Treatment of Varicose Veins by Transilluminated Powered Phlebectomy Surgery: A 9-Year Experience

Randall W. Franz, MD, FACS, FICA, RVT¹ Jodi F. Hartman, MS² Michelle L. Wright, MPH²

¹ The Vascular and Vein Center at Grant Medical Center, Columbus, Ohio

² Orthopaedic Research & Reporting, Ltd., Gahanna, Ohio

Address for correspondence and reprint requests Randall W. Franz, MD, FACS, FICA, RVT, The Vascular and Vein Center at Grant Medical Center, 285 East State Street, Suite 260, Columbus, OH 43215 (e-mail: rfranz2@ohiohealth.com).

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Abstract

Keywords

- ▶ TriVex
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- ▶ venous surgery

Transilluminated powered phlebectomy (TIPP) is a minimally invasive technique for varicose vein removal that addresses some limitations of traditional procedures. The study objective was to analyze perioperative and follow-up outcomes after TIPP and present modifications gleaned over 9 years of performing the technique. Four hundred and thirty-one patients who underwent TIPP performed between June 2002 and April 2011 were included in this retrospective review. Descriptive statistics were used to describe demographic, treatment, and outcome data. The mean procedure time was 20.2 minutes. The majority (50.5%) of cases involved 10 to 20 incisions. No significant varicosities were reported at a follow-up of 12 weeks. Postoperative complications included 2 (0.5%) deep vein thromboses, 8 (1.9%) cellulitis episodes, 16 (3.7%) hemosiderin staining cases, 2 (0.5%) abscesses, and 2 (0.5%) cases of excessive or hypertrophic scarring. All but one patient reported good outcomes and were satisfied with the procedure. With proper training and experience, TIPP with a lower oscillation frequency and secondary tumescence results in good outcome and high patient satisfaction.

With advancements in technology and improvements in established procedures, multiple techniques for the treatment of superficial venous disease are now available. Current techniques employed include compression therapy; endovenous laser or radiofrequency ablation of saphenous and perforator veins; phlebectomy; sclerotherapy; subfascial endoscopic perforator surgery; and transilluminated powered phlebectomy (TIPP).¹ TIPP is a minimally invasive method of varicose vein removal that is an alternative to traditional ambulatory phlebectomy procedures. This technique incorporates three technologies: (1) tumescent anesthesia, which assists in defining the operative plane via hydrodissection; (2) transillumination, which facilitates direct visualization of varicosities; and (3) a powered endoscopic tissue dissector, which rapidly and efficiently resects and removes varicosities.^{2,3} Direct visualization of varicosities has the potential to reduce the risk of missed veins and incomplete vein resection,

while minimizing the number of incisions required. In theory, such advantages may reduce operative time and improve cosmesis.^{4,5} The use of tumescent anesthesia assists in reducing postoperative pain and patient morbidity, while expediting recovery.⁶ Previous clinical studies^{3,4,7–12} and a recent meta-analysis¹³ support the use of TIPP for the removal of varicose veins, especially when extensive. Perioperative and follow-up outcomes based on one surgeon's 9-year experience performing TIPP in the era of endovenous laser ablation therapy are analyzed. Insight and technique modifications gleaned over time are also provided.

Method

This study involved a retrospective review of data and received institutional review board approval. Over a 9-year period from June 2002 to April 2011, 431 patients with and

without saphenous vein incompetence underwent TIPP for the treatment of varicose veins performed by one vascular surgeon at three institutions according to a standard protocol. Indications for surgery included lower extremity pain, bleeding, heaviness, itching, superficial phlebitis, swelling, tiredness, and unsightly veins. Prior conservative treatment consisting of 30- to 40-mm Hg stocking compression for a minimum of three months or the time period designated by individual insurance companies was unsuccessful for all patients. Patients with a history of deep venous thrombosis (DVT) based on venous duplex ultrasound (US) scan or who had excessive anesthesia risk were excluded.

All patients underwent similar preoperative clinical evaluations, which included venous duplex US scanning to assess reflux and to exclude acute or chronic DVT. Saphenous reflux was defined as reverse flow for greater than 0.5 seconds. The CEAP (clinical, etiological, anatomical, and pathological factors) clinical classification was used to grade varicosities.¹⁴ Patients with Class 2 through 5 were considered candidates for surgery.

Incompetent saphenous veins were treated with conventional high ligation (first year only) or endovenous laser ablation. These adjunctive procedures typically were performed one month before TIPP. Two weeks afterward, venous duplex US scanning was performed to confirm saphenous closure and absence of DVT. Clinical examination also was performed to confirm absence of complications.

