The successful performance of any arterial bypass procedure starts with, ideally, the surgeon being armed with the maximal amount of information about the patient. This is commonly thought of as a history, physical examination, arteriography, and any preoperative testing for medical clearance. Most surgeons would not willingly abandon some effort to image both the inflow and outflow arteries, whether by conventional angiography, ultrasound, magnetic resonance arteriography, computerized tomography, or other more arcane techniques. However, these same surgeons often pay little attention to the greatest portion of their bypass, the vein itself.

That this is so is probably because the saphenous vein was most frequently encountered by surgeons during vein stripping, and certainly preoperative anatomic definition of the saphenous vein was not performed. In addition, it has taken the surgical community time to regard veins as more than passive tubes awaiting use as an arterial bypass. As the importance of the physiologic importance of the live autogenous vein became revealed to the surgical community, methods were progressively developed to preserve the live vein. In this context, it became increasingly apparent that minimizing intraoperative injury to the vein conduit was desirable. In addition, because of the frequent anatomic variations seen in any of the cutaneous veins used for arterial bypass, improved preoperative knowledge of the vein allowed surgeons to select the most satisfactory veins available while avoiding those that were too small or otherwise diseased while minimizing the incisions and dissections required to make this choice. This last point cannot be overemphasized as wound complications from vein harvest sites are a frequent and troublesome complication of arterial bypass surgeries.

The overall goal of this chapter is to supply the clinician or technologist with the specific knowledge necessary to perform preoperative vein mapping while, hopefully, convincing him or her of its utility and ultimate logic. Like many technologic advances, the need for vein mapping may seem obscure, especially to surgeons who have performed these surgeries for decades without this knowledge. But like personal computers, post-it notes, and remote controls, vein mapping, once used, makes the life of the operator so much easier that it soon becomes indispensable.

Preoperative Imaging with Venography

At Albany Medical Center, preoperative vein imaging evolved hand in hand with the reintroduction of the in situ bypass technique. While the initial cases were done by incising the skin overlying the saphenous vein and incising the valves with the modified Mills valvulotome (“open” technique), further evolution of the instrumentation led to the development of the Leather and then other valvulotomes, which are passed blindly up the vein from a below-knee incision to the groin incision (“closed” technique). The use of a closed technique, although attractive in terms of decreasing operative dissection and operative time, is very sensitive to variations in saphenous vein anatomy, as the surgeon does not directly expose and thereby examine the entire vein or veins available, making the selection of the best available vein more problematic. In addition, certain branching patterns, when unrecognized, are frequently points of injury to the bypass when a closed technique is used.

For these reasons, the saphenous vein was for several years imaged with contrast venography. The results of these studies were summarized in part by Shah et al. The methods reported in that paper are still effective and useful in some selected cases. The saphenous vein is punctured in the foot, ideally in one of the many prominent sidebranches covering the medial aspect of the foot. The use of a tourniquet is helpful for the puncture, but should be removed subsequently. Contrast medium is injected into the saphenous vein. Importantly, the vein is then flushed with heparinized saline after the venogram is performed.
completed to minimize the chance of contrast-induced thrombosis.

Alternatively, the same information may be gained intraoperatively at the beginning of the bypass procedure. An incision is made over the saphenous vein, usually just below the knee. Once the vein is thought to be identified, it is cannulated through an opened side-branch with a 22-gauge plastic angiocath (sheath only) and a single film is taken of the thigh after 10–12 ml of contrast is instilled into the vein. This has the advantage of not requiring the delay and inconvenience of preoperative venography, but is less likely to give the surgeon the complete picture of the vein.

Although these venographic techniques were used in several hundred bypass procedures, they are both invasive. In addition, venography gives relatively little information in regard to vein wall thickness, calcification, and other aspects of vein quality that are more apparent with ultrasonographic techniques. Venography is also not a practical method of imaging multiple limbs in the same patient at the same time.

There are some circumstances in which these methods are still of use. First, when first starting to perform duplex vein mapping, accuracy may be monitored by performing venograms. This is especially important when the imager encounters variations that he or she has not seen previously and helps shorten the learning period for the imager. Second, there are individuals in whom the vein anatomy is sufficiently complicated and/or difficult to image with duplex due to patient anatomy (extreme obesity) or inability to cooperate in whom an intraoperative venographic study would be useful. Third, emergency cases done late at night when duplex may not be available may benefit from on-table venography instead.

Method of Imaging

The equipment necessary for adequate saphenous and other cutaneous vein mapping is that commonly available and employed in vascular imaging studies of most kinds. A 10- to 12-MHz transducer is what is generally employed. Lower MHz probes are occasionally useful to image deeper veins in extremely obese individuals, but lack the resolution necessary for delineating the important details seen with the higher MHz probes. A 4.5-MHz pulsed Doppler is also occasionally employed primarily to check for vein patency. Color is rarely, if ever, necessary and may in some circumstances obfuscate important details. The reason that color flow is usually not helpful is that the unaugmented flow rates in these cutaneous veins provides only sporadic color filling of the vessel, which is of little use in outlining their course. The transmit power (decibels) of the transducer probe is generally turned down as this delivers a cleaner, clearer image by minimizing backscatter. Focal zones should be adjusted to maximize the near-field resolution (Figure 11–1).

Because the course of the vein is drawn upon the skin with indelible marker and then stain, the unprotected probe head may become permanently stained, especially through the relatively porous probe membrane. To avoid this, the probe is covered with a plastic sandwich bag containing ultrasound gel.

Preparation of the examination area or room is of vital importance for successful mapping. The room should be well heated to minimize peripheral vasoconstriction. In a similar fashion, the patient should remain clothed and covered, exposing only the necessary limb. Sometimes keeping the exposed foot covered is also useful. Finally, the room is generally kept dark in order to assist with visualization of the ultrasound image on the display.

Positioning for imaging of the greater saphenous vein usually requires the stretcher to be placed in reverse Trendelenburg with the knee slightly flexed and the hip externally rotated. Standing the patient is usually not necessary for the majority of cases and is certainly not well tolerated by many in this patient group. Occasionally, the