Twelve-month efficacy and complications of cyanoacrylate embolization compared with radiofrequency ablation for incompetent great saphenous veins

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ABSTRACT

Objective: In this study, the clinical results of radiofrequency ablation (RFA) and n-butyl-cyanoacrylate embolization (CAE) methods were compared in the treatment of incompetent great saphenous veins (GSVs).

Methods: We analyzed retrospectively 244 patients (128 patients in the RFA group, 116 patients in the CAE group) with incompetent GSVs who were treated with RFA and CAE according to the patients' choice between June 2013 and June 2016. All patients were thoroughly examined preoperatively and at 1, 3, 6, and 12 months after the operation, and the clinical results and the quality of life were evaluated. Color Doppler ultrasound (CDUS) results were compared between two groups after the operation and at 12 months. Complete vein occlusion was defined as the success of the treatment.

Results: There was no significant difference between patients treated with RFA or CAE in terms of demographic and clinical features. In CDUS after operation, total occlusion was detected in the saphenous vein in both groups. At the 12-month CDUS, complete occlusion of the GSV was observed in 99.5% of the CAE group and 96.6% of the RFA group ($P = .072$). Skin burn, which we consider a major complication, occurred only in one patient. No other major complications were seen in either group. Severe pain, ecchymosis, and sensitivity were the most common of the side effects, and these were significantly higher in RFA group than in CAE group. Severe pain occurred in 12.5% of the RFA patients and 4.3% of the CAE patients ($P = .042$), ecchymosis occurred in 20.3% of the RFA patients and 12% of the CAE patients ($P = .044$), and sensitivity occurred in 21.9% of the RFA patients and 12.1% of the CAE patients ($P = .038$), respectively.

Conclusions: Based on the present data, our findings suggest that CAE is as effective as RFA ablation with similar rates of successful occlusion and can be associated with less pain and fewer complications than RFA; it also may yield better patient comfort. The current results should be verified with further randomized, controlled trials with longer term follow-up and larger patient groups. (J Vasc Surg: Venous and Lym Dis 2018;■:1-7.)

Keywords: Cyanoacrylate embolization; Nontumescent endovenous ablation; Saphenous veins; Chronic venous insufficiency; Great saphenous vein; varicose vein

Superficial venous system insufficiency is a widespread problem among adults, with a rate of 25% in women and 15% in men. Venous insufficiency can present as only a cosmetic problem in the form of telangiectasia, or it can cause serious skin changes such as ulcers. The main symptoms are pain, swelling, night cramps, warmth and burning sensation, tiredness, restlessness, itching, and tingling. Venous insufficiency can affect patient daily life if untreated.[1]

Color Doppler ultrasound (CDUS) examination is most commonly used for diagnosis and follow-up, and it can easily show the severity, level, flow pattern, abnormal vascular structures, diameter, and morphology of veins.[2] The purpose of the treatment must be to eliminate reflux. For many years, surgical methods such as ligation and stripping have been applied as standard therapies, but endovenous interventions have been widely used in recent years.[3,4]

Endovenous radiofrequency ablation (RFA) is based on the thermal ablation of venous tissues using electrical energy. It achieves this by causing hyperthermia with high-frequency alternating current that passes through the tissue. The radiofrequency energy is spread from a catheter with dispersive electrodes at the tip. The electrodes touch the venous endothelium and energy is delivered directly into the tissue, which causes irreversible tissue damage. RFA is performed under tumescent anesthesia (TA). TA is applied into the interfacial space around the saphenous vein. If applied correctly, it creates a protective layer around the vein and reduces heat transfer to neighboring tissues. It protects perivascular tissues and the skin from the high temperatures generated by RFA energy.[5,6]

Cyanoacrylate (CA) is an embolizing agent that has been widely used over the years in endovenous interventions, such as treating intracranial arteriovenous

