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Long-term outcomes of radiofrequency ablation versus cyanoacrylate closure for isolated small saphenous vein insufficiency: A comparative study

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ABSTRACT

Background: Endovenous ablation is widely recommended for treating small saphenous vein (SSV) insufficiency, but isolated SSV (iSSV) reflux remains less frequently studied, especially in comparative settings. This study aimed to evaluate the clinical and anatomical outcomes of radiofrequency ablation (RFA) and cyanoacrylate closure (CAC) in patients with iSSV insufficiency.

Methods: A retrospective review was conducted using prospectively collected data from patients undergoing either modality for iSSV. Preoperative duplex ultrasound examination assessed anatomical patterns and reflux. Ablation strategies were tailored to anatomical variations. Follow-up duplex ultrasound examinations were performed at 6 months, 12 months, and up to 24 months in some patients (median follow-up, 12 months; range, 6-24 months). Outcomes included procedure time, vein occlusion rate, symptom improvement, complications, and changes in the Venous Clinical Severity Score and Aberdeen Varicose Vein Questionnaire.

Results: A total of 379 limbs in 306 patients were treated (85 with RFA and 294 with CAC). CAC had a longer procedure time than RFA ($P < .001$) and a higher occlusion rate at follow-up (99.3% vs 91.8%; $P = .006$). Both groups showed significant improvement in Venous Clinical Severity Score, Aberdeen Varicose Vein Questionnaire score, and pain scores ($P < .001$). Sural nerve injury occurred in two limbs treated with RFA and none with cyanoacrylate. Thrombus extension into the deep vein occurred in both groups, without a significant difference.

Conclusions: Both RFA and CAC were effective and safe for treating iSSV insufficiency. Tailoring treatment to individual venous anatomy may improve outcomes and minimize complications such as sural nerve injury. (J Vasc Surg Venous Lymphat Disord 2026;14:102317.)

Keywords: Small saphenous vein insufficiency; Radiofrequency ablation; Cyanoacrylates; Endovascular procedures; Treatment outcome

Endovenous thermal ablation has become the standard treatment for saphenous vein reflux, replacing traditional surgical stripping owing to its high efficacy and favorable safety profile.[1] Although the great saphenous vein (GSV) has been the primary focus of most studies and guidelines, small saphenous vein (SSV) insufficiency is also common and clinically significant, occurring in approximately 15% of patients.[2] Current guidelines support endovenous ablation as a first-line treatment for SSV reflux[3]; however, the evidence base supporting these recommendations is limited, particularly in the context of isolated SSV (iSSV) disease.

Anatomically, the SSV demonstrates greater variability in its course and termination than the GSV, with frequent deviations from the textbook pattern of saphenopopliteal junction (SPJ) drainage.[4,5] The complex anatomical variability of the SSV in our cohort, as detailed in Tables I and II, was a key factor influencing procedural planning and outcomes. Recognition of these patterns allowed us to select optimal access sites and ablation strategies for each patient, thereby reducing complications such as sural nerve injury and improving occlusion durability.[6,7]

Among the available modalities, radiofrequency ablation (RFA) and cyanoacrylate closure (CAC) are widely used and have shown favorable outcomes in general populations.[8,9] However, comparative data focusing specifically on iSSV insufficiency are scarce. Furthermore, long-term outcomes and anatomical durability after

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these procedures in the context of variable SSV anatomy remain underexplored.

This study aimed to compare the clinical efficacy, anatomical durability, and complication profiles of RFA and CAC in patients with iSSV insufficiency, with particular attention to anatomical variation and individualized treatment planning.

METHODS

This retrospective study analyzed a prospectively collected cohort of patients treated for iSSV insufficiency between 2012 and 2024. Patients were included if they underwent RFA or CAC for iSSV insufficiency and had at least one postprocedure follow-up visit. Exclusion criteria included combined GSV and SSV insufficiency, recurrent varicose veins, or secondary venous disease. This study was approved by the Institutional Review Board of Kyung Hee University Hospital at Gangdong (KHNMC 2025-06-029). The requirement for informed consent was waived owing to the retrospective nature of the analysis.

