

# Venous thromboembolism complications after endovenous laser ablation for varicose veins and role of duplex ultrasound scan



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## ABSTRACT

**Objective:** A nationwide survey was conducted in Japan to determine the incidence of venous thromboembolism (VTE) after endovenous thermal ablation for varicose veins and to investigate its pathogenic background.

**Methods:** The survey targeted all cases of endovenous thermal ablation between January 2011 and December 2013. Based on this survey, a retrospective study of patients who developed endovenous heat-induced thrombosis (EHIT) of classes 2 to 4, no EHIT-related deep venous thrombosis (DVT), and pulmonary embolism (PE) was conducted. Lower extremity venous ultrasound was performed within 72 hours and at 1 to 3 months postoperatively in all institutions. We investigated factors associated with the occurrence of complications and the usefulness of postoperative ultrasound.

**Results:** Survey responses were collected from 213 institutions. Endovenous laser ablation was performed for 43,203 patients (EHIT 2 in 318 patients, EHIT 3 in 50 patients, EHIT 4 in 7 patients, other DVTs in 24 patients, and PE in 3 patients). The incidence of VTE complications was 1.0% for EHIT 2, 0.11% for EHIT 3, 0.013% for EHIT 4, 0.063% for other DVTs, and 0.0067% for PE based on the adjusted population. Sex, age, obesity, origin of the varicose vein, vein diameter, and preoperative Caprini score were not strong indicators of VTE complications. Of 50 patients with EHIT 3, there were 35 patients who had EHIT 3 during the first postoperative ultrasound session. In one patient, EHIT 3 progressed to EHIT 4 despite initiation of anticoagulant therapy. Of seven patients with EHIT 4, only one patient had EHIT 4 at the first postoperative ultrasound examination. Because ultrasound performed before the occurrence of EHIT 4 revealed that three patients had EHIT 2 or EHIT 3, EHIT 4 could have possibly been predicted by ultrasound. Of three patients with PE, two developed PE before ultrasound, and EHIT was not detected by ultrasound in one of those patients before PE developed. Anticoagulant therapy was administered in most patients with EHIT 3 and all patients with EHIT 4 and PE, with favorable outcomes.

**Conclusions:** The incidence of VTE complications after endovenous laser ablation was low. Furthermore, the value of performing postoperative ultrasound for VTE management seems to be low because the occurrence of severe VTE complications could not be predicted by lower extremity venous ultrasound. Although the perioperative detection of VTE complications by this modality resulted in the early administration of anticoagulant therapy and may have contributed to improved prognosis, the number of those patients was limited. (*J Vasc Surg: Venous and Lym Dis* 2019;7:817-23.)

**Keywords:** Varicose vein; Endovenous laser ablation; Venous thromboembolism; Duplex ultrasound scan

Endovenous thermal ablation (EVTA) for varicose veins has been performed in the United States and European countries for approximately 20 years. In Japan, the Japanese Society of Phlebology issued guidelines for the endovascular repair of varicose veins in 2010,<sup>1</sup> and 980-nm laser devices were approved for reimbursement under the national health insurance system in 2011. EVTA

is considered the first-choice procedure for the treatment of varicose veins.

However, EVTA has also been associated with concern for the risk of venous thromboembolism (VTE) caused by a thrombus extending into a deep vein. Regarding postoperative VTE complications, Kabnick et al<sup>2</sup> first reported the concept of endovenous heat-induced

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thrombosis (EHIT) in 2005. EHIT is classified into four classes (EHIT 1-4) according to the degree of protrusion of a thrombus into the femoral vein. Although earlier reports showed a high incidence of EHIT (16%),<sup>3</sup> later reports have indicated that the incidence of thrombotic complications has decreased to <1%.<sup>4</sup> Furthermore, Lawrence et al,<sup>5</sup> who classified EHIT into six stages, reported that a thrombus extended into the femoral vein at a frequency of 2.6% and that when patients with EHIT were treated with anticoagulant therapy, deep venous thrombosis (DVT) did not occur. In addition, the incidence of pulmonary embolism (PE) is reportedly 0.03%.<sup>6</sup> Rosales-Velderrain et al<sup>7</sup> described three patients who developed PE after EVTA using a radiofrequency device. In Japan, there has been one reported case of death from PE occurring after EVTA.<sup>8</sup>

