in a Diabetic Patient with Severe Ischemic Heel Gangrene: A Case Report

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Ischemic heel necrosis in a diabetic patient represents a difficult and frustrating problem for plastic surgeons and vascular surgeons. Dorsal pedal artery bypass produces an effective and durable effect on management of diabetic foot ulcers, especially forefoot wounds. But the role of pedal artery bypass in managing ischemic heel necrosis remains to be defined. We describe our use of pedal artery bypass to heal ischemic heel necrosis in a diabetic patient. A 73-year-old male came to our outpatient department on January 28, 2004 with severe ischemic heel gangrene. A popliteo-dorsalis pedis bypass with a reversed saphenous vein graft was uneventfully performed under epidural anesthesia. After surgical revascularization, intensive wound care with a skin graft was carried out, and the heel necrotic wound resumed healing. Complete healing was achieved 4 months later. Now the patient can freely walk 3 km daily. Good Doppler signals over the pedal saphenous vein graft and dorsalis pedis artery were noted on a routine examination in May 2009. Management of ischemic heel gangrene continues to be a difficult problem. Although some lengthy reconstructive procedures are reported to ameliorate heel gangrene, restoration of adequate pulsatile arterial flow to the heel wound is critical to managing this lesion. Collateral circulation that perfuses the hindfoot can sometimes be provided by dorsal circulation. Our case report demonstrates the adequate, effective, and durable role of dorsal pedal artery bypass in managing ischemic heel gangrene. The patient was followed-up for more than 5 years with good functional recovery, such that he can walk quite a distance daily after the heel wound had healed.

Key words: dorsal pedal artery bypass, heel necrosis

Introduction

Foot problems remain the most common reason for hospitalization of patients with diabetes mellitus (DM) (8). The primary pathologic mechanisms of neuropathy and ischemia set the stage for pressure necrosis, ulceration, and polymicrobial infection, which if improperly treated, ultimately lead to gangrene and the necessity of amputation (18). Among patients with DM, approximately 15% will develop a foot ulcer at some point in their life. Diabetic foot ulceration precedes lower-limb amputation in 85% of these patients. About 40%~60% of all non-traumatic lower-limb amputations in Taiwan occur in patients with DM, although they represent only 7% of the population (5, 29). In 1984, dorsal pedal artery bypass was first reported by Dr. LoGerfo, which disputed the misconception of small-vessel disease (19).

Treatment of ischemic heel necrosis remains a challenge and often causes frustration for plastic and vascular surgeons (25). The absence of available soft-tissue coverage is one of the obstacles. Although many reconstructive operations are reported for soft-tissue coverage of ischemic heel necrosis, their success greatly depends on restoring adequate blood flow (1).

Many reports demonstrated that pedal artery bypass is a durable and effective limb-salvage procedure for diabetic foot ulcers, especially forefoot wounds (20, 22, 23, 28).

The role of pedal artery bypass in the management of ischemic heel necrosis remains to be

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Fig. 1 A 73 years old male, DM for 15 years, showed foot and heel necrosis

defined. We report one such patient who was followed-up for more than 5 years.

Case Report

A 73-year-old male was transferred to our hospital on January 28, 2004, with severe ischemic heel gangrene and a toe which had completely dried out (Fig. 1). Below the knee (B-K) amputation was suggested by the previous medical center, but the patient refused; so he came to our hospital for further management. At arrival, the diabetic patient had gangrenous change of the right second and third toes with a cool right foot.

During hospitalization, arteriography of the lower abdominal aorta and right lower limb was performed, which showed relatively normal vessels to the level of the adductor hiatus, with a typical diabetic infrapopliteal trifurcation lesion, occlusion of the anterior and posterior tibial arteries, and recanalization of the plantar artery by collaterals (Fig. 2).

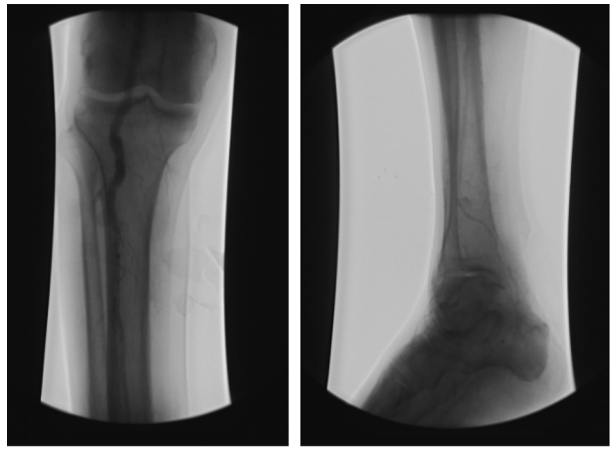

Fig. 2 Angiography

Severe atherosclerotic change and the small caliber of the anterior tibial artery led to compensation by collateral vessels in the ankle region. The impression of angiography was peripheral arterial occlusive disease of the right lower limb.

