Surgical technique and preliminary results of endoscopic subfascial division of perforating veins

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Purpose: Direct surgical ligation of incompetent perforating veins has been reported to effectively treat severe chronic venous insufficiency. It is associated, however, with significant wound complications. We evaluate our early experience with endoscopic subfascial division of the perforating veins.

Methods: From August 5, 1993, to December 31, 1994, 11 legs in nine patients (five male and four female) were treated with endoscopic subfascial division of perforating veins. Nine of the 11 legs had active or recently healed venous ulcers. Mean duration of the ulcerations was 5.6 years. Standard laparoscopic equipment with two 10-mm ports was used to perform clipping and division of medial perforating veins through two small incisions made just below the knee, avoiding the area of ulcer and lipodermatosclerosis. Carbon dioxide was insufflated at a pressure of 30 mm Hg into the subfascial space to facilitate dissection, and a pneumatic thigh tourniquet was used to obtain a bloodless operating field. Concomitant removal of superficial veins was performed in eight limbs. Mean follow-up was 9.7 months (range, 2 to 13 months).

Results: A mean of 4.4 perforating veins (range, 2 to 7) were divided; tourniquet time averaged 58 minutes (range, 30 to 72). Wound infection of a groin incision and superficial thrombophlebitis were early complications; each occurred in one patient. In seven legs the ulcer healed or did not recur and symptoms resolved. In three legs the ulceration improved, and in one it was unchanged.

Conclusions: Endoscopic subfascial division of perforating veins seems to be a safe technique, with favorable early results obtained in a small number of patients. This preliminary experience supports further clinical trials to evaluate this technique. (J VASC SURG 1996;23:517-23.)

Leg ulcers caused by chronic venous insufficiency remain a therapeutic dilemma. To decrease reflux of blood from the deep calf veins into the superficial veins and avoid transmission of the high ambulatory venous pressure, Linton[1] devised an operation to interrupt the incompetent perforating veins. Although healing of venous ulcers after ligation of the perforating veins has been reported, the original procedure as described by Linton seldom is performed today. The main reasons this technique was abandoned were frequent wound complications and the need for prolonged hospitalization because of the long skin incision necessary to ligate the perforators. Other researchers have developed alternate procedures that use shorter skin incisions and avoid incisions in the area of stasis dermatitis and underlying lipodermatosclerosis.[2-4] Edwards[5] recommended that a shearing instrument be passed blindly in the subfascial plane to interrupt the perforating veins.

Hauer[6] introduced the endoscopic technique for division of perforating veins in 1985. His work was soon followed by other investigators in Europe,[7-10] who used different types of endoscope or mediastinoscope to perform the surgery with direct vision through a single incision made in the proximal calf. The use of laparoscopic instruments was described by O'Donnell,[11] who infused saline solution beneath the fascia to facilitate the visualization and dissection of the subfascial plane. In Australia, Conrad[12] began

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Table I. Clinical data and results of 11 endoscopic divisions of perforating veins in 9 patients

Patient no.	*Age*	*Gender*	*Leg*	*History**	*Duration of ulcer (years)*	*No. of perforators interrupted*	*Ancillary procedure†*
1	49	F	Right	VV	5	4	S & A
2	60	F	Left	VV	5	4	S & A
3	59	F	Right	DVT, VV, STP	3	2	S & A
			Left	DVT, VV, STP	—	3	HL & A
4	46	M	Right	DVT, PCD	9	5	—
5	29	F	Right	DVT, VV	—	4	A
6	64	M	Right	DVT, VV	2	7	S & A
7	39	M	Right	DVT	10	7	—
			Left	DVT	10	2	—
8	41	F	Right	VV	4	6	S & A
9	33	M	Left	VV, INC	5	4	S & A