Operative Procedure

The TIPP procedure has been described in a previous report.³ All procedures were performed on an outpatient basis. To summarize, general outlining of the varicose veins is performed while the patient is standing to maximize vein dilation, with reference to the preoperative venous duplex US findings. A dose of prophylactic intravenous antibiotics also is administered. Patients were placed in the standard supine position in the first year, but subsequently were positioned in either a supine, lateral, or prone position, based on the location of the majority of varicosities.

While the patient was under general or spinal anesthesia, TIPP was performed using the endoscopic TriVex System (InaVein, Lexington, MA). Incisions followed natural Langer skin lines to obtain the most cosmetically appealing result and were placed strategically to maximize vein cluster removal within the instrumentation arc. Endoscopic instrumentation was alternated through stab incisions to further minimize the number of incisions. The irrigation-illumination device was inserted into the first stab incision and tumescent anesthesia (3 L of 0.9% normal saline solution with 150 mL of 1% lidocaine and 6 mL of 1:1,000 epinephrine) was instilled at 450 mL/min. The device then was used to transilluminate the varicose veins, including those that may not have been seen or palpated during preoperative marking.

Under this direct visualization, additional 2- to 3-mm stab incisions were created that were used for insertion of the resection device in the diameter appropriate to vein size. Varicose veins were resected by suction and morcellation using higher oscillation frequency (800 to 1,200 rpm) in the first year and lower oscillation frequency (500 rpm) thereaf-

ter. During resection, the skin was held taut to aid resection and prevent skin penetration. Additional tumescence was added as necessary to flush residual vein tissue and blood into the suction and to increase pressure along the resected vein, which provided a tamponade effect.

In the first year only, a second phase of tumescent solution was instilled after completing resection to flush blood and to fill the empty space for compression hemostasis. If required, hematoma evacuation was performed using manual compression along the vein tract. In subsequent years, dermal punch incisions using a 1.5-mm dermal punch biopsy in areas where blood pooled subcutaneously were added. After the punch incisions were created, the second phase of tumescent solution was instilled. Copious irrigation through the dermal punch incisions was performed until drainage was clear.

Stab incisions were closed with benzoin and adhesive strips. Layered compression dressing was applied from the base of the toes to high on the thigh. Patients received extensive education regarding home care and when to notify office staff regarding symptom presentation and then were discharged with a standard prescription for analgesia. Postoperatively, ACE-style wraps were used for 48 hours, followed by graduated compression stockings for 4 weeks.

Patient Population

Three hundred and twenty-four (75.2%) patients underwent one TIPP procedure involving one limb; 96 (22.3%) patients underwent bilateral TIPP procedures; and 11 (2.6%) patients underwent multiple TIPP procedures on the same or both legs. When multiple TIPP procedures were performed, all involved different areas of varicosities and were performed at separate surgical interventions. The resultant study population was 431 patients (547 TIPP cases). This group comprised of 413 (75.5%) females and 134 (24.5%) males, with a mean age of 51.0 years (median = 51.0; standard deviation = 13.3; range, 17.0 to 85.0 years).

Data were collected as part of routine documentation. Patients were monitored for postoperative complications, including DVT, discoloration of lower extremity skin, excessive or hypertrophic scarring, infection, nerve injury, persistent hematoma, residual veins, and thrombophlebitis. Follow-up evaluations were conducted 2 and 12 weeks after the TIPP procedure according to a standard protocol. Monitoring of patients who experienced procedure-related complications or other adverse events continued until resolution of the complication. Patient satisfaction was self-assessed by reporting a good or poor outcome. Procedure times and intraoperative complications were compiled from a review of operative reports. Billing reports were used to determine the number of incisions, which were reported as less than 10, 10 to 20, or more than 20. Demographics, prior adjunctive procedures for saphenous vein incompetence, postoperative complication incidence, and patient satisfaction were collected from a review of office and hospital data reports.

Statistical Analysis

Descriptive statistics, including mean, median, standard deviation, frequency, and percentage, were used to describe

Fig. 1 Transilluminated powered phlebectomy procedure time versus case volume for the consecutive series of 547 cases.

demographic, treatment, and outcome data. Statistical analyses were performed using SigmaStat software, version 2.0 (SPSS, Inc., Chicago, IL).