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malformations,[7] varicoceles,[8] and cirrhosis-related hemorrhages.[9] Recently, CA has started to be used as a treatment option in superficial venous insufficiencies of the lower extremities.[10] Several studies have shown the efficacy and safety of this new approach in venous insufficiency.[11-14] Upon vascular injection, CA solidifies and forms a strong tissue bond by creating an inflammatory reaction via polymerization reaction in case of contact with blood and tissue, and this mechanism provides the occlusion of the incompetent vein. Maximum bond strength can be rapidly obtained. In addition to this feature, CA has low viscosity and sufficient elasticity. Because of its low viscosity, polymerization time is 5 seconds, and the risk of embolization of deep veins is considerably reduced; due to its sufficient elasticity after polymerization, there is no limitation of movement and the patient's comfort is increased.[12,15]

Our aim in this study was to compare the clinical results of RFA and a new CA embolization (CAE) system VenaBlock (Invamed, Ankara, Turkey).

METHODS

This independent retrospective study included 244 patients (128 patients RFA, 116 patients CAE) with incompetent great saphenous veins (GSVs) who applied to Eskisehir Osmangazi University Hospital of Faculty of Medicine, Cardiovascular Surgery Clinic, between June 2013 and June 2016 and were treated with RFA or CAE. Forty-nine patients admitted with incompetent GSVs were excluded from study. RFA or CAE methods assigned according to patient choice. Both treatments presented by the same physician, without prescreening by another physician, by using exactly same standard descriptions, such as level of proof of the treatment, procedure details, procedure and hospitalization time, possible complications, benefits, and post-treatment care; in addition, visual presentations such as videos, animations, and brochures of both treatments were presented. Adequate sample size determined by a statistical noninferiority (z-test) that resulted in 200 patients total (100 patients per group). To achieve statistically significant and plain results, we focused only on the patients with GSV insufficiency in this cohort despite the fact that both treatments can also be used in patients with small saphenous vein and accessory vein incompetence. No additional procedures, such as miniphlebectomy or sclerotherapy, were performed. All patients were examined preoperatively according to the Clinical severity, Etiology, Anatomy, Pathophysiology (CEAP) classification. Clinical results and patient quality of life were assessed by postoperative examination at 1, 3, 6, and 12 months. Data were recorded with the Venous Clinical Severity Score (VCSS) scoring system in all examination, and patients completed an Aberdeen Varicose Vein Questionnaire (AVVQ) before the procedure and at 12 months. CDUS results were compared after the operation and at 12 months. The total occlusion of the treated saphenous vein of a predetermined length in which the procedure was performed was defined as operative success. Any patency or recanalization, reflux, or open segment more than 5 cm in length was considered a failure.[11,16,17] Local ethical approval was obtained from our institution. Informed consent was obtained from each patient before the procedure.

ARTICLE HIGHLIGHTS

- **Type of Research:** Retrospective cohort study
- **Take Home Message:** In 116 patients with varicose veins, treated with cyanoacrylate embolization (CAE) the 1-year saphenous vein occlusion rate was 99.5%, similar to the 96.6% occlusion rate observed in 128 patients treated with radiofrequency ablation ($P = .072$). Early on, patients had less pain and ecchymosis after CAE.
- **Recommendation:** CAE was as effective as radiofrequency ablation with similar rates of occlusion at 1 year, but CAE was associated with less pain, ecchymosis, and discomfort.

Inclusion criteria. Inclusion criteria were age between 21 and 70 years in patients with symptomatic varicose veins. In addition, we included patients with a CEAP classification of C2 to C4b; a GSV diameter at the saphenofemoral junction (SFJ) while standing of between 5.5 and 14 mm; an insufficiency 2 cm distal to the SFJ; reflux in the GSV of 0.5 second or greater as determined by CDUS examination; the presence of insufficiency only in vena saphena magna (VSM) and its branches; and ability to walk unassisted ability to attend follow-up examinations; and mentally competent to approve procedure.

Exclusion criteria. We excluded patients with a deep venous thrombosis (DVT), arteriovenous malformation, severe immobility, severe tortuosity in the VSM, moderate to severe deep venous insufficiency, a VSM dilated at and over 14 mm, presence of old and incipient severe thrombophlebitis, and an inability to follow-up despite the surgery. Patients with a history of intervention on the GSV to be treated, a duplicate or accessory GSV with venous insufficiency, and those who were pregnant were also excluded.

