Minimally Invasive Vein Surgery

STEVEN M. ELIAS, M.D.[1,2], AND KRISTA L. FRASIER[3]

Abstract

Advances in minimally invasive vein surgery (MIVS) techniques made during the last decade have decreased operative morbidity, the number and size of incisions, operative time and recovery time. The following MIVS techniques will be discussed:

1. Transilluminated Powered Phlebectomy (TIPP) TriVex™
2. Radiofrequency Ablation Greater Saphenous Vein (RFGSV) Closure®
3. Laser Ablation Greater Saphenous Vein (EVLT)
4. Subfascial Endoscopic Perforator Surgery (SEPS)
5. Percutaneous Vein Valve Bioprosthesis (PVVB)

The techniques used in MIVS allow surgeons to manage venous pathophysiology associated with all three venous systems of the lower extremities. The results are comparable to those obtained with open procedures.

Introduction

MINIMALLY INVASIVE TECHNIQUES for vein surgery have evolved over the last decade, revolutionizing the management of venous disease.

Endoscopic, endovascular and mechanical methods have supplanted longstanding traditional procedures and allow surgeons to manage the venous pathophysiology associated with all three (superficial, perforator and deep) venous systems in the lower extremities (1). These techniques decrease operative morbidity, the number and size of incisions, operative time, and recovery time. In addition, the results are as durable as the open procedures, or more so, with increased patient satisfaction and effective wound healing rates in applicable instances.

MIVS techniques include:

1. Transilluminated Powered Phlebectomy (TIPP) (TriVex™, Smith and Nephew, Inc., Andover, MA)
2. Radio-frequency Ablation Greater Saphenous Vein (RFGSV) Closure® (VNUS Medical, San Jose, CA)
3. Laser Ablation Greater Saphenous Vein (EVLT)
4. Subfascial Endoscopic Perforator Surgery (SEPS)
5. Percutaneous Vein Valve Bioprosthesis (PVVB)

Each of these techniques is discussed, to provide an overview of corrective procedures available in the era of minimally invasive vein surgery (MIVS).

Discussion

Transilluminated Powered Phlebectomy, TriVex™

Transilluminated Powered Phlebectomy (TIPP) is a mechanical method of ablating

[1]Director, Center for Vein Disease, Division of Vascular Surgery and [3]RVT Manager, Vascular Laboratory, Englewood Hospital and Medical Center, Englewood, NJ, and [2]Assistant Clinical Professor of Surgery, Mount Sinai School of Medicine, New York, NY.

Address all correspondence to Steven M. Elias, M.D., F.A.C.S., Department of Surgery, Box 1263, Mount Sinai School of Medicine, One East 100th Street, New York, NY 10029-6574.

Dr. Elias has disclosed that he serves as consultant to Smith and Nephew, Inc., Andover, MA and US Surgical, Norwalk, CT and is preceptor to VNUS Medical, San Jose, CA and Diomed, Inc., Andover, MA.

branch varicosities. Traditional excision of branch varicosities utilizes either hook phlebectomy or stab avulsion, which typically involves multiple incisions (as many as 25–30) and an average operative time of 1–3 hours. TIPP, brand name TriVex™ (Transilluminated Varicose Vein Extraction), involves an average of 3.5 incisions and an operative time of 16–20 minutes (2). The TIPP technique, first developed by Chesire et al. (3), utilizes two devices, the transilluminator/irrigator and the powered resector (Fig. 1).

The transilluminator/irrigator allows the surgeon to visualize the varicosities and infuse 1st and 2nd stage tumescent anesthesia before and after resection, which aids in partial exsanguination of the veins, hemostasis, and pain relief (Fig. 2). The resector is placed immediately under or next to the varicosities in the subcutaneous tissue. The veins are then suctioned into the rotating blade, where they are cut into small pieces and removed (Fig. 3). Successful vein removal can be documented by transillumination.

This technique has been utilized since early 2000, when the initial clinical trials were completed (3). Advantages of this minimally invasive surgical technique are short operative time, minimal number of incisions, accurate removal of varicosities due to better visualization, and patient satisfaction comparable to satisfaction from traditional methods. Technical complications are associated with inexperience and tend to occur early on in the learning curve. They consist primarily of bruising, hematoma formation and fat necrosis. These complications are similar to adverse events associated with traditional excision and are minimized with experience (4).