In Japan, the Japanese Endovenous Ablation Committee for Varicose Veins (JEVA) was established in 2011 and consists of six societies: the Japanese Society of Phlebology, Japanese Society for Vascular Surgery, Japanese College of Angiology, Japanese Dermatological Association, Japan Society of Plastic and Reconstructive Surgery, and Japanese Association of Cardiovascular Intervention and Therapeutics. The committee has certified surgeons and hospitals that are qualified to perform EVTA and manages certified surgeons and hospitals. Although small-scale surveys have been conducted on VTE complications occurring after EVTA in Japan in the past, no large-scale survey has been conducted. This committee conducted a nationwide survey to determine the incidence of VTE complications after EVTA in Japan and to investigate the pathogenic background of these complications.

## METHODS

**Study design and data collection.** A survey that targeted all cases of EVTA performed between January 2011 and December 2013 was conducted by JEVA-certified surgeons at all JEVA-certified institutions. All institutions were requested to perform a retrospective medical record review during the time allotted because data collection is one of the criteria to receive approval for EVTA qualification. The questionnaire is shown in [Appendix 1](#) (online only). The Japanese guidelines recommend performing postoperative lower extremity venous ultrasound to monitor for VTE within 72 hours and at 1 to 3 months after EVTA.<sup>1</sup> Postoperative VTE complications were defined as EHIT classes 2 to 4, other types of DVT that are not directly associated with EHIT, and PE. On the basis of the responses to this survey, we conducted a retrospective observational study of cases of VTE complications after EVTA to determine the incidence of postoperative VTE complications. Furthermore, the details of patients with EHIT 3, EHIT 4, DVT not directly associated with EHIT, and PE were analyzed to identify

## ARTICLE HIGHLIGHTS

- **Type of Research:** Retrospective comparative cohort study
- **Key Findings:** In this Japanese nationwide survey, the incidence of venous thromboembolism (VTE) complications after endovenous laser ablation for varicose veins was low (0.11% for endovenous heat-induced thrombosis class 3 and 0.013% for class 4, 0.063% for other types of deep venous thrombosis, and 0.0067% for pulmonary embolism). Duplex ultrasound scan could not predict severe VTE complications.
- **Take Home Message:** The incidence of VTE complications after endovenous laser ablation was low, and the value of performing routine postoperative ultrasound for management of VTE seems to be low.

factors associated with the occurrence of complications and to assess the usefulness of postoperative ultrasound for predicting VTE complications. Detailed information was not obtained from the patients without VTE complications and the patients with EHIT 1 and EHIT 2. As patients with EHIT 2 were not targeted in this study, we reported only their numbers and did not collect any detailed data for them.

**Laser treatment.** The most commonly used laser device at 138 institutions was a bare-fiber 980-nm laser device (EndoLaser Venous System 980; Biolitec, Jena, Germany), which is the only device approved for reimbursement under the national health insurance system in Japan, followed by a 1470-nm laser device at four institutions, a 1320-nm laser device at three institutions, and an 810-nm laser device at one institution. The standard distance of the fiber tip to the deep vein was 1 to 2 cm according to the Japanese guideline.<sup>1</sup> Radiofrequency devices, which were approved in 2014, were not used in Japan during the study period. In the survey, all institutions reported that they followed the Japanese guideline for performing postoperative ultrasound. We assumed that most patients underwent postoperative ultrasound for medical safety purposes with a small number of exceptions. There is no recommendation in the Japanese guidelines for additional follow-up duplex ultrasound scanning after the discovery of EHIT, so follow-up times were left to the discretion of the operating physician.

For this study, Institutional Review Board approval was waived because no personal data were obtained by our questionnaire.

## RESULTS

Survey responses were collected from 213 of 382 JEVA-certified institutions. At 143 of these institutions, endovenous laser ablation (EVLA) was performed in 43,203 cases

during the survey period. We investigated both the great saphenous vein (GSV) and small saphenous vein (SSV; GSV, 74%; SSV, 21%; both GSV and SSV, 1%; accessory saphenous vein and other vein, 1%).