Results

Three hundred and fifty-five (64.9%) TIPP cases underwent TIPP only, whereas 192 (35.1%) cases were associated with saphenous vein incompetence and required an adjunctive procedure. Thirty-six (6.6%) cases underwent prior high ligation and 156 (28.5%) required endovenous laser ablation. The mean TIPP procedure time was 20.2 minutes (SD = 12.3; median = 17.0; range, 4.0 to 108.0 minutes). For most patients, TIPP procedural time was short (►Fig. 1). Distribution of total incisions was as follows: 227 (41.5%) cases with less than 10 incisions; 276 (50.5%) cases with 10 to 20 incisions; and 44 (8.0%) cases involving more than 20 incisions. In all cases, the TIPP procedure was well-tolerated and no intra-operative complications occurred.

At a 12-week follow-up, no significant varicosities were reported among the 431 patients (547 cases). Thirty postoperative complications involving 29 (6.7%) patients were reported (►Table 1). Discoloration of the lower extremity skin due to hemosiderin staining occurred in 16 (3.7%) cases. Eight (1.9%) cases of cellulitis required extensive treatment and monitoring, including antibiotic use for more than seven days. Two (0.5%) cases of DVT occurred—one involving the peroneal vein and the other affecting the posterior tibial vein. In both cases, the DVT resolved, as confirmed by duplex US scanning. Two (0.5%) abscesses developed, but resolved after incision and drainage and antibiotic treatment. Excessive or hypertrophic scarring occurred in two (0.5%) cases and corresponded to areas of extensive varicosities where large (> 5 mm in diameter) varicose vein removal was required. One (0.2%) patient with excessive scarring was unsatisfied with the outcome of the procedure. The remaining 430 patients (99.8%) patients were satisfied with TIPP and reported a good outcome.

Discussion

Over a 9-year period, 547 TIPP cases were performed. A ratio of ~2:1 of cases involving TIPP only versus those requiring a prior procedure to treat saphenous vein incompetence was observed, with endovenous laser ablation being the preferred adjunctive treatment. The majority (75%) of patients underwent one TIPP procedure. As anticipated, given the affected patient population, the procedure was performed on a 3:1 ratio of women versus men, at a mean age of 51.0 years. As more TIPP cases were performed and experience with the technique was gained, we expected a decrease in both procedure time and the stab incision distribution count, as the surgeon would become more adept with the technique itself and also would become more selective in stab incision sites. As expected, a slight decrease in procedure time was observed as TIPP case volume increased (►Fig. 1).

Overall, approximately one-half of the TIPP cases performed in this series required 10 to 20 incisions, compared with ~42% of cases involving less than 10 incisions and 8% requiring more than 20 incisions. Simpler, less complex cases were chosen early in the learning curve to allow time to master the skills needed to perform more challenging cases. As the skill and comfort levels of the technique increased, more complex cases were accepted, which typically involve more varicosities and, thus, require more stab incisions. It still should be noted, however, that throughout the study period, the selection criteria included CEAP Class 2 through 5 patients with chronic venous disease and severe varicosities (typically between 3 and 5 mm), who generally were not candidates for sclerotherapy. On the contrary, most published TIPP studies either are limited to⁴ or are comprised mainly^{2,6,7,11,12} of CEAP Class 2 or 3 patients. Another factor impacting total incision distribution is the use of punch incisions, which was incorporated after the first year to allow for more drainage. Thus, an overall trend toward using less stab incisions due to better incision site selection likely was present.

Table 1 Comparison of commonly reported complications associated with TIPP

Published study	Single surgeon series	Cases with follow-up	Saphenous vein insufficiency procedure at same surgical intervention	Complication follow-up period	Cellulitis or severe inflammation	Deep vein thrombosis	Discoloration/hyperpigmentation	Persistent hematoma	Nerve damage or injury	Residual veins	Scarring, persistent brown	Skin perforation	Thrombophlebitis	Wound
Franz et al ¹ 2011	Yes	547	No	12 wk	8 (1.9%)	2 (0.5%)	16 (3.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.5%)	0 (0.0%)	0 (0.0%)	2 (0.5%)
Akesson ⁷ 2008	Yes	19	Yes	2 wk	–	–	1 (5.3%) major; 6 (31.6%) minor	–	–	6 (31.6%) minor	–	–	1 (5.3%)	–
de Zeeuw et al ¹⁰ 2007	Yes	20 (10 before to build learning curve)	No	4 wk	–	–	4 (20%)	1 (5%)	3 (15%)	–	–	–	1 (5%)	6 (30%)
Passman et al ² 2007	No	221	Yes	4–8 wk	(3.2–7.4%)	–	–	(3.2–18.6%)	–	–	–	–	–	(3.1–4.0%)
Chetter et al ¹² 2006	Yes	29	Yes	6 wk	–	–	2 (7%)	2 (7%)	2 (7%)	–	–	–	–	–
Aremu et al ⁴ 2004	No	188	Yes	6 wk	0 (0.0%)	0 (0.0%)	–	1 (1.1%)	14 (15.9%)	8 (9.1%)	–	–	–	–
Scavee et al ⁶ 2003	No	40	Yes	6 wk	–	–	–	23 (57%)	2 (5%)	2 (5%)	–	–	11 (28%)	–
Shamiyeh et al ¹³ 2003	Yes	41	Yes	6 wk	–	–	–	2 (4.9%)	–	–	1 (2.4%)	1 (2.4%)	1 (2.4%)	–
Arumugasamy et al ⁸ 2002	No	20	Yes	6 wk	–	–	–	1 (5%)	0 (0.0%)	–	–	1 (5%)	–	0 (0%)
Cheshire et al ⁹ 2002	No	117	Yes	6 wk	4 (3%)	1 (0.9%)	–	14 (12%)	43 (37%)	–	–	–	–	–