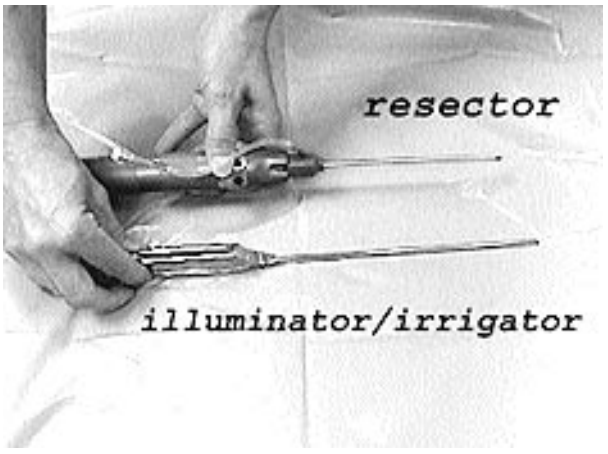

Fig. 1. TriVex™ transilluminator/irrigator and powered resector. Courtesy of Smith & Nephew, Endoscopy, Andover, MA.

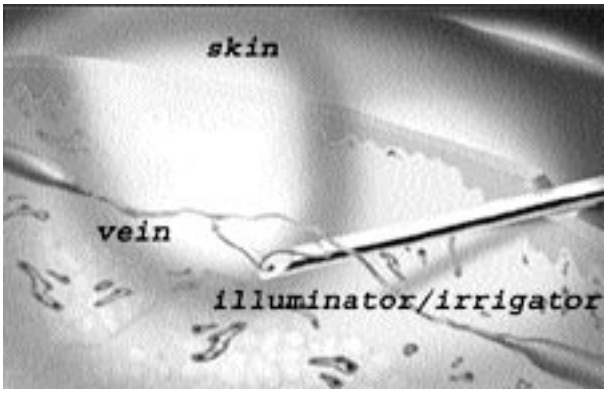

Fig. 2. Tumescent anesthesia causes hydrodissection, which aids in removal of the varicosities. Courtesy of Smith & Nephew, Endoscopy, Andover, MA.

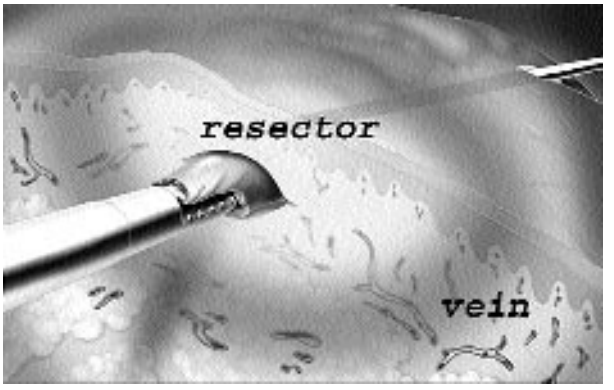

Fig. 3. TriVex™ System Resector morcellating vein. Courtesy of Smith & Nephew, Endoscopy, Andover, MA.

Radiofrequency Ablation (Closure®) and Laser Ablation (EVLT) Greater Saphenous Vein

Radiofrequency (Fig. 4) and laser ablation (Fig. 5) are endovascular approaches to saphenous vein incompetence. Traditional stripping and removal of the saphenous vein requires incision sites at the groin and knee or ankle level. The open procedure requires either general or regional anesthesia. Morbidity from traditional stripping may include hematoma, pain and saphenous neuropathy.