Among the 43,203 cases, the following postoperative VTE complications occurred: EHIT 2 in 318 cases, EHIT 3 in 50 cases, EHIT 4 in 7 cases, other types of DVT in 24 cases, and PE in 3 cases. Of the 143 institutions, 118 reported that all cases of VTE complications including EHIT 2 occurred during the perioperative period. Twenty-five institutions did not report EHIT 2 systematically because of the questionable clinical significance of EHIT 2; therefore, they reported only some cases of EHIT 2. The size of the adjusted population allowing calculation of the accurate incidence of VTE complications was 30,007 cases reported by these 118 institutions. Among these 30,007 cases, the incidence of VTE complications was 1.0% (300 cases) for EHIT 2, 0.11% (32 cases) for EHIT 3, 0.013% (4 cases) for EHIT 4, 0.063% (19 cases) for other types of DVT, and 0.0067% (2 cases) for PE (Table I).

Details of the patients with VTE are described as follows. As shown in Tables I and II, 50 patients developed EHIT 3. The Caprini score reflects the preoperative risk for development of postoperative thromboembolic complications (Appendix II, online only). In the 50 patients, the first ultrasound examination was performed at an average of 3.4 days postoperatively, and 35 patients were found to have EHIT 3 at the first ultrasound examination. Among these 35 patients, ultrasound was performed at an average of 4.1 days postoperatively. The second ultrasound examination revealed that 15 patients developed EHIT 3. According to the results of the first ultrasound examination, five patients did not have EHIT, whereas two patients had EHIT 2. The anticoagulant therapy administered to the patients with EHIT 3 consisted of warfarin alone in 25 patients; a combination of heparin and warfarin in 18 patients; anti-factor Xa inhibitor in 2 patients; and a combination of urokinase, heparin, and warfarin in 1 patient. Another patient without anticoagulant therapy was followed up, and it was unknown whether the remaining three patients received anticoagulant therapy. Thirty-one patients were treated in outpatient clinics, whereas seven patients were

admitted to hospitals. One patient was found to have EHIT 3 by ultrasound examination on postoperative day 4, and it progressed to EHIT 4 on postoperative day 8, although treatment with heparin, warfarin, and aspirin was started. VTE complications in the remaining patients did not progress further.

Seven patients developed EHIT 4 (Tables I-III). The results of ultrasound examination in the patients with EHIT 4 are shown in Tables II and III. The first ultrasound examination was performed at an average of 1.7 days postoperatively, and one patient was found to have EHIT 4 at the first ultrasound examination. The second ultrasound examination revealed that five patients developed EHIT 4. According to the results of the first ultrasound examination, three patients did not have EHIT. Although the patient with EHIT 3 had received antithrombotic therapy with heparin, warfarin, and aspirin, the condition progressed to EHIT 4. The third ultrasound examination revealed that one patient developed EHIT 4, and this patient was found to have EHIT 2 during both the first and second ultrasound sessions. Thus, the ultrasound findings before the occurrence of EHIT 4 in seven patients were EHIT 3 in one patient, EHIT 2 in two patients, and EHIT 1 or the absence of EHIT in three patients; the remaining patient had already developed EHIT 4 before the screening ultrasound examination. The ablated vein diameter was reported in three patients, in whom the diameters of the ablated GSV were 5.1 mm, 6.2 mm, and 6.8 mm, respectively.

The anticoagulant therapy administered to all patients with EHIT 4 consisted of a combination of heparin and warfarin in four patients; warfarin alone in two patients; and a combination of heparin, warfarin, and thrombolytic therapy in one patient. Two patients were treated in outpatient clinics, and five patients were admitted to hospitals.

We investigated other types of DVT that were not related to EHIT because it is possible for PEs to originate from another venous area (Table IV). Twenty-four patients had DVT occurring at sites not directly associated with EHIT, such as femoral, popliteal, and calf-type DVT. Warfarin was orally administered to six patients, all of whom were treated in outpatient clinics.