Conditions such as ecchymosis, pain, induration, paresthesia, superficial thrombophlebitis, and temporary color changes on the skin were considered minor complications that can be treated with simple medical interventions. Conditions such as motor nerve lesion, major artery and vein injury, skin burn, arteriovenous fistula formation, DVT, and pulmonary thromboembolism were considered major complications that need to be monitored closely.

RFA. All patients treated with RFA underwent spinal or general anesthesia in the coronary surgery operating room. Puncture was performed with Seldinger technique on the VSM from an appropriate area at knee level under ultrasound guidance, and a 7F sheath was placed. The RFA applicator was passed through the sheath under ultrasound guidance. The extreme end of the catheter was carried forward about 2 cm distal of the SFJ. An average of 320 mL TA was applied to all patients. Covidien ClosureRFG Radiofrequency Generator and Covidien ClosureFastendovenous RFA catheter were used. The procedure was completed by ablating 15 seconds at 120°C on each 7-cm segment at knee level. RFA energy applied twice to the initial two segments. Subsequently, the decrease in vein diameter and the increase in echogenicity of the vein wall were controlled with Doppler ultrasound guidance preoperatively. All patients had elastic bandages applied after the procedure. The procedure took an average of 35 to 40 minutes to this point. The bandages were opened, and a medium pressure compression stocking was applied after 12 hours and prescribed for 1-month use. Patients were discharged 1 day later.

CAE. The procedure for all patients treated with CAE was performed in the coronary surgery operating room. None of the patients received general or regional anesthesia. Puncture was performed under local anesthesia with Seldinger technique on the VSM from an appropriate area at knee level under ultrasound guidance, and a 6F sheath was placed. An Invamed VenaBlock (manual: 6F/90 cm) embolizing agent system was used in all patients. The catheter was advanced to about 3 cm distal of the SFJ. The patient was placed in the Trendelenburg position, and the SFJ was collapsed by pressing the ultrasound guidance probe. Every 5-second push on the gun trigger delivered 0.3-mL CA with a pullback rate of 2 cm/second applied every 10 cm until the vein segment was fully supplied with CA. At the end, 0.03 mL of CA was applied every centimeter. This procedure was repeated every 10 cm along the GSV. In about 20 to 30 seconds, CA was injected continuously along the saphenous vein trace and simultaneous external pressure was applied. At the end, the catheter and the sheath were removed and manual compression was applied at the puncture site. Occlusion of the GSV was confirmed with ultrasound evaluation during the procedure. If any unoccluded segment was seen, the procedure was repeated through a separate access point. All patients were treated with elastic bandages after the procedure. The procedure took an average of 15 to 20 minutes to this point. The bandages were opened 2 hours later. Patients were discharged on the same day. We did not perform phlebectomy or sclerotherapy in the same session as saphenous ablation. We waited 3 to 6 months and then performed phlebectomy or sclerotherapy as needed.

Compression is not required after CAE treatment, whereas it is required in RFA. Post-treatment compression stockings were used in the RFA group.

Statistical analysis. Continuous data are expressed as mean ± standard deviation. Categorical data are given in percentage (%). The Shapiro-Wilk test was used to investigate the suitability of the data to normal distribution. Independent samples *t*-test analysis was used for cases with two groups when comparing the groups that show normal distribution. A paired *t*-test was used for cases when comparing same groups. Pearson χ^2, Pearson exact χ^2, and Fisher's exact χ^2 analysis were for created cross tables. A Kaplan-Meier analysis and log-rank test was performed for survival analysis and calculate success rates. IBM SPSS Statistics 21.0 (IBM Corp., Armonk, NY) programs were used in the application of analysis. A *P* values of less than .05 was considered the statistically significant.