Endovenous ablation of the saphenous vein is performed by obtaining percutaneous access to the greater saphenous vein, most commonly at the level of the knee under duplex ultrasound guidance. A guidewire is then advanced to the saphenofemoral junction, over which the Closure® or EVLT catheter is passed (Figs. 4 and

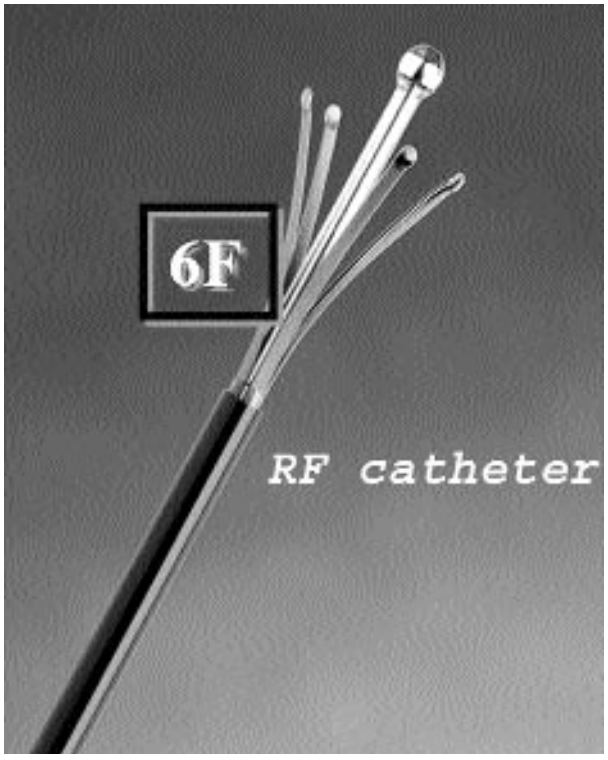

Fig 4. Radiofrequency catheter. Courtesy of VNUS Medical, Sunnyvale, CA. 6F refers to diameter of catheter.

Fig. 5. Laser (EVLT) fiber.

5). The radiofrequency or laser energy is transmitted to the vein wall, causing it to contract and close. Endovenous ablation of the saphenous vein is performed using local anesthesia and sedation. No incisions are necessary, and the patient can return to normal activity the following day. Radio-frequency technology and laser ablation have been utilized for the past 5 years and 3 years respectively. More than 90% of saphenous veins remain closed two years after the procedure. These results compare favorably with traditional procedures, with decreased morbidity and increased patient satisfaction (Fig. 6) (5, 6).

Subfascial Endoscopic Perforator Surgery

Perforator incompetence is prevalent in patients with venous stasis ulceration (more than 90% of patients have the condition) (7). Under normal conditions, blood flows from the superficial system to the deep venous system via the perforator veins. Incompetent perforator veins cause venous pressure to be reversely directed toward the skin, resulting in venous hypertension and stasis ulceration.

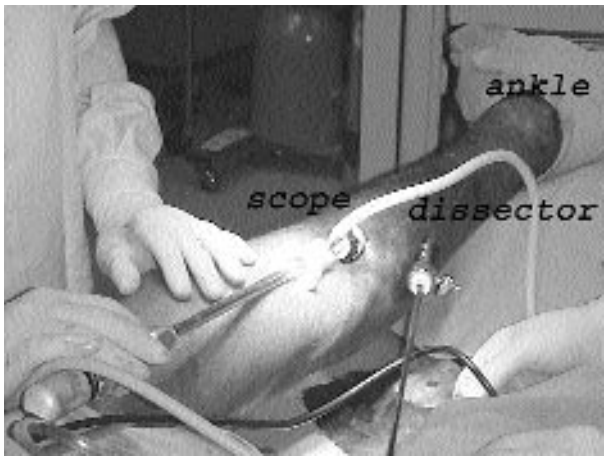

Fig. 6. Remote incision sites for endoscope and working port incision for dissection and perforator clipping.

Traditional methods of open perforator ligation (Linton's procedure) require incision to be made through edematous, infected fields within the ulcer bed. Wound dehiscence and significant postoperative pain are reported in 20–40% of patients (8). Hospital admission is usually necessary.

Subfascial Endoscopic Perforator Surgery (SEPS) is an operative technique with an endoscopic approach to incompetent perforator vein ligation. Incisions are made remote from the site of ulceration (Fig. 6), and balloon dissection is utilized to create a subfascial space using CO_2 insufflation similar to laparoscopy (Fig. 7). These two factors minimize both wound complications (by placing incision sites in healthy skin) and complaints of postoperative pain (by utilizing blunt balloon dissection). A 10 mm incision is used for placement of the endoscope and a 5 mm working port incision for dissection and perforator clipping (Fig. 8). After placing the clips, the pressure in the veins is reduced, so that healing of any ulceration is enhanced.