**DVT*, deep venous thrombosis, *VV*, venous varicosities; *STP*, superficial thrombophlebitis; *PCD*, protein C deficiency.
†Procedures performed simultaneously with endoscopic perforator vein ligation: *S*, stripping of greater saphenous vein; *A*, avulsion of superficial varicosities; *HL*, high ligation of previously stripped saphenous vein.
‡*E*, Excellent, ulcers healed and pain resolved; *I*, improved, persistent ulceration but smaller and easier to manage with improved symptoms; *U*, unchanged.
§*CEAP*, clinical, etiologic, anatomic, and pathophysiologic classification, as described in Porter JM, Moneta G, and An International Consensus Committee on Chronic Venous Disease, J VASC SURG 1995;21:635-45.

using carbon-dioxide insufflation in 1993 and published a report on his first seven patients in 1994. Independently of his work, we performed our first endoscopic video-controlled division of the perforating veins with carbon-dioxide insufflation on August 5, 1993. In our technique we exsanguinated the leg with a pneumatic thigh tourniquet to facilitate dissection. We summarize preliminary results with our endoscopic technique performed in 11 legs.

PATIENTS AND METHODS

Patients. From August 5, 1993, to December 31, 1994, 11 legs in nine patients were treated with endoscopic division of the perforating veins. During the same period the senior author (PG) performed 77 operations in 60 patients for leg varicosity. The conventional technique for subfascial perforator ligation was not used during this period. Of the nine patients who underwent endoscopic division of perforators, five were male and four were female; the mean patient age was 46.6 years (range, 29 to 64 years). Patients with lipodermatosclerosis or active or healed venous ulcers were considered for this procedure. Patients with surgical complications and those taking Coumadin (DuPont Pharmaceuticals; Wilmington, Del.) for recent deep venous thrombosis were excluded from the study. Patients with infected ulcers received local wound care to treat the infection before surgery.

Leg ulcers were present at surgery or shortly before in 9 of 11 legs. The mean duration of the ulcers was 5.6 years. All patients received medical care for at least 2 months before surgery. This care included bed rest, frequent leg elevation or decrease of daily ambulation, local care of the ulcer, and enforcement of elastic compression of the leg in the form of graduated firm compression elastic stockings. The clinical data of the patients who underwent surgery are detailed in Table I. Preoperative evaluation of the patients included strain gauge and outflow plethysmography to exclude obstruction and confirm deep venous or perforator incompetence. Duplex scanning of the venous system of the leg was used to confirm incompetence and to rule out obstruction of the deep veins. All 11 limbs were studied with ascending and descending venography to define venous anatomy, to confirm occlusion or valvular incompetence of the deep veins, and to identify incompetent perforators. In this study, ascending venography was used in every case to detect incompetent perforating veins. The use of a grid placed on the X-ray film was helpful in determining the exact distance of the perforating vein from the ankle.

Surgical technique. After the induction of general or epidural anesthesia, the affected leg and the groin are prepared and draped in a sterile fashion. The operating table is placed in a 10-degree Trendelenburg position. The pneumatic tourniquet is placed on

Follow-up (months)	*Outcome‡*	*Preoperative CEAP grade§*	*Postoperative clinical class*
13	E	$C_{6\text{-}S}$, E_P, $A_{S,D,P}$, P_R	$C_{0\text{-}5\text{-}A}$
13	E	$C_{6\text{-}S}$, E_P, $A_{S,D,P}$, P_R	$C_{0\text{-}5\text{-}A}$
12	E	$C_{5\text{-}S}$, E_S, $A_{S,D,P}$, P_R	$C_{5\text{-}A}$
11	I	$C_{4\text{-}S}$, E_S, $A_{S,D,P}$, P_R	$C_{4\text{-}S}$
12	U	$C_{6\text{-}S}$, E_S, $A_{S,D,P}$, $P_{R,0}$	$C_{6\text{-}S}$
10	E	$C_{3\text{-}S}$, E_S, $A_{S,D,P}$, P_R	$C_{0\text{-}A}$
10	E	$C_{6\text{-}S}$, E_S, $A_{S,D,P}$, P_R	$C_{5\text{-}A}$
8	I	$C_{6\text{-}S}$, E_S, $A_{S,D,P}$, $P_{R,0}$	$C_{6\text{-}S}$
8	I	$C_{6\text{-}S}$, E_S, $A_{S,D,P}$, $P_{R,0}$	$C_{6\text{-}S}$
2	E	$C_{6\text{-}S}$, E_P, $A_{S,D,P}$, P_R	$C_{5\text{-}A}$
8	E	$C_{6\text{-}S}$, E_P, $A_{S,D,P}$, P_R	$C_{5\text{-}A}$

