» **Original Article** «

Thrombosis of the Saphenous Vein Stump after Varicose Vein Surgery

Hiroto Rikimaru, MD, PhD

We evaluated thrombus extension in the proximal stump of the saphenous vein at 6 days, 4 weeks, and 16 weeks after saphenous vein surgery performed between July 2013 and March 2014 (18 patients, 29 limbs, and 31 stumps) using duplex ultrasonography. All thrombotic events were classified as endovenous heat-induced thrombosis (EHIT). Thrombus was observed in 27 stumps (87.1%), with only four (12.9%) stumps remaining without thrombus on postoperative day 6. Thrombus as EHIT class 2 was observed in one stump and as EHIT class 3 in another; in the remaining 25 stumps, it was observed as EHIT class 1 postoperatively. No further extension of thrombus was found at 4 and 16 weeks after surgery. The rate of thrombus formation in the proximal stump of the saphenous vein after conventional surgery is comparatively higher than that after thermoablation techniques. Further studies are required to determine adequate evaluation methods and appropriate therapies for stump thrombosis after varicose vein surgery. (This article is a translation of *J Jpn Coll Angiol* 2015; 55: 105–110).

Keywords: saphenous vein surgery, saphenous vein stump, endovenous heat-induced thrombosis, varicose vein, deep vein thrombosis

Introduction

Although the proximal stumps of the saphenous vein are not routinely observed using duplex ultrasonography after varicose vein surgery, there have been reports of thrombus formation in the stump^{1,2)} with progression into the deep veins or causing pulmonary thromboembolism.^{3,4)} The present study aimed to investigate the frequency and extent of thrombus formation in the stump of the saphenous vein after varicose vein surgery.

Department of Vascular Surgery, Tome City Hospital, Tome, Miyagi, Japan

Received: May 10, 2016; Accepted: June 2, 2016
Corresponding author: Hiroto Rikimaru, MD, PhD. Department of Surgery, Soma General Hospital, 142 Tsubogasaku-Niinumata, Soma, Fukushima 976-0011, Japan
Tel: +81-244-36-5101, Fax: +81-244-36-5819
E-mail: rkvsurg@gmail.com
This article is a translation of *J Jpn Coll Angiol* 2015; 55: 105–110.

Materials and Methods

Using duplex ultrasonography, we examined the saphenous vein stump for the presence of intraluminal thrombus in 43 limbs of 29 consecutive patients at 6 days, 4 weeks, and 16 weeks after varicose vein surgery at our hospital. Fourteen limbs of 11 patients were excluded because of the lack of attendance on any scheduled date and 29 limbs of 18 patients were examined on all the anticipated dates. Each thrombus was classified according to the classification for endovenous heat-induced thrombosis (EHIT).^{5,6)} In the present study, thrombus formed in the stump without protrusion into the deep vein was determined as class 1 regardless of the form or size of the thrombus. The length of each saphenous vein stump was also measured. All examinations and measurements were performed by the author alone. Patients with great saphenous vein (GSV) incompetence underwent partial stripping of the GSV using the InvisiGrip™ vein stripper (Le Maitre Vascular, USA) under spinal anesthesia. The proximal end of the saphenous vein was divided and double-ligated, including a single transfixing suture approximately at the branch of the superficial epigastric vein after all branches of saphenofemoral junction had been divided. Patients with small saphenous vein (SSV) incompetence underwent high ligation of the SSV under local anesthesia. The proximal end of the saphenous vein was divided and double-ligated, including a single transfixing suture, approximately at the ascending branch or as proximal as possible after every proximal branch, if any, was divided. All surgical wounds were closed by subcuticular suturing. Patients with bilateral varicose veins underwent surgical operation for both limbs simultaneously. Treatment for concomitant SSV and GSV incompetence was performed under spinal anesthesia at the same time. Patients that received spinal anesthesia recovered after bed rest with elevation of the lower limbs until they were allowed to walk the morning after surgery. Patients operated under local anesthesia were allowed to walk immediately after surgery. Compression therapy using elastic bandages (above-knee for GSV surgery and below-knee for SSV surgery) was performed in all patients immediately after surgery until the following morning, with elastic stocking provided for 3 weeks thereafter. Student's