Postoperative pain is minimal and patients are able to continue wound care the following day. Stasis ulcer healing rates and maintenance of healing 5 years after SEPS range from 90% for patients with a normally functioning deep venous system to 75–80% for patients with deep venous insufficiency, when combined with compression therapy and wound care (9, 10). Aver-

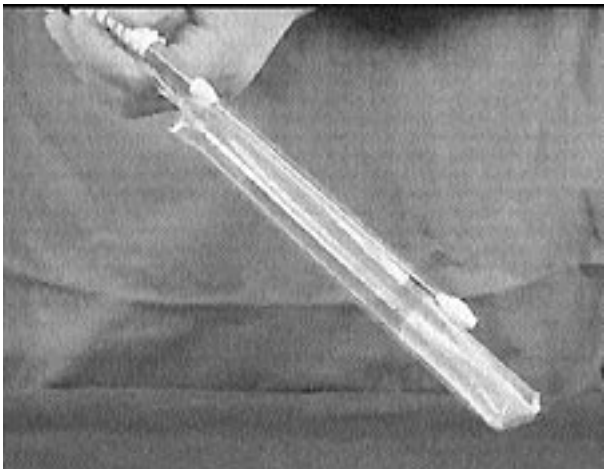

Fig. 7. Balloon dissector.

age healing time for ulceration is six weeks. As with the other minimally invasive techniques, SEPS allows direct visualization of venous pathology with significantly lower morbidity.

Percutaneous Vein Valve Bioprosthesis

A significant number of patients with venous stasis ulceration have associated deep venous insufficiency (11, 12). To date, surgeons have been hesitant to repair and improve deep venous flow hemodynamics; however, a few centers do aggressively treat deep venous incompetence. Traditional surgical methods include axillary vein valve transplant, valvuloplasty, and vein valve transposition (13). All of these methods require significant incisions and in-house recovery time.

Percutaneous Vein Valve Bioprosthesis (PVVB) is a technique used to correct valvular incompetence by utilizing a percutaneous approach to deliver a functioning vein valve to an incompetent segment of the deep venous system. The device consists of a glutaraldehyde-treated bovine jugular vein with a competent valve mounted on a nitinol stent (Fig. 9). Percutaneous access is obtained at the level of the internal jugular vein. A guidewire and introducer are advanced to the level of the femoral vein (old nomenclature, "superficial femoral"). The bovine valve is then passed along the introducer to the femoral vein at the site of valvular incompetence and deployed (Fig. 10). The technique is similar to a placement of a vena cava filter.

This procedure is now in phase 1 clinical trials to evaluate safety and efficacy. The potential benefits of this minimally invasive approach include: small remote incision, same-

Fig. 9. Bovine jugular vein mounted on nitinol stent. Courtesy of VenPro, Irvine, CA.