RESULTS

A total of 244 patients with lower extremity venous insufficiency were enrolled in the study. Thirty patients were lost to follow-up (4 patients at the third month, 13 patients at the sixth month, and 13 patients at twelfth month), which resulted in 214 complete follow-ups. There was no significant difference between patients treated with RFA or CAE in terms of demographic and clinical features. The average age was 46.30 years in the RFA group and 49.21 years in the CAE group. All treated patients were symptomatic according to the CEAP and VCSS classifications. The mean duration of symptoms was 9 to 10 years and was similar in both groups ($P = .058$; Table I). No other characteristics were noted except rheumatoid arthritis (n = 1), psoriatic arthritis (n = 3), psoriasis (n = 5), malignancy (n = 1), hypertension (n = 19), and diabetes (n = 13) in the patients' history. There was a history of varicose veins in first-degree relatives of 75 patients (31%). Of the 141 women, 101 (72%) gave birth between one and six times. There were 106 patients (43%) who had right VSM insufficiency and 138 patients (57%) who had left VSM insufficiency. No deep venous insufficiency, DVT, or arterial insufficiency findings were found on CDUS examination. There was no significant difference according to CEAP classification between the patients treated with RFA and CAE. There were 217 patients (89%) between C2 and C4 and 27 patients (11%) between C4 and C6 (Table I).

The diameters of the saphenous veins (average, 7 mm) and the length of the saphenous vein that was treated (average, 45-47 cm) were similar. TA was applied in the RFA group in addition to general or spinal anesthesia. The average TA amount was 320 mL (range, 200-480 mL). In the CAE group, the procedure was applied with local anesthesia with 2 to 5 mL of lidocaine. The average CA amount was 1.7 mL (range, 1-2 mL). The

Table I. Demographic and clinical features

	RFA	CAE	*P* value
Age, years	47.30 ± 13.75 (21-79)	49.21 ± 13.10 (22-78)	.946[a]
Men/women	55/73	48/68	.693[b]
Right/left	56/72	50/66	.503[b]
Mean duration of symptoms, years	10.32 ± 3.91 (2-26)	9.41 ± 4.21 (2-15)	.058[a]
CEAP classification			
C (Clinic)			
C2-C4	115	102	.676[b]
C4-C6	13	14	
E (Etiologic)			
E primary	128	116	.325[b]
A (Anatomic)			
A superficial	43	40	.498[b]
A superficial + perforating	85	76	
P (pathophysiologic)			
P reflux	128	116	.325[b]

CA, Cyanoacrylate; *RFA*, radiofrequency ablation.
Values are presented as mean ± standard deviation (range) or number.
Boldface *P* values indicate they are statistically significant ($P < .05$).
[a]Independent sample *t*-test.
[b]Pearson χ^2 test.

Table II. Results of the procedure

	RFA	CAE
VSM proximal diameter, mm	7.2 ± 2.31 (5-13)	7.0 ± 4.23 (5.2-14)
VSM length that was treated, cm	47.2 ± 8.61 (24-53)	45 ± 4.33 (22-51)
Anesthesia type	General/spinal	Local
TA amount, mL	320 (200-480)	–
CA amount, mL	–	1.7 (1-2)
Procedure duration, minutes	44.80 ± 8.12 (12-65)	19.60 ± 7.88 (12-52)
Duration of discharge, hours	45 ± 5.9	5 ± 2.5
Occlusion in postoperative CDUS VSM	128	116
12-month CDUS recanalization and reflux	5	1

CA, Cyanoacrylate; *CDUS*, color Doppler ultrasound; *RFA*, radiofrequency ablation; *TA*, tumescent anesthesia; *VSM*, vena saphena magna.
Values are presented as mean ± standard deviation (range) or number.

procedure and discharge durations were significantly lower in the CAE group ($P = .023$ and $P = .001$, respectively). The average duration of the procedure was 45 minutes and the average duration of hospitalization was 45 hours in the RFA group; in contrast, the average duration of procedure was 20 minutes and the average duration of hospitalization was 5 hours in the CAE group. Total occlusion was found in the saphenous vein in all patients in both groups on CDUS examination after the operation. Partial recanalization and minimal reflux were found in five patients in RFA group and in one patient in CAE group on CDUS examinations at 12 months (Table II). A life-table analysis demonstrated complete occlusion rates of GSV were observed by 99.5% in CAE group and 96.6% in RFA group ($P = .072$; Fig).