the proximal third of the thigh, and the leg is exsanguinated with an Esmarch bandage. The tourniquet then is inflated to 300 mm Hg and is continuously monitored during surgery with a pressure gauge. The time of the inflation is also monitored.

Two 15-mm longitudinal incisions are made about 5 cm apart in the medial aspect of the calf 8 to 10 cm distal to the level of the tibial tuberosity. The first incision is placed 3 cm below the medial edge of the tibia. This incision is carried through the subcutaneous tissue under direct vision. Any varicose vein identified in this area is excised; the saphenous nerve, if encountered, is carefully preserved. With the assistance of small retractors the subcutaneous fascia is exposed and incised. The first 10-mm laparoscopic port is inserted beneath the fascia, placing a blunt obturator through its lumen to facilitate passage (Fig. 1). Once the port is beneath the fascia, carbon dioxide is insufflated to achieve a pressure of 30 mm Hg; pressure is continuously monitored during the procedure. A straight-lens 10-mm camera is inserted to visually confirm proper positioning. Should the port be misplaced, emphysema in the subcutaneous tissue would be apparent, and the camera would visualize the subcutaneous fatty tissue.

After the camera is positioned properly, the second 10-mm laparoscopic port is placed under direct vision through the second skin incision (Fig. 2). This port is inserted over a trocar introducer, which can be visualized by the camera when it enters the subfascial space. The loose connective tissue that bridges the space between the muscle and the fascia can be bluntly dissected under videoscopic control with forceps or a grasper (Fig. 3). Perforating veins are easily visualized as larger structures bridging the gap between the muscle and the fascia. Because the leg was exsanguinated, the veins have a whitish appearance. Some perforator veins are accompanied by fine nerves or small arteries, which are preserved unless they prevent full exploration of the subfascial space; in these cases they are also divided or included in the clips. After the veins are isolated, a 10-mm stapling device is used to clip the vein in two areas, between which the vessel is divided with endoscopic scissors (Fig. 4). Dissection proceeds medially down to the edge of the tibia, laterally to the posterior midline, and distally to the level of the ankle. The most significant perforating veins are the Cockett perforators, which connect the posterior arch vein with the posterior tibial veins. Exploring the area close to the tibia and, if necessary, incising the paratibial fascia reveals the paratibial perforators, which, as emphasized by Bergan, should also be divided. Eventually the entire area between the medial malleolus and the laparoscopic port insertion site can be visualized, and all perforating veins can be interrupted (Fig. 5).

After the procedure is complete, the instruments and ports are removed and the tourniquet is released. In patients with incompetent greater or lesser saphenous veins, stripping is performed. The incision used for the first port can be used to introduce the stripper into the greater saphenous vein. Stab avulsion of the varicose tributaries is then performed in the usual fashion. At the completion of the procedure the skin incisions that were used to insert the laparoscopic ports are closed with interrupted 2-0 Vicryl sutures (Ethicon Endo-Surgery; Cincinnati, Ohio) for the subcutaneous tissue and interrupted 4-0 subcuticular Vicryl sutures for the skin. The leg is wrapped with an elastic bandage. After surgery the legs are elevated to 30 degrees; ambulation to the bathroom is permitted after 3 hours. After overnight observation, patients are usually discharged within 24 hours of surgery. They are instructed to use elastic bandages for a period of 10 days to 2 weeks and to use firm compression (30 to 40 mm Hg) graduated elastic stockings afterwards. Patients with active open ulcers also are instructed in the proper care thereof.