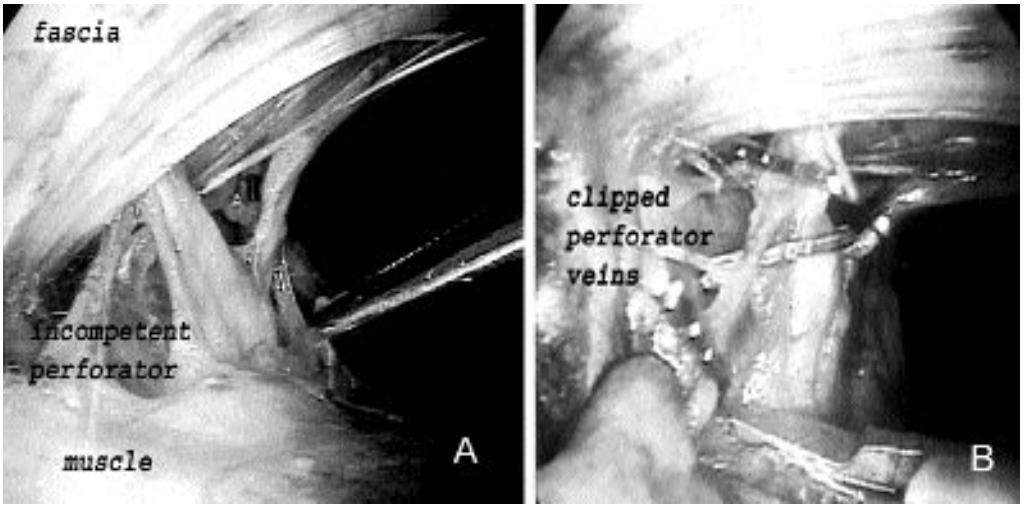

Fig. 8. (A) Endoscopic view of perforator vein prior to clipping. **(B)** After clipping.

day surgery, local anesthesia, and perhaps the ability to place multiple valves to mimic a normally functioning deep venous system.

Conclusion

The advent of minimally invasive vein surgery techniques allows the surgeon to manage venous pathophysiology associated with all three venous systems in the lower extremities. Many patients may require a combination of MIVS techniques to correct venous insufficiency and stasis changes. These techniques complement each other, and when combined, can enhance the clinical outcome. MIVS can be performed as an outpatient procedure with few, if any, small incisions. MIVS techniques, which incorporate endoscopy, transillumination, ultrasound or fluoroscopy, also make it possible for the surgeon to visualize venous pathology. From the vascular surgeon's perspective, it is reassuring to "see" the pathology. In addition, patient satisfaction is enhanced by minimal discomfort and less postoperative morbidity as compared to traditional open procedures.

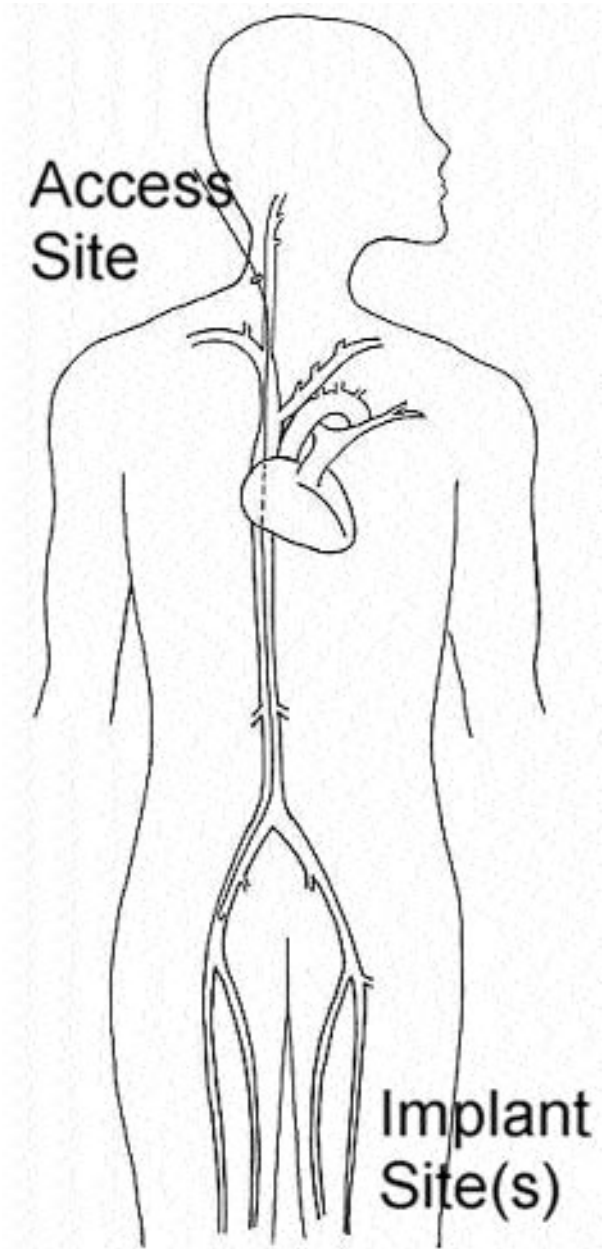

Fig. 10. Percutaneous access site and vein valve implant site(s). Courtesy of VenPro, Irvine, CA.

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