Abbreviation: wk, weeks.

Table 2 Possible solutions for minimizing commonly encountered complications after TIPP^{9,12}

Complication	Potential causes	Possible solutions
Skin perforation	<ul style="list-style-type: none"> • Too much pressure on skin. • Skin not taut enough. • Performing resection in angled areas with loose skin. 	<ul style="list-style-type: none"> • Individualize patient positioning for optimal access to varicosities. • Hold skin taut during resection.
Nerve damage or injury	<ul style="list-style-type: none"> • Most likely caused during saphenous vein dissection instead of varicosity removal during TIPP. • In anteromedial aspect of limb, below the knee, may result from varicose vein extraction by powered phlebectomy device. 	<ul style="list-style-type: none"> • Recommend performing TIPP as separate surgical intervention. • Minimize dissection in anteromedial portion of limb near tibial ridge.
Deep vein thrombosis	<ul style="list-style-type: none"> • Insufficient movement after surgery. 	<ul style="list-style-type: none"> • Same-day ambulation for all patients. • Administer prophylactic low-molecular-weight heparin in high-risk patients.
Incomplete vein resection/thrombophlebitis	<ul style="list-style-type: none"> • Inadequate preoperative outlining of varicosities. • During resection, incomplete removal. • Excessive tumescent anesthesia in first phase stage may result in too much vasoconstriction, which may increase likelihood of missing varicosities. 	<ul style="list-style-type: none"> • Before TIPP, outline varicosities while patient is standing to maximize vein dilation. • Individualize patient positioning for optimal access to varicosities. • Hold skin taut during resection. • Monitor instillation of tumescent anesthesia. • Patients with thrombosed or fibrotic varices may require supplemental vein removal with a small clamp or hook under the skin after initial resection.
Hematoma	<ul style="list-style-type: none"> • Surgeon inexperience with technique. • Patient factors. 	<ul style="list-style-type: none"> • Use compression during and after procedure. • Individualize patient positioning. • Use lower oscillation frequency. • Use “pulsed technique” with resector to allow sufficient time for proper aspiration to prevent blood accumulation. • Include epinephrine in tumescent solution to limit blood extravasation, which may reduce hematoma incidence. • Use high-pressure infusion system for primary and secondary tumescence. • Perform secondary tumescence with extensive flushing. • Employ dermal punch incisions for additional drainage sites.
Excessive or hypertrophic scarring	<ul style="list-style-type: none"> • Resector pressed with too much force against vein and skin. • Resector pressed too often at same location. • May correspond to areas of extensive varicosities. 	<ul style="list-style-type: none"> • Ensure continuous movement of resector along vein using soft pressure.
Permanent skin discoloration	<ul style="list-style-type: none"> • Extravasation of blood, which may lead to residual skin hyperpigmentation secondary to hemosiderin staining. 	<ul style="list-style-type: none"> • Include epinephrine in tumescent solution to limit blood extravasation, which may reduce hyperpigmentation. • Employ dermal punch incisions and secondary tumescence to enable copious flushing and drainage. • Prescribe bleaching cream.
Wound infection	<ul style="list-style-type: none"> • Lack of prophylactic antibiotic. • Use of suture for closure. • Patient factors. • Environmental factors. 	<ul style="list-style-type: none"> • Administer preoperative prophylactic antibiotics. • Use adhesive strips to permit drainage. • Prescribe 1-week course of antibiotics as prophylaxis during follow-up to any patient reporting redness (redness vs. cellulitis difficult for patients to discern).

Abbreviation: TIPP, transilluminated powered phlebectomy.

