How often is deep venous reflux eliminated after saphenous vein ablation?

Alessandra Puggioni, MD,[a] Fedor Lurie, MD, PhD,[a,b] Robert L. Kistner, MD,[a,b] and **Bo Eklof, MD, PhD,[a,b]** *Honolulu, Hawaii*

Background and Purpose: **Deep venous reflux resolution after great saphenous vein surgery has been reported, but the studies evaluated mainly patients with deep segmental reflux. We prospectively analyzed the effects of greater saphenous vein ablation on coexisting primary deep axial venous reflux compared with segmental venous reflux.**

Patients and Methods: **Between February 1997 and June 2001, patients with primary deep venous reflux scheduled for greater saphenous vein surgery were included in the study. Limbs of patients with a history of deep venous thrombosis, thrombophlebitis, trauma, and orthopedic or venous surgery were excluded. After surgery, duplex scanning was repeated and patients were examined for persistent deep venous reflux.**

Results: **Thirty-three patients (38 limbs) were followed up with duplex scanning. Follow-up ranged from 2 weeks to 38 months. Preoperative axial deep reflux was present in 17 extremities, and segmental reflux was present in 21. The total number of incompetent segments was 59. Overall reflux abolishment rate was similar in extremities with axial and segmental reflux (30% vs 36%; $P > .05$). When segments were analyzed individually, abolishment of superficial femoral vein reflux was observed more often in extremities with segmental reflux than those with axial reflux (odds ratio, 4). In the extremities where deep reflux was not abolished with greater saphenous vein ablation, degree of reflux did not change significantly ($P > .1$). Duplex scanning was performed more than once during follow-up in 9 patients. In 3 of these patients reflux resolved by the second follow-up evaluation, and in 2 reflux was decreased at the second and third follow-up evaluations.**

Conclusion: **In patients with concomitant deep and superficial venous reflux, saphenous vein ablation results in resolution of deep reflux in about a third of patients. Superficial femoral vein reflux is seldom corrected in limbs with axial reflux compared with those limbs with segmental reflux. To appreciate the effects of greater saphenous vein ablation, longer follow-up may be needed. (J Vasc Surg 2003;38:517-21.)**

Deep venous reflux resolution after greater saphenous vein (GVS) surgery was reported by Walsh et al[1] in 1993 and by Sales et al[2] in 1995. These authors achieved successful correction of deep venous insufficiency after greater saphenous vein ablation in more than 90% of patients. They hypothesized that the presence of superficial venous incompetence might cause overflow into the deep system through the perforator vessels and cause dilatation and then incompetence of the valves of the deep veins ("overload theory"). Reports of clinical results of greater saphenous vein surgery in the presence of deep reflux are not consistent. While Scriven et al[3] reported poor outcome after saphenous vein surgery when deep venous reflux was present, Shami et al[4] and Padberg et al[5] found clinical improvement after saphenectomy in patients with ulcers and combined superficial and deep reflux. However, in the latter paper[5] deep reflux was reported to resolve in only 3 of 24 segments (12.5%).

From the Department of Research,[a] Straub Foundation Honolulu, Hawaii, and the Department of Surgery,[b] University of Hawaii, John A. Burns School of Medicine.

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Reprint requests: Fedor Lurie, MD, PhD, Straub Foundation, 1100 Ward Ave, Ste 1045, Honolulu, HI 96814-1617 (e-mail: tedlurie@yahoo.com).

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Deep axial reflux is defined as reflux present in both the superficial femoral vein and popliteal vein or the deep femoral vein and popliteal vein when those are connected. Although the influence of deep axial reflux on severity of chronic venous disease has been outlined by several authors,[3,6,7] most patients in the series of Walsh et al[1] and Sales et al[2] had segmental deep reflux. Our prospective study was designed to evaluate the effects of greater saphenous vein ablation on coexisting primary deep axial or segmental venous reflux.