RESULTS

The number of incompetent medial perforators identified on the preoperative venograms averaged 5.1 per venogram (range, 3 to 10). During surgery a mean 4.4 perforating veins were divided in the 11 legs (range, 2 to 7). Tourniquet time averaged 57.6 minutes (range, 45 to 72 minutes). In three legs, the endoscopic procedure alone was performed. In six

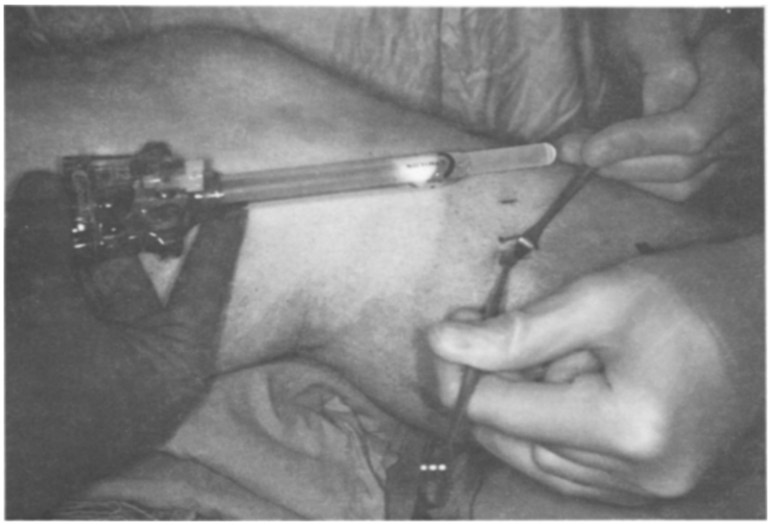

Fig. 1. 10-mm laparoscopic port is placed with help of blunt obturator into subfascial space. Note the small skin incision to permit air seal around port.

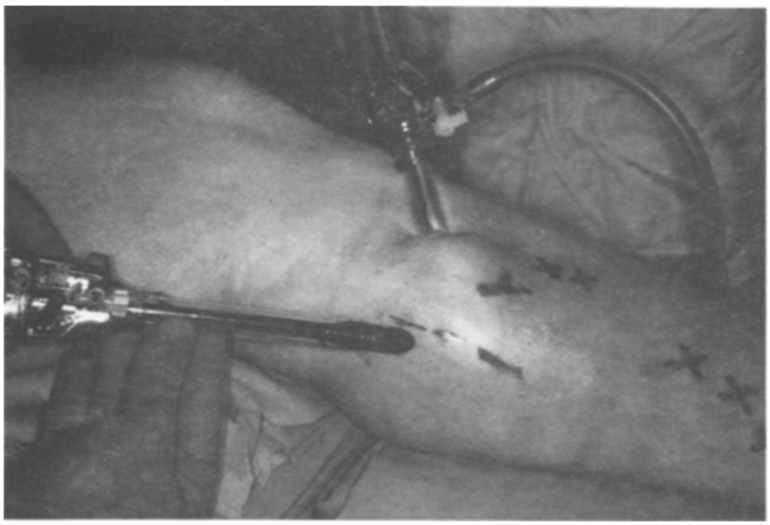

Fig. 2. Carbon dioxide is insufflated through first port, and placement of second port is performed under video control.

legs, stripping of the greater (five patients) or lesser (one patient) saphenous vein and avulsion of the varicose veins were performed in addition to division of the perforators. In two legs, avulsion of varicose veins without stripping was performed with perforator division (Table I). One patient had a superficial wound infection at the site of the high ligation of the saphenous vein at the groin. No wound complications at the site of the port insertions were present. One patient had superficial thrombophlebitis in residual varicose veins in the medial aspect of the knee. In seven legs, the ulcers either healed or did not recur, and symptoms of pain and heaviness in the leg resolved or decreased significantly. In three legs, improvement in the size of the ulcers or in symptoms has been achieved. One leg was ranked as unchanged after surgery. Despite a decrease in the size of the ulcer, the patient's symptoms did not improve. The patient, a 46-year-old man with protein C deficiency, had a history of multiple deep venous thrombosis. He had tenderness at the medial aspect of the knee. A postoperative duplex scan excluded acute deep venous thrombosis but showed thrombus in some superficial medial veins just proximal to the port

Fig. 3. Clipping and division of perforators is performed with laparoscopic instruments through second port; first port is used for video control.