Table 1 Patients' background

Age	62.1 ± 11.5	
Sex		
Male	4	(6 limbs, 6 veins)
Female	14	(23 limbs, 25 veins)
Vein		
GSV	23	
SSV	8	
Side		
Rt	14	
Lt	15	
Anesthesia		
Spinal	14	
Local	4	
CEAP classification		
C2	8	
C3	13	
C4a	7	
C5	1	

GSV: great saphenous vein; SSV: small saphenous vein;
CEAP: clinical-etiology-anatomy-pathophysiology

t-test was used for all statistical analyses. P-values of <0.05 were considered statistically significant.

Results

The demographics of patients included in this study are presented in **Table 1**. A total of six limbs in four males and 23 limbs in 14 females were identified, with a mean age of the patients being 62.1 years ±11.5 years. The total number of stumps included in the final study analysis was 23 GSV stumps and eight SSV stumps as two limbs had both GSV and SSV incompetency at the same time and were treated simultaneously. Fourteen limbs were right-sided and 15 limbs were left-sided. According to the Clinical-Etiology-Anatomy-Pathophysiology (CEAP) classification, eight limbs were grade C2, 13 were grade C3, seven were grade C4a, and one was grade C5. Surgery was performed under spinal anesthesia in 14 cases and under local anesthesia in four cases. No case of simultaneous venous thrombosis was identified by duplex ultrasonography prior to surgery. No patient included in the present study had a history of deep venous thrombosis or pulmonary thromboembolism. No patient received medications associated with increased risk of thrombotic events, such as hormone therapy. Evaluations for thrombophilia were not performed except in a patient who developed thrombus as EHIT class 3 in the saphenous stump.

The classifications of each thrombus on every examination date are presented in **Table 2**. A representative duplex ultrasonography image of the stump thrombosis for each class using EHIT classification is shown in **Fig. 1**. Thrombi

Table 2 Classification of thrombus

Thrombus classification	6 days after operation	4 weeks after operation	16 weeks after operation
Overall			
None	4	4	3
EHIT class 1	25	26	28
Class 2	1	1	0
Class 3	1	0	0
Class 4	0	0	0
GSV			
None	3	3	3
EHIT class 1	20	20	20
Class 2	0	0	0
Class 3	0	0	0
Class 4	0	0	0
SSV			
None	1	1	0
EHIT class 1	5	6	8
Class 2	1	1	0
Class 3	1	0	0
Class 4	0	0	0

EHIT: endovenous heat-induced thrombosis; GSV: Great saphenous vein; SSV: Small saphenous vein

as EHIT class 1 or greater were identified in 27 (87.1%) of all 31 stumps under examination, with only four stumps (12.9%) found to have no evidence of thrombus at 6 days postoperatively.

Thrombus as EHIT class 1 was identified in 20 (87.0%) of 23 great saphenous vein stumps, with no evidence of thrombus at 6 days postoperatively observed in three GSV stumps (13.0%). No progression of any thrombus as EHIT class 1 was observed in GSV stumps at 4 weeks or 16 weeks postoperatively. No subsequent thrombus formation was identified in GSV stumps without thrombus.

Thrombus as EHIT class 1 was identified in 5 (67.5%) of eight small saphenous vein stumps, with no evidence of thrombus at 6 days postoperatively observed in one SSV stump (12.5%). Thrombi as EHIT class 2 and 3 were observed in each one SSV stump. No progression of any thrombus as EHIT class 1 in SSV stumps was observed at either 4 weeks or 16 weeks postoperatively. No subsequent thrombus formation was identified in SSV stumps without thrombus at 4 weeks postoperatively, but thrombus as EHIT class 1 was observed at 16 weeks postoperatively.