METHODS

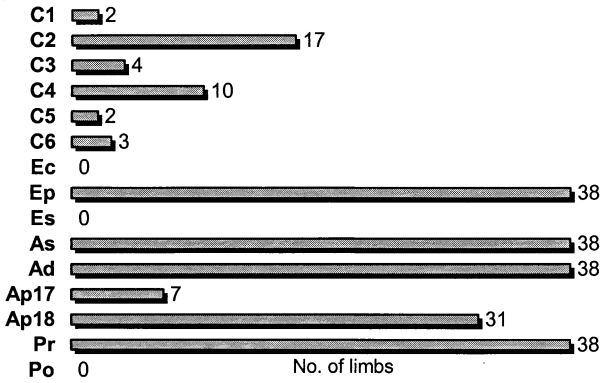
Patients with coexisting greater saphenous vein reflux and deep reflux scheduled to undergo saphenous vein surgery between February 1997 and June 2001 were included in the study. Limbs with lesser saphenous vein reflux, history of trauma, or previous orthopedic or venous surgeries were excluded. In addition, patients with a history suggestive for deep venous thrombosis (DVT) or with deep vein wall thickening or distortion on duplex scans were excluded. Thirty-eight limbs in 33 patients were available for follow-up duplex ultrasound (US) scanning and were studied. On the basis of clinical presentation, limbs were graded from C1 to C6, according to the CEAP classification.[8]

Duplex US scanning was performed before surgery and at follow-up between 2 weeks and 22 months (average, 5.7 ± 6.2 months). In 9 patients, multiple duplex US scans were obtained, up to 38 months after surgery. These pa-

Table I. Anatomic distribution of incompetent valve reflux at preoperative Doppler US scanning in 38 limbs

Location of reflux	*No. of limbs*
SFV only	19
DFV only	1
PV only	0
SFV and PFV	1
SFV and PV*	14
DFV and PV*	0
SFV, DFV, and PV*	3
Total	38

SFV, Superficial femoral vein; *DFV,* deep femoral vein; *PV,* popliteal vein.
*Axial reflux.



CEAP classification of 38 limbs with superficial and deep reflux before surgery.

tients underwent follow-up duplex US scanning more than once because they had been enrolled in a different study, ie, radiofrequency ablation of the greater saphenous vein. An ATL HDI 300 (Advanced Technology Laboratories, Bothel, Wash) or a Logiq 700 (GE Medical Systems, Milwaukee, Wis) scanner was used. The greater saphenous vein, perforating veins, common femoral vein, superficial femoral vein, deep femoral vein, and popliteal vein were studied. The tibial veins were not routinely evaluated for reflux because duplex scanning of the posterior tibial veins produces inconsistencies and a low yield of reflux in symptomatic limbs.[9] Patients were evaluated in the standing position, and the non-weight-bearing extremity was examined. All tests were performed by two technologists between 9:00 AM and noon. Because the incidence of valves in the common femoral vein is not more than 80%,[10] and because the significance of reflux in this segment is unclear, data for the common femoral vein were not included in our analysis. Peak velocity and duration of reflux were recorded during the Valsalva maneuver and with manual compression and decompression. Reflux was defined as retrograde flow lasting for more than 0.5 seconds, and was classified as grade 1 (0.5-1 seconds), grade 2 (1-2 seconds), grade 3 (2-3 seconds), or grade 4 (>3 seconds). Peak velocity was classified as class 1 (<10 cm/s), class 2 (10-20 cm/s), class 3 (20-30 cm/s), or class 4 (>30 cm/s).

Greater saphenous vein high ligation and stripping or endovascular closure from the groin to the knee and stab avulsion phlebectomy was combined in all patients. Ten limbs underwent stripping, and 28 underwent radiofrequency ablation of the greater saphenous vein. The endovascular closure encompassed the greater saphenous vein from below the first tributary visible on intraoperative duplex scans[11] distal to the saphenofemoral junction. Perforator ligation was performed in 14 limbs (11 calf, 3 thigh), and sclerotherapy was performed in 8 limbs (7 calf, 1 thigh). Deep axial reflux was defined as reflux present in both the superficial femoral vein and popliteal vein or the deep femoral vein and popliteal vein when those were connected. After surgery, compression bandages were applied and worn by the patient for 1 week.