A right popliteo-dorsalis pedis bypass procedure with subcutaneous tunneling and good-quality reversed greater saphenous vein graft was uneventfully performed under epidural anesthesia. After surgical revascularization, intensive wound care with hyperbaric oxygen (HBO) therapy was carried out, and the heel necrotic wound resumed healing. He underwent amputation of the demarcated, gangrenous right second toe. The patient was discharged with palpable dorsalis pedis pulsation and clean wounds. Over the following months, the wound was debrided multiple times due to the full-thickness ischemic soft-tissue necrosis with an exposed Achilles tendon. After adequate local debridement, skin grafts were placed over the wound. A split-thickness skin graft (STSG) from the left thigh was placed over the soft-tissue defect at the right heel. Complete healing was achieved 4 months later (Fig. 3) when the patient was able to walk again.

He has continued to do well and had normal results on duplex graft surveillance examinations. One year after the free-flap reconstruction, the patient had a decreased pedal pulse; nevertheless, the ankle-brachial index (ABI) remained above 1. A Doppler examination was used as post-bypass surgery surveillance to identify flow-reducing lesions before graft failure occurred (Fig. 4). Good Doppler signals over the pedal saphenous vein graft and dorsalis pedis artery were noted in a routine July 2009 examination. Segmental limb pressure with pulse volume plethysmography was used to noninvasively evaluate the peripheral arterial condition. The seg-

Table 1. Segmental limb pressures [mmHg (ratio: lower limb/brachial artery)]

	Segmental limb pressure	
Right limb	1 month before bypass surgery	8 months after bypass surgery
Brachial artery	120	128
Proximal femoral artery	132 (1.10)	132 (1.03)
Infrapopliteal	122 (1.02)	141 (1.10)
Ankle	undetectable	152 (1.19)
Ankle	undetectable	140 (1.09)

Fig 3. (A) 2005 0408, (B) 20090129. Dorsalis pedis bypass

Fig4. Debridement of the wound and a full-thickness skin graft (FTSG) on the Achilles tendon

mental limb pressures recorded by the referring hospital (January 2004) showed severe atherosclerosis of the right lower-leg artery, and the pulse pressure could not be detected B-K in the right limb. Eight months after bypass surgery, the segmental limb pressure was 140 mmHg at the level of the right ankle with an ABI of 1.09 (Table 1).

During follow-up, necrosis in the Achilles tendon area was found 1 year after the bypass operation. Debridement of the wound multiple times and a full-thickness skin graft (FTSG) on the Achilles tendon successfully restored the soft tissue (Fig. 5).

After 64 months of follow-up, there have been no complications. The patient continues to have a fully functional ambulatory life. Now, the patient can freely walk up to 3 km every day.

Discussion

Management of ischemic heel gangrene continues to be a difficult problem. Primary amputation such as B-K amputation is often suggested to resolve this frustrating problem, sometimes despite successful revascularization (11, 26). The combination of distal neuropathy, repeated local trauma, prolonged exposure to decubitus pressure, and complex peripheral arterial disease makes heel gangrene particularly problematic in diabetic patients. Although some lengthy reconstructive procedures are reported to manage heel gangrene, restoring adequate pulsatile arterial flow to the heel wound is critical to lesion management. Collateral circulation that perfuses