In a patient with thrombus as EHIT class 3 at 6 days postoperatively, anticoagulation therapy using warfarin was performed for 3 months with compression therapy using elastic stockings continued for 12 weeks after surgery. The thrombus reduced as EHIT class 2 at 4 weeks postoperatively and as EHIT class 1 at 16 weeks postoperatively. Antithrombin III level, anti-cardiolipin beta-2-glycoprotein-1 antibody level, protein C activity, and protein S activity were all within the normal range. Enhanced computed

Fig. 1 (A) Saphenous stump without thrombus. (B) Class 1: Saphenous stump with thrombus not extending into deep vein. (C) Class 2: Saphenous stump thrombosis with extension into deep vein of a cross sectional area of less than 50%. (D) Class 3: Saphenous stump thrombosis with non-occlusive extension into deep vein of a cross sectional area of more than 50%.

tomography did not show pulmonary thromboembolism in this patient.

In a patient with the thrombus as EHIT class 2 at 6 days postoperatively, compression therapy was continued for 4 weeks after surgery without anticoagulation therapy. The thrombus reduced as EHIT class 1 at 4 weeks postoperatively, with no further progression observed at 16 weeks postoperatively. Examination for thrombophilia and pulmonary thromboembolism was not performed as consent could not be obtained from the patient. No respiratory symptom indicating pulmonary thromboembolism was observed.

The mean lengths of the GSV and SSV stumps were $1.26 \text{ cm} \pm 0.28 \text{ cm}$ and $2.06 \text{ cm} \pm 1.25 \text{ cm}$, respectively. No varicose change was observed in any saphenous stump. The mean lengths of SSV stumps with class 2 and class 3 EHIT were 3.35 cm and 1.18 cm, respectively. The mean lengths of the 27 stumps with thrombosis and 4 stumps without thrombosis at 6 days postoperatively were $1.46 \text{ cm} \pm 0.70 \text{ cm}$ and

$1.50 \text{ cm} \pm 1.13 \text{ cm}$, respectively, with no statistically significant difference observed ($P = 0.919$).

Discussion

The number of patients treated with endovenous ablation therapy for varicose veins is increasing in Japan due to the recent provision on public insurance.⁷⁻⁹⁾ Accordingly, the incidence of EHIT, one of the complications of catheter ablation therapy, has increased. EHIT is defined as thrombosis formation in the proximal end of the saphenous vein after catheter ablation therapy, and is classified into classes 1–4 according to the extent of the thrombus.^{5,6)} Duplex ultrasonography is considered mandatory after catheter ablation therapy to screen for occlusion of ablated vessels and complications such as deep venous thrombosis, with the incidence of EHIT reportedly ranging from 0% to 15.5%.^{7,10)}

On the other hand, the proximal stump of the saphenous vein after operative surgery (stripping, high ligation) is not routinely visualized by duplex ultrasonography unless thrombotic complications due to thrombus extending into the deep venous system or causing pulmonary thromboembolism after surgery is suspected.^{3,4)}

In the present study, thrombosis classified as greater than EHIT class 1 was observed in 27 (87.1%) out of 31 all stumps, with only four stumps (12.9%) found to have no evidence of thrombus. This result may indicate a higher frequency of thrombosis in the saphenous vein stumps after conventional high ligation compared with catheter ablation therapy; however, the sample size is too small to lead the conclusion.

The reasons underlying the higher frequency of thrombosis in the saphenous stump after surgery observed in the present study are unclear. In the majority of cases with catheter ablation therapy, the blood flow of the superficial gastric vein was preserved. On the other hand, in the conventional surgery, all branches of the saphenofemoral junction (SFJ) were ligated and divided during the surgery. As the result, the proximal stump of the saphenous vein was always completely blind, potentially leading to an increased frequency of thrombosis in the proximal stump of saphenous vein after surgery.

Thrombus as EHIT class 2 or class 3 was identified in two stumps (6.5%) of two patients (11.1%), indicating that patients are at increased risk of pulmonary thromboembolism postoperatively despite no cases of this disease being observed in the present study.