Although previous studies demonstrated that duplex US scans are reproducible,[12,13] reproducibility can be low when tests are repeated over substantial time intervals.[14] Therefore significant change in reflux time was arbitrarily defined as decrease or increase of 2 seconds or longer, whereas significant change in the velocity of reflux was defined as decrease or increase of 20 cm/s or longer.

For statistical analysis we used the χ^2 test, Fisher exact test, and odds ratio, when appropriate. $P < .05$ was considered significant.

RESULTS

The study included 38 extremities in 33 patients (17 women, 16 men; mean age, 55 ± 15 years) with a combination of superficial and deep venous reflux. Before surgery reflux was distributed as follows: superficial femoral vein, 37 limbs; deep femoral vein, 5 limbs; and popliteal vein, 17 limbs. Segmental deep reflux was present in 21 extremities, and axial deep reflux in 17 extremities; total number of incompetent segments was 59. Table I shows the location of deep reflux on preoperative duplex US scans of 38 limbs. Peak velocity and duration of reflux in each segment are shown in detail in Table II. Presence of incompetent calf perforator vessels before surgery was detected in 31 limbs, and incompetent thigh perforator vessels were found in 7 limbs. According to the CEAP classification, 2 limbs had C_1 disease, 17 had C_2 disease, 4 had C_3 disease, 10 had C_4 disease, 2 had C_5 disease, and 3 had C_6 disease (Figure).

Of the 37 limbs with incompetent superficial femoral vein before surgery, 9 limbs demonstrated no superficial femoral vein reflux after greater saphenous vein ablation. Deep femoral vein reflux was eliminated in 3 of 5 cases, and popliteal vein reflux was eliminated in 7 of 17 cases. On the first postoperative duplex US scans, complete disappearance of reflux was noted in all segments in 2 of 17 limbs (12%) with axial reflux before surgery. In the remaining 15 limbs, 10 (59%) had persistent axial reflux and 5 (29%) demonstrated improvement, with change from axial to segmental reflux due to popliteal vein reflux disappearance. After greater saphenous vein stripping, deep reflux was eliminated in 57% of segments (8 of 14), and after endovascular closure it was eliminated in 29% of segments (13 of

Table II. Preoperative peak velocity and duration of reflux in individual segments

	Peak velocity					*Duration*				
	Class					*Grade*				
Site of reflux on duplex scan	*0 (0)*	*1 (<10 cm/s)*	*2 (10-20 cm/s)*	*3 (20-30 cm/s)*	*4 (≥30 cm/s)*	*0 (<0.5 s)*	*1 (0.5-1 s)*	*2 (1-2 s)*	*3 (2-3 s)*	*4 (>3 s)*
SFV	1	21	10	3	3	1	3	9	2	23
DFV	33	3	2	0	0	33	2	2	0	1
PV	22	12	5	0	0	21	0	6	1	10

SFV, Superficial femoral vein; *DFV,* deep femoral vein; *PV,* popliteal vein.

Table III. Comparison of preoperative and postoperative reflux among segments in 17 extremities with preoperative axial reflux

	Preoperative reflux	*Postoperative reflux*	*Elimination rate**	
			%	*n*
Segments				
SFV	17	15	12	2/17
DFV	3	1	67	2/3
PV	17	10	41	7/17
Total	37	26	30	11/37
Limbs				—
SFV and PV†	14	12	14	2/14
DFV and PV†	0	—	—	—
SFV, DFV, and PV†	3	3	0	0/3
Total	17	15	12	2/17

SFV, Superficial femoral vein; *DFV,* deep femoral vein; *PV,* popliteal vein.
*Observed at first follow-up duplex scanning.
†Axial reflux.

