Use of Fibula-Free Tissue Transfer With Preoperative 2-Vessel Runoff to the Lower Extremity

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Objective: To present our experience with fibula-free tissue transfer in patients with documented 2-vessel runoff to the lower extremity on preoperative angiography.

Methods: A case series of 16 patients with segmental mandibular defects reconstructed with a fibula-free flap by the senior author with 100% stenosis of the anterior or posterior tibial arteries were retrospectively reviewed for radiographic data and complications.

Results: All flaps performed were successful, and there were no donor site complications. Angiography documented flow of contrast to the foot by a patent anterior or posterior tibial artery in all patients. Occlusive arteriosclerotic disease was identified in the anterior tibial artery in 10 patients and in the posterior tibial artery in 6 patients.

Conclusions: Using our specific criteria, we experienced no complications with the use of a fibula-free flap in extremities with 100% obstructive vascular disease in the anterior or posterior tibial artery. Preoperative angiography is indicated to select appropriate candidates for fibula-free tissue transfer with 2-vessel lower extremity runoff to avoid potential donor site ischemic complications.

Arch Facial Plast Surg. 2005;7:261-264

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HIDALGO[1] WAS THE FIRST TO describe the fibula-free flap for reconstruction of segmental mandibular continuity defects. This versatile flap provides up to 25 cm of bone stock that may be harvested with or without a cutaneous paddle.[2] The fibula osseous flap allows reconstruction of near-total mandibular defects with bone that is able to resist normal masticatory forces and is able to support dental implants primarily or secondarily.[1-3] Its vascular supply is derived from the peroneal artery and its two vena commitantes, which course along the length of the fibula between the tibialis posterior and flexor hallucis longus muscles. The peroneal artery branches off from the posterior tibial artery in the posterior leg 2 to 3 cm distal to the bifurcation of the popliteal artery into the anterior tibial artery and the posterior tibial artery. The peroneal artery typically ends in terminal branches above the ankle, and the tibial arteries continue distally to supply the foot.

The most devastating potential donor site complication of harvesting a fibula-free flap is catastrophic ischemia of the lower extremity. The anterior or posterior tibial arteries may be diseased in 10% to 20% of patients. Harvest of a peroneal artery supplying collateral circulation to the territory of a deficient tibial artery has the potential to cause foot ischemia.[4] Numerous methods have been used for preoperatively evaluating a patient for a fibula-free flap reconstruction. Imaging allows assessment for leg selection and adequacy of perfusion of the leg. Angiography currently provides the most accurate

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detail of arterial anatomy and is considered the gold standard for vascular assessment, but it carries a small risk that a patient will develop thrombosis, hemorrhage, or embolism. Noninvasive alternatives for evaluating crural vascular anatomy include magnetic resonance (MR) angiography and color flow Doppler imaging.[5-7]

The ideal method for preoperative radiographic assessment prior to creating a fibula-free flap is controversial. Even less clear are the imaging criteria that contraindicate the safe use of a fibula flap. Clearly, 3-vessel runoff to the foot is ideal, and single-vessel runoff is not usable. In this article, we will address our positive expe-

Figure 1. Preoperative angiogram demonstrating complete occlusion of the posterior tibial artery at the level of the midcalf. Anterior tibial and peroneal arteries are patent.

rience and patient selection criteria for safe 2-vessel fibula-free tissue transfer.

METHODS

We retrospectively reviewed patients who underwent reconstruction of mandibular defects with a fibula-free flap with 2-vessel runoff on angiography or MR angiography. Consecutive patients treated by the senior author (Y.D.) from 1997 to 2004 with fibula-free tissue transfer and 2-vessel runoff on preoperative imaging are described. Patients were considered candidates for a fibula-free flap reconstruction if the angiogram demonstrated a dominant arterial supply to the foot from a patent anterior or posterior tibial artery as well as an intact peroneal artery. Records were reviewed for radiographic data and postoperative complications.

RESULTS

Sixteen patients with 2-vessel runoff underwent reconstruction with a fibula-free flap and a total of 86 fibulas were operated on during the study period. All patients were evaluated preoperatively with angiography of the lower extremities and had atherosclerotic disease in either the anterior or posterior tibial artery in the leg selected for flap harvest. Complete occlusion was noted in the anterior tibial artery in 10 patients and in the posterior tibial artery in 6 patients. All patients demonstrated a dominant vascular supply to the foot by the single remaining patent tibial artery, with a well-visualized collateral branch to the region supplied by the occluded tibial artery given off at the level of the ankle (**Figures 1, 2,** and **3**). There were no complications from angiography. All fibula-free tissue transfers with 2-vessel runoff performed by the senior author were successful, and there were no donor site complications or evidence of gangrene, extremity loss, or total skin graft loss. There were 2 cases of subtotal skin graft take. The resulting wound closed subsequently with simple wound care.