Labropoulos et al. reportedly observed thrombosis in the saphenous vein stump in 15 (15.3%) of the 98 patients with thrombotic symptoms out of a total of 2235 patients who underwent GSV harvesting for coronary bypass surgery. Two cases (2.7%) of thrombosis in the saphenous vein stump were also observed out of 75 randomly selected cases in which patients underwent high ligation or stripping of the GSV for saphenous vein incompetency.²⁾ Their results are in good agreement with the frequency of EHIT reported by previous studies and greatly differ from the results of the present study. The reasons for this marked difference are unclear. The criteria for EHIT and thrombus in the GSV stump may influence study results, particularly for class 1 thrombus. For example, one of the previous studies excluded thrombus completely filling in the stump from the criteria of EHIT class 1, contrary to the definition of this study.¹⁾ The present study included 14 patients who received spinal anesthesia and were immobilized in bed for approximately half a day. This may also have contributed to the increased frequency of thrombosis observed in the present study; however, this result could not be conclusively verified as comparison was not possible due to the presence of thrombus as EHIT class 1 in the GSV stump of

all patients with unilateral vein incompetency (seven cases; five cases under spinal anesthesia and two cases under local anesthesia).

No progression or further thrombus formation in the saphenous stump was observed during the observation period, except for one patient without thrombus at 4 weeks postoperatively who formed thrombus as EHIT class 1 at 16 weeks postoperatively. The majority of thrombus as EHIT class 1 (25 stumps, 80.1%) observed at 6 days postoperatively demonstrated no thrombus extension at 16 weeks without any therapeutic procedure except compression therapy using elastic stockings for only 3 weeks. The stump thrombosis as EHIT class 1 may not be clinically important as organization of the thrombus may proceed over time, thereby decreasing the risk of pulmonary thromboembolism.

Conversely, progression of thrombus and causation of pulmonary thromboembolism has been reported in cases of the stump thrombosis as EHIT class 2 or greater.^{3,4)} Examination using duplex ultrasonography to identify thrombus formation and provide appropriate therapy may be necessary during the early postoperative period. Further studies may be required to determine the necessity of such examinations in all patients following surgery and determine the validity of selecting therapies according to the extent of thrombus.

The treatment for the patients with stump thrombosis as EHIT class 2 and 3 in the present study was equivalent to the therapy for EHIT,^{1,6)} and no thrombus extension or symptomatic pulmonary thromboembolism was observed in the treatment outcomes. Although direct or indirect thermal degeneration and steam bubble injury of the endothelium have been posited as causes of EHIT,¹¹⁾ the mechanisms responsible for thrombosis in the saphenous vein stump postoperatively, obviously without heat injury, may differ from that of EHIT. Therefore, further investigations may be required to determine the appropriateness of current treatments for EHIT in the management of postoperative stump thrombosis.

The mean lengths of the proximal GSV and SSV stumps in the present study were $1.26 \text{ cm} \pm 0.26 \text{ cm}$ and $2.06 \text{ cm} \pm 1.25 \text{ cm}$, respectively, indicating that neither stumps had "complete" flush ligation and thereby leaving a cul-de-sac cavity capable of forming thrombus. Although Mozes et al. reported that flush ligation to avoid propagation of thrombus can be easily accomplished with open surgery,¹²⁾ GSV stumps in the present study were divided at a point slightly distant to "complete" flush ligation because "complete" flush ligation can result in stenosis of the proximal femoral vein. To prevent proximal femoral vein stenosis, side clamping of the femoral vein and suturing of the GSV stump may be required in all patients despite the impracticalities of consequent wound extension and prolongation of surgical

duration. Furthermore, no thrombus formed in the GSV stump in the present study protruded into the deep vein. Therefore, the ligation level of GSV in this study was considered appropriate.

The appropriate level for flush ligation of the small saphenous vein is controversial due to the potential for consequent nerve injury.^{4,13)} The validity of the ligation level for SSV performed in the present study may be questionable as the thrombus as EHIT class 2 and 3 observed in the present study were both formed in the SSV stumps. As the lengths of the stumps in which the thrombus as EHIT class 2 and class 3 formed were 3.35 cm and 1.18 cm, respectively, the length of the stump in which the class 3 EHIT formed was relatively short. We observed no significant statistical difference between the lengths of the 27 stumps that formed thrombus and the four stumps without thrombus at 6 days postoperatively. Further, the relationship between stump length and thrombus extent was unclear. The risk of venous thromboembolism reportedly increases after SSV surgery.¹⁴⁾ Further studies are required to determine the most appropriate level of SSV ligation.