**Table I.** Preoperative characteristics of patients and limbs with venous thromboembolism (VTE) complications

	No.	Incidence, %	Age, years	Sex, M/F	BMI, kg/m <sup>2</sup>	Unilateral/bilateral	GSV/SSV	CEAP class, C2/C3/C4/C5/C6)	Caprini score, 1/2/3/4/5/6/7/8
EHIT 3	50	0.11	66 ± 11 (36-97)	21/29	23.1 ± 3.3	47/3	47/5	32/11/7/2/1	4/17/11/11/4/1/1
EHIT 4	7	0.013	67 ± 6.2 (59-79)	4/3	23.6 ± 0.96	6/1	7/1	2/1/5/0/0	0/3/3/0/0/0/1/0
Other DVT	24	0.063	61 ± 6.5 (44-74)	3/21	22.1 ± 2.0	24/0	17/6	21/2/0/1/0	0/3/16/5/0/0/0/0
PE	3	0.0067	61 ± 13 (46-68)	0/3	22.0 ± 3.2	1/2	5/0	2/1/0/0/0	0/0/1/2/0/0/0/0

BMI, Body mass index; CEAP, Clinical, Etiology, Anatomy, and Pathophysiology; DVT, deep venous thrombosis; EHIT, endovenous heat-induced thrombosis; GSV, great saphenous vein; PE, pulmonary embolism; SSV, small saphenous vein. Continuous variables are presented as mean ± standard deviation (range).

**Table II.** Details of venous thromboembolism (VTE) complications after endovenous laser ablation (EVLA)

	Days from surgery	Symptomatic/asymptomatic	Diameter of GSV, mm	Diameter of SSV, mm	Aneurysmal SFJ or SPJ	Anticoagulation therapy	Prognosis
EHIT 3	6.8 ± 6.7 (1-14)	3 (pain)/47	7.4 ± 1.7 (4.0-10)	6.2 ± 0.60 (5.6-7.0)	8	46	Progression to EHIT 4 in 1 case
EHIT 4	15 ± 12 (4-45)	2 (swollen leg)/5	6.1 ± 0.80 (5.1-6.8)	NA	0	7	PTS in 2 cases
Other DVT	107 ± 138 (2-480)	3 (swollen leg)/21	7.0 ± 1.6 (4.3-9.3)	6.6 ± 0.92 (5.4-8.0)	0	6	All recovered
PE	2 ± 1.7 (1-4)	3 (dyspnea)/0	7.5 ± 1.3 (6.0-8.5)	NA	1	3 (Table V)	All recovered

DVT, Deep venous thrombosis; EHIT, endovenous heat-induced thrombosis; GSV, great saphenous vein; NA, not applicable; PE, pulmonary embolism; PTS, post-thrombotic syndrome; SFJ, saphenofemoral junction; SPJ, saphenopopliteal junction; SSV, small saphenous vein. Continuous variables are presented as mean ± standard deviation (range).

Last, the three patients with PE are described in Table V. The first case was a 68-year-old woman with a body mass index (BMI) of 18.6 kg/m<sup>2</sup>. For left great saphenous varicose veins of Clinical, Etiology, Anatomy, and Pathophysiology (CEAP) class C2, EVLA was performed with the patient under local anesthesia and sedation. Her preoperative Caprini score was 3 points. On postoperative day 1, she underwent lower extremity venous ultrasound examination, which did not detect EHIT or any DVT. On postoperative day 4, she developed respiratory distress and was diagnosed as having nonmassive PE. She was treated with a combination of heparin and warfarin. The second case was a 68-year-old woman with a BMI of 22.6 kg/m<sup>2</sup>. For both great saphenous varicose veins of CEAP class C3, EVLA was performed with the patient under general anesthesia. Because she was taking an oral contraceptive, her preoperative Caprini score was 4 points. On postoperative day 1, she developed respiratory distress and shock after first ambulation. Massive PE was diagnosed. A combination of heparin, warfarin, and a thrombolytic agent was administered, and an inferior vena cava filter was placed. The third case was a