Table IV. Comparison between preoperative and postoperative reflux among segments in extremities with preoperative segmental reflux

	Preoperative reflux	*Postoperative reflux*	*Elimination rate**	
			%	*n*
SFV	20	13	35	7/20
DFV	2	1	50	1/2
PV	0	0	—	—
Total	22	14	36	8/22

SFV, Superficial femoral vein; *DFV,* deep femoral vein; *PV,* popliteal vein.
*Observed at first follow-up duplex scanning.

45) ($P = .35$). Of the 21 limbs with preoperative segmental reflux, there was complete resolution in 7 limbs (33%), reflux remained unchanged in 13 limbs (62%), and reflux was eliminated in 1 of 2 segments in 1 limb (5%). In extremities with axial reflux the rate of reflux resolution in the 37 incompetent segments was 30% (11 of 37; Table III), and in the extremities with segmental reflux it was 36% (8 of 22; $P > .5$; Table IV). Total reflux resolution rate was similar between extremities with axial reflux and segmental reflux ($P > .05$). Resolution of superficial femoral vein reflux was four times more likely in extremities with segmental reflux (odds ratio, 4). However, because of small sample size, we did not reach the level of statistical significance (95% confidence interval, 0.7-22.9). In the extremities in which deep reflux was not eliminated with saphenous vein ablation, the degree of reflux among segments did not change significantly (Tables V and VI).

Table V. Significant change in peak reflux velocity among segments in limbs without deep reflux elimination

	Peak reflux velocity		
	Decreased	*Unchanged*	*Increased*
SFV	3	17	1
DFV	0	2	0
PV	0	9	0

Change in reflux velocity defined as decrease or increase of ≥20 cm/s.
SFV, Superficial femoral vein; *DFV,* deep femoral vein; *PV,* popliteal vein.

Table VI. Significant change in reflux time among segments in limbs without deep reflux elimination

	Reflux time		
	Decreased	*Unchanged*	*Increased*
SFV	2	17	2
DFV	0	2	0
PV	0	6	3

Change in reflux time defined as decrease or increase of ≥2 seconds.
SFV, Superficial femoral vein; *DFV,* deep femoral vein; *PV,* popliteal vein.

Nine patients were followed-up with duplex scanning more than once after surgery (Table VII). In 4 patients reflux was still present after surgery but disappeared during follow-up: in 3 patients superficial femoral vein reflux disappeared by 3, 9, and 13 months after surgery, respectively, and in 1 patient popliteal vein reflux resolved by 3 months after surgery. In 2 limbs reflux persisted after surgery, but reflux velocity decreased significantly by the second follow-up in 1 patient, and reflux time decreased by the third follow-up in the other patient. Compared with the first follow-up, successive examinations did not reveal a significant increase in reflux velocity or time in any of the studied segments.

Table VII. Significant change in reflux velocity and time among segments in 9 limbs with more than one follow-up

	Second follow-up (mean, 8 mo)			*Third follow-up (mean, 13 mo)*		
	Decreased	*Eliminated*	*Increased*	*Decreased*	*Eliminated*	*Increased*
Velocity						
SFV	0	2	0	0	1	0
PV	0	1	0	0	0	0
Time						
SFV	1	2	0	0	1	0
PV	0	1	0	1	0	0

Change in reflux velocity defined as decrease or increase of ≥20 cm/s; change in reflux time defined as decrease or increase of ≥ 2 seconds.
SFV, Superficial femoral vein; *PV,* popliteal vein.

Fourteen limbs had preoperative incompetent popliteal vein and calf perforator vessels. Perforator vessels were treated successfully with surgery in 11 limbs, and in 4 of those popliteal reflux was eliminated. In 3 of these limbs perforator vessels were not treated, and in 2 of these popliteal vein reflux resolved after surgery. In 4 limbs with segmental reflux in the superficial femoral vein, preoperative duplex scans revealed the presence of thigh perforator vessels. In 1 of these patients perforator vessels were not treated, and superficial femoral vein reflux persisted after surgery. Superficial femoral vein reflux persisted in 2 of 3 limbs in which perforator vessels were treated.