Skin burn, which we consider a major complication, occurred only in one patient. No other major complications were seen in either group. Severe pain, ecchymosis, and sensitivity were the most common of the side effects, and these side effects were significantly higher in RFA group than in CAE group. Severe pain occurred in 12.5% of the RFA patients and 4.3% of the CAE patients ($P = .042$), ecchymosis occurred in 20.3% of the RFA patients and 12% of the CAE patients ($P = .044$), and sensitivity occurred in 21.9% of the RFA patients and 12.1% of the CAE patients ($P = .038$), respectively. Although there were more side effects in RFA group, these differences were not statistically significant ($P > .05$). Paresthesia was seen in three patients, hematoma in one patient, and anesthesia-related urinary retention in three patients was seen in the RFA group, but none occurred in the CAE group (Table III).

All patients had significant improvement in VCSS and quality-of-life scores postoperatively ($P < .001$). VCSS at preintervention and at 12 months were 5.79 ± 1.19 and 1.11 ± 0.94, respectively, for the RFA group and 5.75 ± 1.23 and 1.03 ± 0.96, respectively, in the CAE group. The AVVQ scores at preintervention and at 12 months were 18.21 ± 6.93 and 5.13 ± 1.49, respectively, for the RFA group and 17.43 ± 6.38 and 4.93 ± 1.56, respectively, in the CAE group. There were no statistically significant differences between the improvement in VCSS ($P = .921$) and AVVQ scores in both groups ($P = .752$; Table IV).

For the life-table analysis (Kaplan-Meier), all patients were included. The overall clinical recurrence-free rates after a mean follow-up of 11.9 months were 96.6% for RFA and 99.5% for CAE. The standard error of the survival curve point estimates was below .05 at all times. The overall mean survival time was 11.932 (95% confidence interval, 11.867-11.996). Log-rank testing revealed no significant difference between groups as well ($P = .072$; Table V).

DISCUSSION

Minimally invasive treatments, such as sclerotherapy, RFA, and endovenous laser ablation (EVLA), have emerged as alternatives to surgical treatment in saphenous venous insufficiency in recent years. Many studies have compared these treatment methods with surgery in the literature, and short-term (90%-100%) and long-term (78%-84%) results show they are as effective as surgical treatments. In addition, these treatments are