46-year-old mildly obese woman with a BMI of 25.0 kg/m<sup>2</sup>. For both great saphenous varicose veins of CEAP class C3, EVLA was performed with the patient under general anesthesia. Her preoperative Caprini score was 4 points. On postoperative day 1, she developed respiratory distress and shock; massive PE was diagnosed, and heparin was administered. All three patients recovered without any further complications. All patients with PE had general anesthesia or sedation in the setting of admission but not in the outpatient setting. Two of three patients with PE developed PE on postoperative day 1 after undergoing bilateral GSV ablation under general anesthesia. Ultrasound had been performed before the development of PE in only the first case. Because EHIT or any DVT was not detected at the time of ultrasound examination even in the first case, the occurrence of PE could not be predicted by postoperative ultrasound screening.

## DISCUSSION

In this nationwide survey of the Japanese population, the incidence of VTE complications after EVLA for varicose veins was low. Venous duplex ultrasound scan

**Table III.** Characteristics of patients with endovenous heat-induced thrombosis (EHIT) class 4

Age, years/sex	Height, cm	Body weight, kg	BMI, kg/m <sup>2</sup>	CEAP class	Origin	Caprini score	Device	Days from surgery	Symptom	Ultrasound examination, EHIT class			Anticoagulant	Treatment
										First	Second	Third		
59/M	165	64	23.5	3	Left SSV	2	870 nm	4	None	3	4	Warfarin, heparin	Admission	
65/M	160.8	56.9	22.2	4	Left GSV	7	980 nm	9	None	None	4	Warfarin	Outpatient clinic	
79/M	162	62	23.6	4	Right GSV	3	980 nm	10	None	2	4	Heparin	Admission	
60/F	Missing	Missing	Missing	4	Left GSV	2	980 nm	15	Swollen leg	None	4	Warfarin, heparin	Admission	
65/F	150	55	24.4	2	Right GSV	3	980 nm	7	None	4	NA	NA	Warfarin	Outpatient clinic
72/F	174	75	24.8	2	Left GSV	3	980 nm	21	Swollen leg	None	4	NA	Warfarin, heparin	Admission
74/M	Missing	Missing	Missing	4	Bilateral GSV	2	980 nm	45	None	2	2	4	Warfarin, heparin	Admission

BMI, Body mass index; CEAP, Clinical, Etiology, Anatomy, and Pathophysiology; GSV, great saphenous vein; NA, not applicable; SSV, small saphenous vein.

**Table IV.** Deep venous thrombosis (DVT) location of 24 cases not directly associated with endovenous heat-induced thrombosis (EHIT)

	After EVLA to			
	GSV	SSV	GSV + SSV	Other vein
Femoral	0	1	0	0
Popliteal	2	0	0	0
Gastrocnemius	2	1	1	0
Soleal	7	4	4	1
Distal DVT (unspecified)	1	0	0	0

EVLA, Endovenous laser ablation; GSV, great saphenous vein; SSV, small saphenous vein.

could not predict the occurrence of severe VTE complications.

Since 980-nm laser devices were approved for reimbursement under the national health insurance system in Japan in 2011, EVLA has been adopted as an alternative first-choice procedure to conventional high ligation and stripping for the treatment of varicose veins. Nevertheless, there have been concerns about the risk of DVT and PE caused by the extension of a thrombus into a deep vein.

The factors (sex, age, obesity, vein diameter, Caprini score, catheter tip position, and superficial epigastric vein distance to the saphenofemoral junction [SFJ]) affecting the occurrence of VTE complications after EVTA have been discussed, but not a single factor has yet been found to be a strong predictor. Sufian et al,<sup>6</sup> Rhee et al,<sup>9</sup> and Jacobs et al<sup>10</sup> reported that male sex is a risk factor for complications of VTE after EVTA, whereas Chi et al<sup>11</sup> reported that older women are at a higher risk than men. There is no consensus as to whether sex is a risk factor of VTE complications after EVTA. In our study, all 3 patients with PE and 21 of the 24 patients with DVT not associated with EHIT were women, whereas an almost equal number of men and women developed

EHIT 3 and EHIT 4. However, it should be taken into account that varicose veins are significantly more common in women than in men.