DISCUSSION

This study evaluated the effects of greater saphenous vein ablation in patients with coexisting superficial and deep venous reflux. Walsh et al[1] and Sales et al[2] found that deep venous reflux was eliminated with saphenectomy in 27 of 29 limbs (93%) and 16 of 17 limbs (94%), respectively. In our study 9 of 38 limbs (24%) demonstrated complete resolution of deep venous reflux (19 of 59 segments, 32%). Our data are in agreement with those of Ting et al,[15] who evaluated 102 limbs with mixed superficial and deep reflux before and after saphenous ablation and found that superficial femoral vein reflux disappeared in about 28% of segments and popliteal vein reflux was eliminated in 28% of segments.

Our data are also in agreement with those of Padberg et al,[5] who observed complete disappearance of deep venous reflux in only 3 of 11 limbs (27%) after saphenectomy. With the advent of duplex scanning, several authors reported the presence of common femoral vein reflux in limbs with superficial vein incompetence as a usual finding.[16,17] The common femoral vein valve is estimated to be present in about 80% of the population.[10] In absence of a common femoral vein valve, reflux might be secondary to a reverse flow originating from the saphenofemoral junction. In this case the registered reflux is not due to true deep valve incompetence, and elimination of reflux after greater saphenous vein stripping is expected. For these reasons we elected to exclude the common femoral vein segment from our analysis.

The only deep reflux persistence after saphenectomy reported by Sales et al[2] occurred when combined femoral vein and popliteal vein reflux was present. In our series, superficial femoral vein was four times less likely to become competent in extremities with axial reflux compared with extremities with segmental reflux. However, this difference was not statistically significant, because of small sample size. Padberg et al[5] and Ting et al[15] found a statistically significant reduction in deep reflux at postoperative air plethysmography, as measured by venous filling index, mean ejection fraction, and mean residual volume. We found no statistically significant improvement in reflux velocity and time in most patients with persistent deep venous reflux after surgery (Tables V and VI).

Subsequent follow-up in our study showed that hemodynamic changes, including complete disappearance of reflux, might still occur several months after surgery. However, it must be taken in account that with current duplex scanning techniques reflux measurement reproducibility decreases when tests are repeated over significant time intervals.[14] We attempted to increase the accuracy of detecting an increase or decrease in reflux by arbitrarily defining as significant a change in reflux velocity of 20 cm/s and in time of 2 seconds. The possibility that many of the changes we observed might reflect limitations in reproducing duplex measurements of reflux must be considered.

The role of deep venous reflux in the pathogenesis of varicose veins of the lower extremities is unclear. In a study by Almgren et al[17] in 1989, incidence of deep venous insufficiency in patients with recurrent or residual varicose veins was as high as 42.9%. In the same study they found that after age 60 years, 42% of the patients with varicose veins had deep venous reflux, compared with 19% of patients younger than 29 years.

The relationship between superficial and deep venous reflux, and why deep venous reflux is sometimes resolved after greater saphenous stripping needs further investigation. Several authors[1,2] have tried to explain this phenomenon with the overload theory. According to this theory, in venous disease there is overflow through perforator vessels from the superficial to the deep system, which causes distention of deep veins and eventually deep valve incompetence. This does not explain why the deep system should be "overloaded" in the absence of venous obstruction, because blood can flow freely from the deep veins.

The presence of an incompetent perforator vein proximal to a competent deep venous valve might be responsible for the interpretation of reverse flow on duplex scans as deep valvular incompetence. Interruption of flow through this perforator vessel will lead to elimination of reverse flow in the deep system.

In our series, after greater saphenous vein ablation, deep reflux disappeared only in 24% of limbs and reflux time and velocity did not significantly improve.

While most hemodynamic changes in the deep system occurred by the first follow-up evaluation, in a few cases deep reflux was not resolved until months after surgery. This observation has not been made in previous studies in which follow-up was short. Future research is needed to determine the long-term effects of saphenous vein ablation on the deep system and the clinical significance of this phenomenon.

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