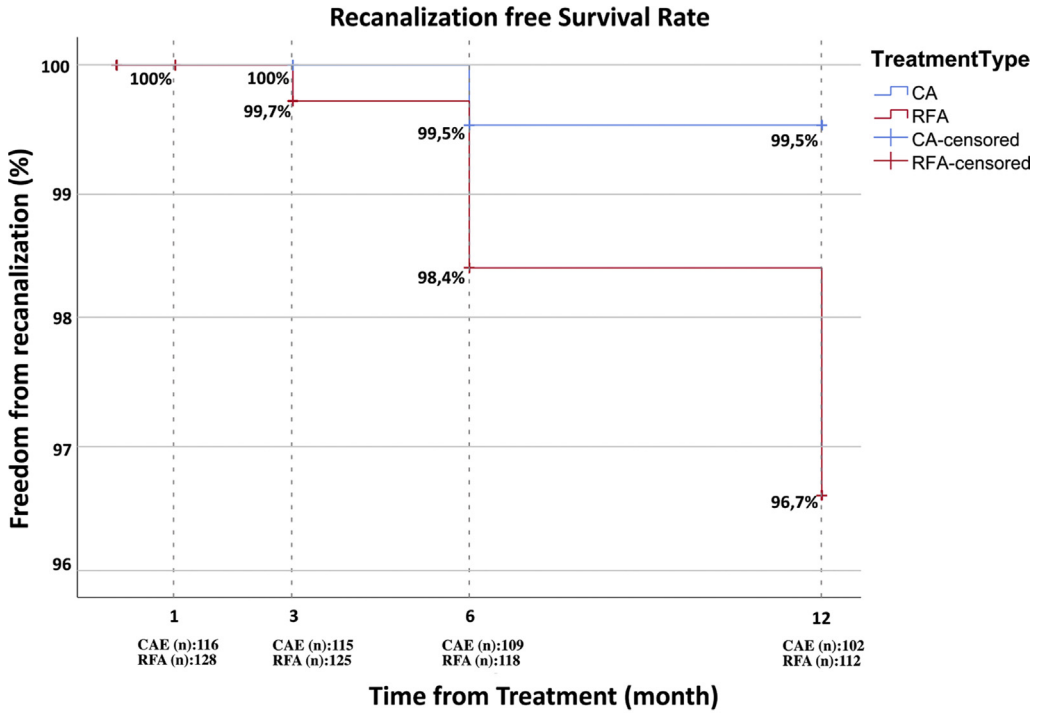

Fig. Kaplan–Meier survival analysis. *CA*, Cyanoacrylate; *Cum*, cumulative; *RFA*, radiofrequency ablation.

frequently preferred methods today because of their ease of application, fewer number of complications, shorter hospital stay, faster mobilization, and less associated pain.[18-20]

Articles in the literature have compared minimally invasive treatments with each other in recent years. In a comprehensive study with a total of 2354 patients, RFA and EVLA were applied to incompetent saphenous veins, and the results were similar, with a recanalization rate of 2% and patient satisfaction of 86%.[21] Uncu et al[22] found that RFA had higher occlusion rates than EVLA in their study, in which they used new-generation RFA devices. Several studies in the literature have shown the superiority of RFA and EVLA.[3] In our study, reflux and recanalization were not observed after the operation in any of the patients who were treated with RFA, but at 12 months, slight reflux and partial recanalization were observed in five patients (4%). Moreover, Rasmussen et al[23] showed a 95.2% success rate with the same RFA system and similar patient population. These rates are consistent with those in the literature.

CA has been used as an intravascular embolizing agent for about 30 years and has started to be used in the treatment of venous insufficiency in recent years. An occlusion of 92% to 99% was provided in incompetent saphenous veins in studies with CA, and it was seen to be a highly effective treatment method.[16,17] A randomized study comparing RFA and CAE showed that CAE was as effective as RFA and safe at 3 months in the treatment of an incompetent VSM.[20] In our study, reflux and recanalization were not observed after the operation in any of the patients who were treated with CAE and RFA and, at 12 months, occlusion was observed in 99% in CAE group and in 96% in RFA group. The success rates of both methods were quite high and consistent with

Table III. Complications and side effects in patients treated with radiofrequency ablation (*RFA*) and cyanoacrylate embolization (*CAE*)

	RFA	CAE	*P* value
Complications			
DVT	0 (0)	0 (0)	–
Skin burn	1 (0.8)	0 (0)	.339[a]
Thrombophlebitis	4 (3.1)	2 (1.7)	.685[a]
Cellulite	3 (2.3)	2 (1.7)	.998[a]
Paresthesia	3 (2.3)	0 (0)	.240[a]
Urinary retention	3 (2.3)	0 (0)	.240[a]
Side effects			
Severe pain	16 (12.5)	5 (4.3)	**.042**[a]
Ecchymosis	26 (20.3)	12 (10.3)	**.044**[b]
Sensitivity	28 (21.9)	14 (12.1)	**.038**[b]
Induration	7 (5.5)	4 (3.5)	.645[b]
Edema	3 (2.3)	1 (0.9)	.360[a]
Pigmentation increase	4 (3.1)	2 (1.7)	.685[a]
Hematoma	1 (0.8)	0 (0)	.339[a]

CA, Cyanoacrylate; *DVT*, *deep* venous thrombosis; *RFA*, radiofrequency ablation.
Values are presented as number (%). Boldface *P* values indicate they are statistically significant ($P < .05$).
[a]Fisher's Exact χ^2.
[b]Pearson χ^2 test.

Table IV. Clinical assessment

	RFA	CAE	*P* value
VCSS			
Preoperative	5.79 ± 1.19	5.75 ± 1.23	.910[a]
Postoperative at 12 months	1.11 ± 0.94	1.03 ± 0,96	.921[a]
AVVQ			
Preoperative	18.21 ± 6.93	17.43 ± 6.38	.655[a]
Postoperative at 12 months	5.13 ± 1.49	4.93 ± 1.56	.752[a]

AVVQ, Aberdeen Varicose Veins Questionnaire; *CAE*, cyanoacrylate embolization; *RFA*, radiofrequency ablation; *VCSS*, Venous Clinical Severity Score.
Values are presented as mean ± standard deviation.
[a]Pearson exact χ^2.

those in the literature.[24] In our study, partial reflux and recanalization were observed in five patients in RFA group and in one patient in CAE group, which suggests that CAE is as effective as RFA method in treatment of saphenous venous insufficiency.