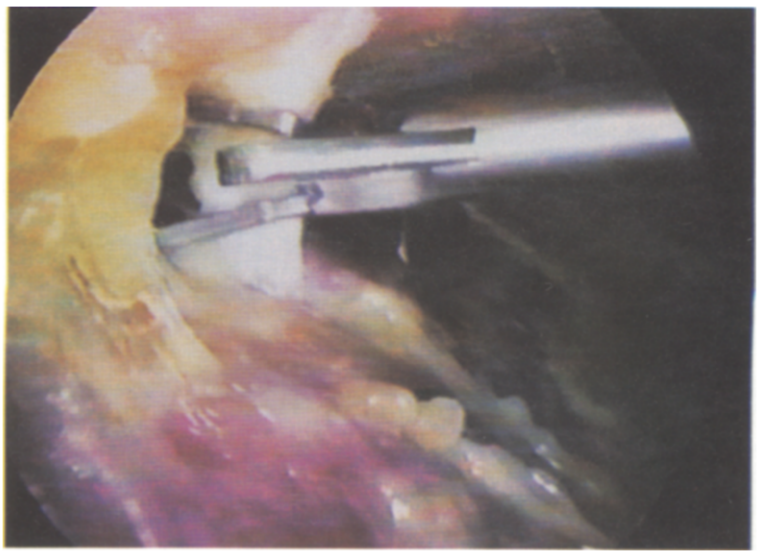

Fig. 4. Division of a high Cockett perforator with endoscopic scissors after placement of vascular clips.

insertion sites, confirming superficial thrombophlebitis. The patient had a recurrent deep venous thrombosis 2 months after surgery.

DISCUSSION

Chronic venous insufficiency afflicts 3% to 4% of our population, and 10% of these patients ultimately have venous ulcerations.[13] Incompetence of the perforating veins plays an important role in venous hypertension and stasis changes of the skin and subcutaneous tissue of the leg. Although physical examination suggests the location of incompetent perforating veins in many patients, using the double tourniquet tests or identifying fascial defects in the Linton line, imaging of incompetent perforators is required to confirm the diagnosis and map their location. We found ascending venograms to be useful for this purpose, as have others.[11]

Because the number of perforators identified during surgery was slightly less than the number seen on the venogram, it is possible that venography cannot always distinguish between perforators penetrating the fascia and horizontal veins connecting superficial varicosities. Another possibility is that

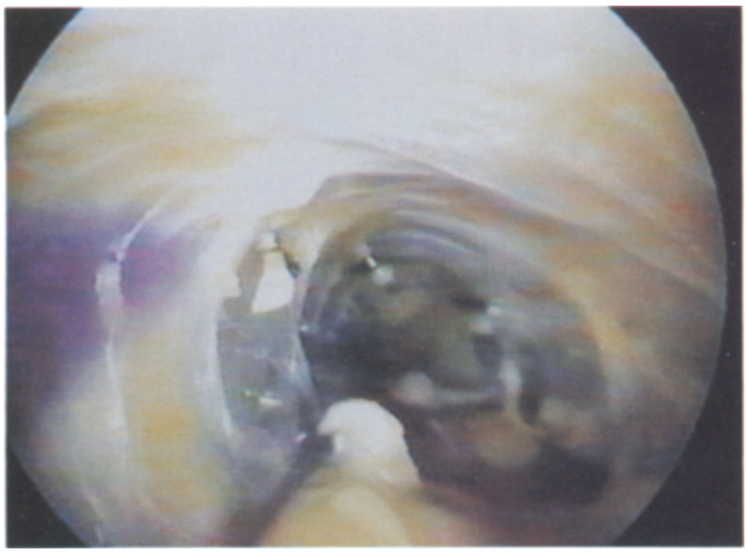

Fig. 5. Full view of subfascial space after clipping and division of all medial perforating veins.