Although obesity has been considered a risk factor for VTE, it is unknown whether obesity is associated with VTE after EVTA. Recent consecutive reports have shown no association between obesity and VTE.<sup>12,13</sup> In our study, although patients with EHIT 3, DVT not associated with EHIT, and PE included those with a BMI of 25 kg/m<sup>2</sup> or higher, no patients with EHIT 4 had a high BMI. Therefore, the association between obesity and VTE complications is unclear.

Regarding the ablated vein diameter, Lawrence et al<sup>5</sup> analyzed patients with EHIT extending to the femoral vein (excluding complete occlusion) and reported that the incidence of EHIT was significantly higher when the diameter of the GSV exceeded 8 mm. Lin et al,<sup>14</sup> who analyzed patients with EHIT, reported that the incidence of EHIT was higher in patients with preoperative SFJ reflux and a large GSV diameter, whereas Rhee et al<sup>9</sup> reported no significant difference in the mean ablated vein diameter between patients with and patients without EHIT. Harlander-Locke et al<sup>15</sup> analyzed patients with EHIT extending to the popliteal vein (excluding complete occlusion) to determine the incidence of EHIT after EVTA of the SSV, and they reported that EHIT was significantly more likely to occur when the diameter of the SSV was 6 mm or larger. Among the patients with EHIT 3 in our study, the diameter of the GSV was 8 mm or larger in 17 of 45 patients, and the diameter of the SSV was 6 mm in 3 of 4 patients. Of the seven patients with EHIT 4 in our study, the diameter of the GSV was measured in only three patients. In the three patients with PE in our study, the diameters of the GSV were small (6.5 mm, 8.0 mm, and 8.5 mm, respectively). Although patients with a larger diameter GSV developed VTE complications after EVTA, the predictive value of the vein diameter alone for the occurrence of VTE complications seems limited.

**Table V.** Cases with pulmonary embolism (PE) after endovenous laser ablation (EVLA)

Age, years/sex	BMI, kg/m <sup>2</sup>	CEAP class	Origin	Vein Caprini score	Vein size, mm	SFJ aneurysm	Anesthesia	Symptoms	Onset	PE severity	Treatment	Result	EHIT	DVT
68/F	18.6	C2	Left GSV	3	6.0	No	Local, sedation (admission)	Dyspnea	POD 4	Nonmassive	Heparin, warfarin	Recovered	None (POD 1, 7, 28)	Soleal vein
68/F	22.6	C3	Bilateral GSV	4	8.0	Yes	General (admission)	Dyspnea, shock	POD 1	Massive	Heparin, warfarin, thrombolytic therapy IVC filter	Recovered	None (POD 4)	None
46/F	25.0	C3	Bilateral GSV	4	8.5	No	General (admission)	Dyspnea, shock	POD 1	Massive	Heparin	Recovered	None (POD 1, 7)	None

BMI, Body mass index; CEAP, Clinical, Etiology, Anatomy, and Pathophysiology; DVT, deep venous thrombosis; EHIT, endovenous heat-induced thrombosis; GSV, great saphenous vein; IVC, inferior vena cava; POD, postoperative day; SFJ, saphenofemoral junction.

Rhee et al<sup>9</sup> reported that the incidence of EHIT was high in patients with a high preoperative Caprini score. In vascular surgery, a preoperative Caprini score of 0 points is considered indicative of the lowest risk of VTE, with 1 point or 2 points representing a low risk, 3 to 4 points indicating a moderate risk, and 5 points or higher representing a high risk.<sup>16</sup> Because the performance of surgery for varicose veins adds 1 point to the score, this study did not include any patients with the lowest risk. Among the patients with EHIT 3, there were 21 patients at low risk, 22 at moderate risk, and 7 at high risk. Among the patients with EHIT 4, three patients were at low risk, three patients at moderate risk, and one patient at high risk. In contrast, all three patients with PE were at moderate risk (scores of each patient: 3 points, 4 points, and 4 points, respectively). The severity of the VTE complications and the preoperative Caprini scores were not necessarily correlated. One of the patients with PE had been receiving hormone therapy, which can be discontinued, and careful attention should be paid to its use.