Clinical and quality-of-life evaluations were performed during the follow-up visits of all patients, and the results are presented in Table IV. Both CAE-treated and RFA-treated patients showed significant improvements. Our results are similar to previous studies done with CAE.[16,24,25]

The most important disadvantage of RFA compared with CAE is the necessity of using TA. TA creates a protective layer around the vein and protects perivascular tissues and the skin from high temperatures. But it also increases side effects, such as pain, hematoma, and ecchymosis.[18,26,27]

Major complications, such as DVT, were not observed in either group in our study. Pain, ecchymosis, and sensitivity were the most common side effects and these side effects were significantly higher in the RFA than in the CAE group (Table III). We attribute this to RFA's high thermal effect and the use of TA. Although hematoma risk is greater in this patient group because the use of TA needs multiple injections, there was only one slight hematoma that developed in one patient in our study. Skin burn on a small area occurred in one patient owing to a superficial GSV, and slight paresthesia developed in three patients because of RFA's high thermal effect. These complications quickly improved with simple medical interventions. A pigmentation increase was observed in four patients in RFA group and two patients in CAE group at superficial small parts close to the entry point. There was no significant difference between the groups. Urinary retention occurred in three patients in the RFA group as a result of general or spinal anesthesia.

Table V. Means and overall comparisons for survival time[a]

			95% CI	
Treatment type	Estimate	SE	Lower bound	Upper bound
CAE	11.971	0.029	11.916	12.027
RFA	11.895	0.049	11.783	12.007
Overall	11.932	0.033	11.867	11.996
Overall comparisons		χ^2	dif	Sig
Log-rank (Mantel-Cox)		3.229	1	0.072

CAE, Cyanoacrylate embolization; *CI*, confidence interval; *RFA*, radiofrequency ablation; *SE*, standard error.
[a]Estimation is limited to the largest survival time if it is censored.

In our study, the duration of the procedure is significantly shorter in patients treated with CAE. Whereas RFA is performed under general or spinal anesthesia, CAE is performed under local anesthesia, and the use of TA in RFA increased the duration of the procedure significantly in RFA group. In addition, mobilization in CAE group was achieved quickly, and the length of stay in hospital was also shorter. All these factors reduced the costs and increased patient comfort in favor of CAE. These durations and results are similar to those reported in previous studies.

We report a single-center experience with GSV incompetence, and this study has several limitations. Probably one of the most important limitations of this study is the nature of a retrospective analysis with a midterm follow-up time. Because we just clinical routine—clinical follow-up on day 3 and at months 1, 3, 6, and 12—this follow-up may not provide enough information about patient symptoms. The use of different anesthesias introduces a selection bias. Our clinical practice led us to perform a RFA procedure under general or spinal anesthesia owing to patient choice because of the associated pain. Selection bias is a common issue in the venous insufficiency literature because surgical approaches are an option for comparison. In the best case scenario, we have to compare this new technique with a thermal ablation technique involving TA. Moreover, we focused on the technique and closure rate of incompetent GSV, and we did not analyze the disappearance of varicosities and recurrence of varicose veins. We did not analyze the overall cost of treatment, including treatment cost and the cost related to return to work.

CONCLUSIONS

Based on the present data, our findings suggest that CAE is as effective as RFA ablation with similar rates of successful occlusion. CAE may be associated with less pain and fewer complications than RFA and might provide better patient comfort. The current results should be verified with further randomized, controlled trials with longer term follow-up and larger patient groups.

AUTHOR CONTRIBUTIONS

Conception and design: CO
Analysis and interpretation: CO, MS
Data collection: CO

Writing the article: CO
Critical revision of the article: CO, MS
Final approval of the article: CO, MS
Statistical analysis: Not applicable
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Overall responsibility: CO

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