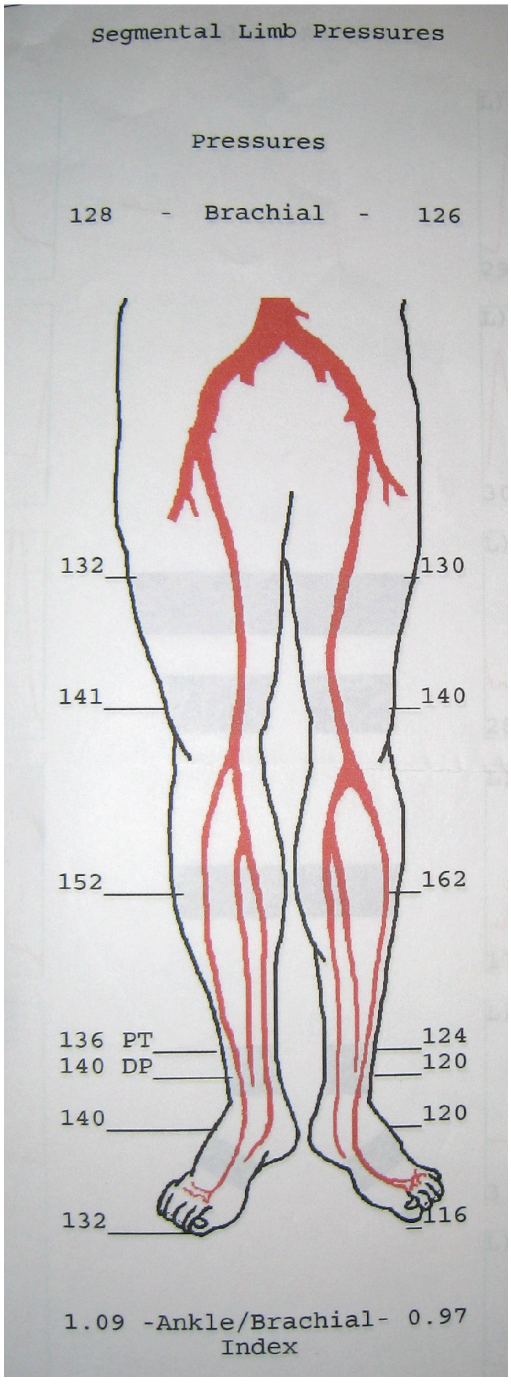

Fig. 5. Functional outcome with the ability to walk more than 10 km per day

the hindfoot sometimes may be provided by dorsal circulation (30).

The goals of noninvasive testing for peripheral arterial disease are to confirm the clinical diagnosis and further define the level of obstruction. A variety of algorithms are used to noninvasively diagnose peripheral arterial disease in the vascular laboratory. Some of these include segmental limb pressure with pulse volume plethysmography and arterial ultrasonography. Segmental limb pressures are compared to adjacent ipsilateral segments, the contralateral-paired segment, and the greater of the two brachial systolic pressures. A reduction of 20 mmHg or greater in pressure is considered significant if such a gradient is present either between segments along the same leg or when compared to the same level in the opposite leg (21).

A Doppler examination is useful to identify flow-reducing lesions before graft failure occurs. Graft surveillance has proven quite useful in efforts to preserve the patency of bypass grafts. Five-year primary patency rates of infrainguinal bypass grafts range 60%~85% (27). Surgical revision of the stenoses identified with ultrasound increases the 5-year patency rate up to 93% (2, 7). Standard surveillance protocols recommend ultrasound evaluation of the graft twice during the first postoperative year, and annually thereafter (10).

Hindfoot necrosis of diabetic patients is a difficult problem in cases with tendon exposure. Various flaps have become available in the clinical setting using local, regional, and distant tissues of the body (14, 15, 17, 24). In this case, flourishing granulation formation over the Achilles tendon was observed after bypass surgery, which made the FTSG possible as soft-tissue restoration. Using the concept of a reconstructive ladder, the primary rung is considered first to manage the wound before more-complex procedures are attempted. The reconstructive ladder is a term coined by reconstructive plastic surgeons to describe levels of increasingly complex management of wounds (3). There are several small variations in the reconstructive ladder (4, 13, 16) in the scientific literature, but the principles remain the same of choosing reconstructive methods from rungs 1 to 9 in the order of healing by secondary intention, primary closure, delayed primary closure, STSG, FTSG, tissue expansion, random pattern flap, pedicle flap, and free flap.

FTSG offers numerous advantages in managing large ischemic wounds with exposed tendons when the recipient bed allows it. In the case of this ambulatory amputee with diabetes who otherwise faced BK amputation, we decided on an approach with dorsal pedal artery bypass and soft-tissue restoration as the best option. These provided durable wound coverage and preservation of long-term independent activity. In selected, ambulatory patients who have soft-tissue defects or exposed tendons, this technique can successfully extend the limits of limb salvage.

This patient was followed-up for more than 5 years with good functional recovery, i.e., the patient can walk 3 km everyday after the heel wound

healed. This case demonstrates that adjunctive HBO and adequate wound care after successful surgical revascularization can enhance wound healing and help patients return to a functional walking status (6, 9, 12). Our case report demonstrates the adequate, effective, and durable role of dorsal pedal artery bypass in managing ischemic heel gangrene.

Conflict of Interest

The authors declare that there is no conflict of interest.

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