From an outcomes perspective, comparison of operative time and complication incidences from the current series with those from previously published studies is difficult, as these studies typically report results based on cases in which concomitant saphenous vein insufficiency procedures and TIPP were performed during the same surgical intervention (**►Table 1**).^{2,6–9,11,12} Comparison of complication incidences also is problematical due to varying definitions used among studies. Mindful of this limitation, the most commonly reported complications associated with the use of TIPP reported in the literature are summarized in **►Table 1**. Of the 10 studies compared, five included results from multiple surgeons and the other five were single surgeon series. The case volume of the current study exceeds those of the multi-center studies, as well as those limited to single surgeon series, which involved relatively small patient populations (**►Table 1**). Low incidences of DVT (0.0 to 0.9%), persistent brown scarring (0.5 to 2.4%), and skin perforation (0.0 to 5%) were reported among the studies. The incidence of cellulitis also was relatively low (0.0 to 7.4%). A wide range of incidences was reported for the remaining complications, including discoloration, persistent hematoma, nerve damage or injury, residual veins, thrombophlebitis, and wound. Besides disparity in definitions of complications between studies, other reasons for the varying incidences include differences in timing of saphenous vein insufficiency procedures (before versus at same surgical intervention), use of first versus second generation systems, secondary tumescent methods, and case volumes. Bruising was not included in the analysis due to inconsistent reporting and the varying definitions employed when reported. However, one trend based on the experience from this series and as noted from the review of the literature is that some minor bruising should be expected following TIPP. When reported, such bruising typically resolves within the cited follow-up period^{2,4,10} and is part of the natural healing process after the procedure. Strategies for minimizing complications after TIPP are itemized in **►Table 2**.

A major difference between the management philosophy for varicose vein removal used in this series and many described in the literature is that procedures for concomitant saphenous vein incompetence are performed in a staged fashion, when needed, before and at a separate surgical intervention than TIPP.³ Of the 10 studies compared in **►Table 1**, only one other study did not involve cases in which saphenous vein insufficiency procedures were performed at the same surgical intervention as TIPP.¹⁰ This particular study was a small randomized trial that assessed the use of TIPP under tumescent anesthesia for the treatment of tributary varicose veins and, therefore, excluded patients with reflux of the saphenofemoral junction or greater saphenous vein.¹⁰ The strategy of staging TIPP for secondary varicosities until after saphenous vein incompetence treatment allows time for many varicosities to diminish or resolve, which reduces the number of varicosities requiring resection during TIPP.^{11,15,16} Any complications that may arise after the saphenous vein incompetence procedure also may be managed before performing TIPP. Therefore, performing the sa-

phenous vein insufficiency procedure during the same surgical intervention as TIPP may inflate incidences of nerve damage, hematoma, pain, and residual varicose veins. Over the years, this approach of performing saphenous vein incompetence procedures before TIPP at a separate surgical intervention has gained widespread acceptance and now is commonly employed in the vascular community. This protocol has had a major impact on minimizing the complication incidence of the current series. Furthermore, this series presents an accurate portrayal of complications directly associated with TIPP, as the complications reported cannot be attributed to adjunctive procedures, which is not the case for the majority of previous studies.^{2,4,6–9,11,12}

Inherent biases involved with retrospective studies, including lack of a control group, are the main weaknesses of this study. Standardized clinical assessment and patient satisfaction surveys would be beneficial in comparing results with those from other studies, but were not components of the routine evaluation system used. Because procedures were performed at three different institutions, there also were limitations in the types of variables available and the manner in which they were reported. However, despite performing TIPP at multiple institutions, standardized protocols were followed. The study's main strengths are the standardized protocol performed by one surgeon and the large volume of cases. In addition, because the TIPP procedures were performed without an adjunctive procedure during the same surgical intervention, this study provides an accurate portrayal of complications directly associated with TIPP, and therefore, may be used to shape surgeon and patient expectations after the procedure.

Conclusions

This review of 547 cases performed by one surgeon over a 9-year period is beneficial in analyzing the outcomes and complications associated with TIPP. When required, addressing incompetent saphenous veins at a separate surgical intervention before TIPP minimizes complications. Therefore, performing endovenous ablation one month before TIPP is highly recommended to allow time to manage any complications that may arise and for many varicosities to diminish or resolve. At a follow-up of 12 weeks, all (99.8%) patients aside from one with excessive scarring, were satisfied with the procedure and reported a good outcome. With proper training and experience, utilization of TIPP with a lower oscillation frequency and secondary tumescence results in good outcome and high patient satisfaction.

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