COMMENT

The extent of preoperative radiographic assessment prior to performing a fibula-free flap is controversial. Several authors[8-12] do not feel that routine preoperative imaging is indicated. They reserve angiography for evaluation of patients with abnormal distal pulses or history of lower extremity trauma. However, imaging detects congenital and acquired abnormalities in lower extremity vessels that may be missed on clinical examination. Patients undergoing a segmental mandibulectomy are often at high risk for peripheral vascular disease secondary to smoking and advanced age. Significant atherosclerotic disease may be detected that determines the site of fibula harvest or the need for alternative reconstructions. If congenital variations of the popliteal artery branches (diagnosed in 7.8% of femoral angiograms[13]) are detected, the reconstructive plan may need to be revised. Congenital absence of the peroneal artery is rare (incidence, 0.1%).[14] In addition, serious complications may result if the peroneal artery is the dominant vascular supply to the foot, which has been reported in 5% to 7% of the population.[13,15,16] Candidates with peroneal arterial magna are at an especially high risk for ischemia with fibula-free flaps. This congenital anomaly occurs in 0.2% to 0.9% of the population. These patients have normal pulses and are without claudication despite having the peroneal artery as the sole arterial supply of the foot.[10,12,13,17] Overall, imaging has been reported to alter the reconstructive plan of 21% to 25% of patients being evaluated for a fibula-free flap.[17,18]

Angiography is considered the procedure of choice by many surgeons for evaluating arterial anatomy.[17,19] We consider this the preferred method of investigation. Digital subtraction arteriography provides accurate, detailed, functional anatomy of lower extremity vessels. Disadvantages include expense and the risk of rare complications such as hemorrhage, thrombosis, embolism, pseudoaneurysm, arteriovenous fistula, and contrast nephropathy or allergic reaction.[20] Magnetic resonance angiography is a noninvasive alternative for preoperatively evaluating crural vessels. This study has a cost similar to that of conventional angiography and is capable of identifying vascular abnormalities.[5] Overlay by venous channels may affect the accuracy of MR angiography results in certain individuals.

Color flow Doppler studies have been proposed as an inexpensive, accurate method of evaluating lower ex-

Figure 2. Angiogram of patient in Figure 1 demonstrating the presence of an intact crossover collateral from the anterior to the posterior circulation, which makes this flap harvest safe.

Figure 3. Preoperative angiogram demonstrating occlusion of anterior tibial artery in the proximal calf. This patient has relative sparing of the peroneal artery by atherosclerosis, as is often the case, making it the dominant flow to the foot. There is an intact posterior tibial artery, but the distal collateral is originating from the peroneal which will be taken with flap harvest. This patient is not a good candidate for fibula flap harvest because he or she may experience significant vascular compromise.

tremity vasculature. Color flow Doppler has sensitivity for detecting 95% of occluded vessels and 87.5% of stenotic vessels.[21] Patients with monophasic flow or no flow in any of the trifurcation vessels are considered to be at high risk for ischemic complications. Patients with biphasic flow require evaluation with MR angiography or angiography and patients with triphasic flow do not require any further evaluation.[7]

Imaging criteria for exclusion of a fibula-free flap are not clearly delineated. Smith et al[7] considered a stenosis of greater than 50% in 1 lower extremity artery as a basis to contraindicate a fibula-free flap. In contrast, Lutz et al[10] performed fibula-free flap reconstruction, with no donor morbidity, in 3 patients with complete occlusion of a tibial artery on angiography. We have performed a relatively large number of reconstructions in patients with 2-vessel runoff. This may be related to the referral patterns to our center from multiple specialties for difficult head and neck reconstructions. A number of the patients in our study were referred from other centers and initially were considered to be unsuitable candidates for fibula harvest. Also, almost all of the 2-vessel angiograms revealed severe atherosclerotic occlusion of the remaining tibial vessel rather than congenital absence. Our practice is to routinely perform arteriography on patients who are being considered for a fibula-free flap procedure. We feel that this procedure provides the most detailed information about lower extremity vascular anatomy. In our patients with arteriosclerosis in 1 of the tibial vessels, angiography demonstrated collateral circulation to the region of the stenotic vessel. We believe that it is safe to harvest a fibula-free flap in a patient with 2-vessel runoff, provided that the patent tibial vessel is the dominant arterial supply to the foot. In addition, there must be a well-defined vessel (that we term the *crossover collateral*) at the level of the ankle (distal to proposed peroneal artery harvest) from the remaining tibial vessel to the occluded tibioperoneal territory. We would consider other reconstructive options in patients whose peroneal artery was the dominant or sole artery to the foot or in whom the criteria mentioned herein were not met.

Despite the presence of arteriosclerosis in 1 of the tibial vessels, all of the fibula-free flap reconstructions were successful. The peroneal artery tends to be less severely affected by peripheral vascular disease compared with the tibial vessels, which may be related to the straighter course of the peroneal artery.

Despite the precautions described herein, as with any fibula-free tissue transfer, a small risk of donor site morbidity, including foot loss, remains. We feel that strict use of the criteria described in this article, with particular note made of the crossover collateral, should make 2-vessel extremity donor sites a safe option in experienced hands.

We feel that MR angiography may be used as a screen depending on surgeon preference. If 3-vessel runoff is noted, then no further imaging is required. If, however, 2-vessel runoff is noted, then an angiogram should be performed to establish with as much certainty as possible whether flap harvest will be safe.

In conclusion, a fibula-free flap can be safely performed in patients with 2-vessel runoff of the lower extremity. Angiography provides accurate detail of the arterial supply to the lower extremity. Patients can be considered for fibula reconstruction if the remaining patent tibial artery is the dominant arterial supply to the foot and provides collateral circulation to the region of the stenotic tibial artery with the identification of the crossover collateral. Absence of this vessel should preclude harvest.

Accepted for Publication: December 16, 2004.
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