All patients underwent duplex ultrasound examinations to assess venous anatomy, reflux patterns, and baseline vein diameter, reflux time, and peak reflux velocity. Clinical severity was documented using the Clinical-Etiology-Anatomy-Pathophysiology (CEAP) classification, the Venous Clinical Severity Score (VCSS), and the Aberdeen Varicose Vein Questionnaire (AVVQ).

The choice between RFA and CAC was made at the discretion of the treating surgeon. The ablation starting point was individualized based on anatomical variation, as illustrated in Figs 1 and 2. For RFA, the procedure typically began 2 cm distal to the SPJ or to a variant deep vein connection if present. In cases of cranial extension or anatomical variants such as above-knee or below-knee GSV connection or direct popliteal vein drainage,

ARTICLE HIGHLIGHTS

- **Type of Research:** Single-center retrospective analysis of prospectively collected data
- **Key Findings:** In 379 limbs with isolated small saphenous vein insufficiency, cyanoacrylate closure had a higher occlusion rate at 6 and 12 months (97.9% vs 91.8%) and no sural nerve injuries compared with radiofrequency ablation.
- **Take Home Message:** Cyanoacrylate closure and radiofrequency ablation are both effective for treating isolated small saphenous vein insufficiency, but cyanoacrylate offers better vein closure durability and fewer nerve-related complications.

Table I. Demographics (n = 306)

Characteristics	Total	RFA	CAC	*P* Value
No.	306	85	221	
Age, years	54.7 ± 12.3	54.5 ± 13.3	54.8 ± 11.9	.870
Sex (male : female)	159 : 147	50 : 35	109 : 112	.086
BMI, kg/m^2	24.5 ± 3.3	24.9 ± 3.5	24.2 ± 3.2	.211
Symptoms or signs heaviness	218 (71.2)	52 (61.2)	166 (75.1)	.009
Discomfort	252 (82.4)	59 (69.4)	193 (87.3)	<.001
Cramping	192 (62.7)	59 (69.4)	133 (60.2)	.113
Pain	49 (16.0)	22 (25.9)	27 (12.2)	.003
Itching	11 (3.6)	2 (2.4)	9 (4.1)	.531
Swelling	34 (11.1)	12 (14.1)	22 (10.0)	.310
Eczema	1 (0.3)	1 (1.2)	0	.278
Pigmentation	5 (1.6)	3 (3.5)	2 (0.09)	.133
Ulcer	6 (0.2)	2 (2.4)	4 (1.8)	.759
CEAP clinical score	2.3 ± 0.8	2.3 ± 1.1	2.3 ± 0.8	.886
VCSS	4.0 ± 1.9	3.5 ± 0.9	4.4 ± 2.3	.009
AVVQ QoL score	10.1 ± 8.4	6.9 ± 6.7	12.1 ± 8.9	<.001
Involved limbs	379	98	281	.036
Right	109 (35.6)	38 (44.7)	71 (32.1)	
Left	124 (40.5)	34 (40.0)	90 (40.7)	
Both	73 (23.9)	13 (15.3)	60 (27.1)	
Preoperative venous diameter, mm	5.4 ± 2.1	6.0 ± 2.2	5.3 ± 2.1	.018

AVVQ, Aberdeen Varicose Vein Questionnaire; *BMI*, body mass index; *CAC*, cyanoacrylate closure; *CEAP*, Clinical (C), Etiological (E), Anatomical (A), and Pathophysiological (P); *QoL*, quality of life; *RFA*, radiofrequency ablation; *VCSS*, venous clinical severity score.
Values are number (%) or mean ± standard deviation.

Table II. Procedure details (n = 306)

Parameters	Total	RFA	CAC	*P* value
Anesthesia	306	85	221	<.001
General	51 (16.7)	12 (14.1)	39 (17.6)	
Spinal	82 (26.8)	70 (82.4)	12 (5.4)	
MAC	1 (0.3)	1 (1.2)	0	
Local	172 (56.2)	2 (2.4)	170 (76.9)	
Operation time, minutes	50.1 ± 22.5	41.2 ± 18.6	53.5 ± 22.9	<.001
Access sites	379	98	281	<.001
Upper calf	85 (22.4)	73 (74.5)	12 (4.3)	
Mid-calf	48 (12.7)	17 (17.3)	31 (11.0)	
Lower calf	171 (45.1)	6 (6.1)	165 (58.7)	
Ankle	75 (19.8)	2 (2.0)	73 (26.0)	
Injected glue amount	0.75 ± 0.33	NA	0.75 ± 0.33	NA
Concomitant phlebectomy	295 (77.8)	84 (85.7)	211 (75.1)	.193

CAC, Cyanoacrylate closure; *MAC*, monitored anesthesia care; *RFA*, radiofrequency ablation; *NA*, not available.
Values are number (%) or mean ± standard deviation.