some of the paratibial perforators were missed early in our experience. Since the completion of this study, however, we have used color duplex scanning in most of our patients for preoperative evaluation and mapping. Optimal preoperative evaluation of these patients are likely to include routine use of color duplex scanning to confirm the diagnosis of perforator incompetence, map their location, and define the extent of valvular incompetence or obstruction of the superficial and deep veins of the leg. Ascending and descending venography will be used selectively. The benefit of plethysmographic evaluation of venous function or the use of direct venous pressure measurement in these patients is not well defined.

Interruption of incompetent perforators has been demonstrated to be effective in healing ulcers and decreasing symptoms. Wilkenson and Maclaren[3] reported excellent or good long-term results in 80% of patients treated with subfascial or subcutaneous ligation of perforating veins. With a modified Linton procedure, Cikrit et al.[4] observed complete healing in 81% of legs during a 4-year observation period; however, they also reported an 18% perioperative complication rate and a 22% ulcer recurrence rate. Wound complications of incisions performed in areas where the skin is significantly diseased are frequent. The advantage of endoscopic techniques is not only that incisions can be performed in an area remote from the diseased skin, but also that all perforating veins from the insertion site of the port down to the level of the ankle can be interrupted.

The advantage of the single port technique, used by Hauer,[6] is that it does not require an expensive setup of laparoscopic equipment and video monitoring. The disadvantage is that a single port used both for visual control and instrumentation is less than ideal. The visual field of the surgeon in the subfascial plane is significantly smaller than in techniques in which insufflation is not used. Laparoscopic instruments and video equipment are available in most hospitals, and our technique, with approved instrumentation, does not require any additional investment.

Our preliminary results with the insufflation technique with laparoscopic instruments and the use of a tourniquet still have a short follow-up period, but they are in accordance with the experience of others who performed endoscopic division of perforating veins with other techniques. In one large series available, Jugenheimer and Junginger[8] reported on subfascial division of perforators performed in 103 limbs with a single-port endoscope. Changes in most of the limbs were limited to swelling or dermatitis. In 17 legs that had ulcers, healing was observed in 16. The mean number of veins that were ligated in their series was four, which is similar to our experience. In a series of 10 patients reported by Couto and Baptista,[7] two patients required direct ligation of perforators through separate small incisions after the veins were identified through a rigid scope.

Our preliminary results with subfascial division of perforating veins using laparoscopic instrumentation, carbon dioxide insufflation, and exsanguination of the limb with a thigh tourniquet appear favorable. Exsan-

guination makes dissection easier and prevents insufflation of carbon dioxide into the venous circulation through injured veins. We have used tourniquets for several hundred arterial bypass procedures without complications, and the tourniquet technique has been used in the our institution for orthopedic procedures in thousands of patients with minimal or no complications. One patient in our study had deep venous thrombosis 2 months after surgery. Although the postoperative duplex scan in this patient excluded deep venous thrombosis, it appears prudent not to use a tourniquet in patients with recent deep venous thrombosis or in patients known to have underlying thrombotic disorders who are treated with Coumadin. Potential limitations of the endoscopic technique include the inability to reach the first Cockett perforator behind the malleolus in some patients. A further limitation is that the severe lipodermatosclerosis may resist optimal expansion of the subfascial space in the distal calf. The valvular competence of the perforators cannot be assessed with endoscopy. For this reason all subfascial perforating veins are interrupted during surgery. Interruption of the paratibial perforators may require an incision of the paratibial fascia.

CONCLUSION

Endoscopic subfascial division of the perforating veins appears to be a useful and safe procedure. It should be studied in a multicenter, prospective, randomized trial to assess its benefit compared with best medical management for patients with severe forms of lipodermatosclerosis or healed or active venous stasis ulcers.

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