Conclusion

We evaluated the extension of thrombus formed in the proximal stump of the saphenous vein after saphenous vein surgery in 18 patients (29 limbs, 31 stumps). We observed a higher rate of thrombus formation in the proximal stump of saphenous vein after conventional surgery compared with that after thermoablation techniques. Further studies are required to determine adequate evaluation methods and appropriate therapies for stump thrombosis after varicose vein surgery.

Acknowledgment

I am deeply grateful to Dr. Masayuki Hirokawa (Ochanomizu Vascular and Vein Clinic) and Dr. Hitoshi Goto (Tohoku University) for their advices and comments.

Disclosure Statement

The author has no conflict of interest to disclose.

References

- 1) Hirokawa M. Textbook of Endovenous Laser Ablation, Nihon-Iji-Shinposha Co. Ltd., Tokyo, 2011, p. 90. (in Japanese)
- 2) Labropoulos N, Bishawi M, Gasparis A, et al. Great saphenous vein stump thrombosis after harvesting for coronary artery bypass graft surgery. *Phlebology* 2014; **29**: 215-9.
- 3) Sakata M, Wakita N, Matsumoto R, et al. Massive acute pulmonary embolism after venous ligations for varicose veins. *Jpn J Phlebol* 2003; **14**: 297-301. (in Japanese)
- 4) Origuchi N. How to treat small saphenous varicose veins? *Jpn J Phlebol* 2011; **22**: 299-304. (in Japanese)
- 5) Kabnick LS, Ombrelino M, Agis H, et al. Endovenous heat induced thrombosis (EHIT) following endovenous vein obliteration: to treat or not to treat? A new thrombotic classification. 18th Annual Meeting American Venous Forum. February 23 2006, Miami Florida.
- 6) Hirokawa M. Endovenous heat-induced thrombus (EHIT). *Thrombosis* 2013; **8**: 62-4.
- 7) Hirokawa M, Kurihara N. Standard procedure for endovenous laser ablation with 980 nm diode laser. *Jpn J Vasc Surg* 2012; **21**: 583-8. (in Japanese)
- 8) Kurihara N, Hirokawa M. Endovascular laser ablation using 1470 nm diode laser and radial 2ring fiber. *Jpn J Phlebol* 2015; **26**: 34-40. (in Japanese)
- 9) Sugiyama S, Miyabe Y, Inaki Y. The clinical results of endovascular radiofrequency ablation of incompetent great saphenous vein: six months follow up. *Jpn J Phlebol* 2014; **25**: 291-6. (in Japanese)
- 10) Marsh P, Price BA, Holdstock J, et al. Deep vein thrombosis (DVT) after venous thermoablation techniques: rates of endovenous heat-induced thrombosis (EHIT) and classical DVT after radiofrequency and endovenous laser ablation in a single centre. *Eur J Vasc Endovasc Surg* 2010; **40**: 521-7.
- 11) Hingorani AP, Ascher E, Markevich N, et al. Deep venous thrombosis after radiofrequency ablation of greater saphenous vein: a word of caution. *J Vasc Surg* 2004; **40**: 500-4.
- 12) Mozes G, Kalra M, Carmo M, et al. Extension of saphenous thrombus into the femoral vein: a potential complication of new endovenous ablation techniques. *J Vasc Surg* 2005; **41**: 130-5.
- 13) Winterborn RJ, Campbell WB, Heather BP, et al. The management of short saphenous varicose veins: a survey of the members of the vascular surgical society of Great Britain and Ireland. *Eur J Vasc Endovasc Surg* 2004; **28**: 400-3.
- 14) Sutton PA, El-Dhuwaib Y, El-Dhuwaib Y, et al. The incidence of post operative venous thromboembolism in patients undergoing varicose vein surgery recorded in Hospital Episode Statistics. *Ann R Coll Surg Engl* 2012; **94**: 481-3.