The role of the patent superficial epigastric vein in preventing extension of a thrombus into the common femoral vein was proposed by Lomazzi et al.<sup>17</sup> They demonstrated that a longer extension of >4.5 mm was associated with the development of more EHITs, probably because of the “washout effect” of the patent superficial epigastric vein, as the effect is more rapid when it is closer to the SFJ. A safe distance from the SFJ to the tip of the catheter was investigated to mitigate extension of the EHIT. EHIT was found to occur less frequently when the distance was 2.5 cm compared with 2.0 cm.<sup>18</sup> We did not survey institutions about the role of the inferior epigastric vein or catheter tip distance in this study.

Our three cases of PE and another fatal PE after EVLA<sup>8</sup> in our study period demonstrated the risk of EVLA under general anesthesia or deep sedation in the admission setting. In three of four patients with PE, the PE developed on postoperative day 1 after bilateral GSV ablation while under general anesthesia, suggesting the importance of early postoperative ambulation.

Regarding the timing of ultrasound after EVTA, there are many recommendations for ultrasound to be performed within 1 week postoperatively to determine the presence or absence of DVT and to assess the degree of occlusion of the GSV.<sup>19-21</sup> The guidelines issued by the Society for Vascular Surgery and the American Venous Forum recommend that lower extremity venous ultrasound be performed 24 to 72 hours after EVTA to prevent VTE complications. However, owing to the low rates of perioperative ultrasound use in other countries, the evidence supporting this recommendation is of poor quality (grade 2C).<sup>22</sup> Jones and Kabnick<sup>23</sup> stated that clinical findings are more important than ultrasound findings and that perioperative ultrasound is unnecessary.

EVTA was introduced in Japan later than in other countries and is performed under the management of JEVA. For these reasons, the Japanese guidelines, which recommend the performance of perioperative ultrasound within 72 hours and at 1 to 3 months postoperatively, are followed, and the rate of ultrasound use is high.<sup>1</sup> In this study, all institutions complied with the guidelines and performed ultrasound within 72 hours after EVLA. Of the three patients with PE, two developed PE before ultrasound examination, and the other patient did not have EHIT before the occurrence of PE. The occurrence of PE could not be predicted by preoperative ultrasound examination. Of the seven patients with EHIT 4, three were found to have EHIT 2 or EHIT 3 by ultrasound performed before the occurrence of EHIT 4, which suggests that the occurrence of EHIT 4 could have been predicted to some extent. However, only 2 of the 318 patients with EHIT 2 and 1 of the 50 patients with EHIT 3 developed EHIT 4. The overall rates of progression from EHIT 2 or EHIT 3 to EHIT 4 or PE were low, although most patients with EHIT 3 (46/50) and all patients with EHIT 4 received anticoagulant therapy.

Despite the administration of anticoagulant therapy, EHIT 3 progressed to EHIT 4 in one patient. Given that the detection of VTE complications by ultrasound led to the administration of anticoagulant therapy in this study, the overall incidence of serious complications might have been reduced. There is a possibility that perioperative ultrasound was beneficial in the management of the 53 anticoagulated patients (46 with EHIT 3 and 7 with EHIT 4). However, the cost-effectiveness of postoperative ultrasound is limited.

One limitation of the study is the retrospective survey design. As a result, we were unable to accurately analyze the background factors in the patients without VTE complications. In addition, there is a possibility of recall bias even though all institutions were asked to perform a chart review by the organization backed by the insurance endorsement system.

## CONCLUSIONS

In Japan, the incidence of VTE complications after EVLA was low. All institutions complied with the guidelines and performed timely lower extremity venous ultrasound postoperatively. Based on the analysis of many patients in this study, the value of performing postoperative ultrasound for VTE management is low, and the occurrence of severe VTE complications could not be predicted by lower extremity venous ultrasound examination. Furthermore, although the perioperative detection of VTE by this modality resulted in the early administration of anticoagulant therapy and may have contributed to improved prognosis, the number of those patients was limited.

## AUTHOR CONTRIBUTIONS

Conception and design: HN, MM

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