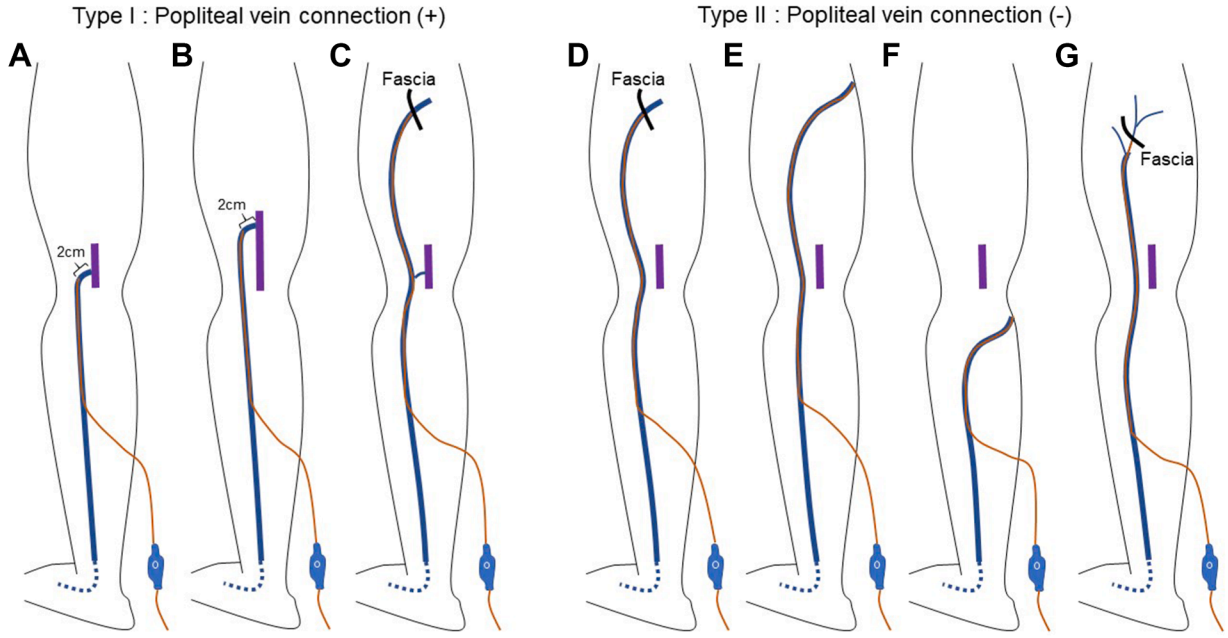


Fig 1. Procedure details about the starting point during radiofrequency ablation (RFA) of the SSV. The starting points were selected depending on the anatomical variations with/without popliteal vein connection. Vein access was made at or above the level of the mid calf. **(A)** Normal anatomical connection: ablation was started 2 cm distal to the saphenopopliteal junction (SPJ). **(B)** High connection: ablation was started 2 cm distal to connection between SSV and deep vein. **(C)** Cranial extension combined with popliteal vein connection: ablation was started from the fascial level and ablation twice at the level of popliteal connection. **(D)** Cranial extension without popliteal vein connection: ablation was started from the fascial level. **(E)** Cranial extension with connected to the AK GSV: ablation was started from the level of GSV connection. **(F)** Cranial extension with connected to the BK GSV: ablation was started from the level of GSV connection. **(G)** Cranial extension with connected to nerve vein or venous network: ablation was started from the fascial level. *AK*, above the knee; *BK*, below the knee; *GSV*, great saphenous vein; *SSV*, small saphenous vein.

the ablation was initiated at the fascial level or the level of the connected segment. When multiple junctions were involved, dual ablation was performed. For CAC, access was obtained at the lowest point of reflux, and glue was delivered beginning 5 cm distal to the SPJ or variant junction. In cases with cranial extension or

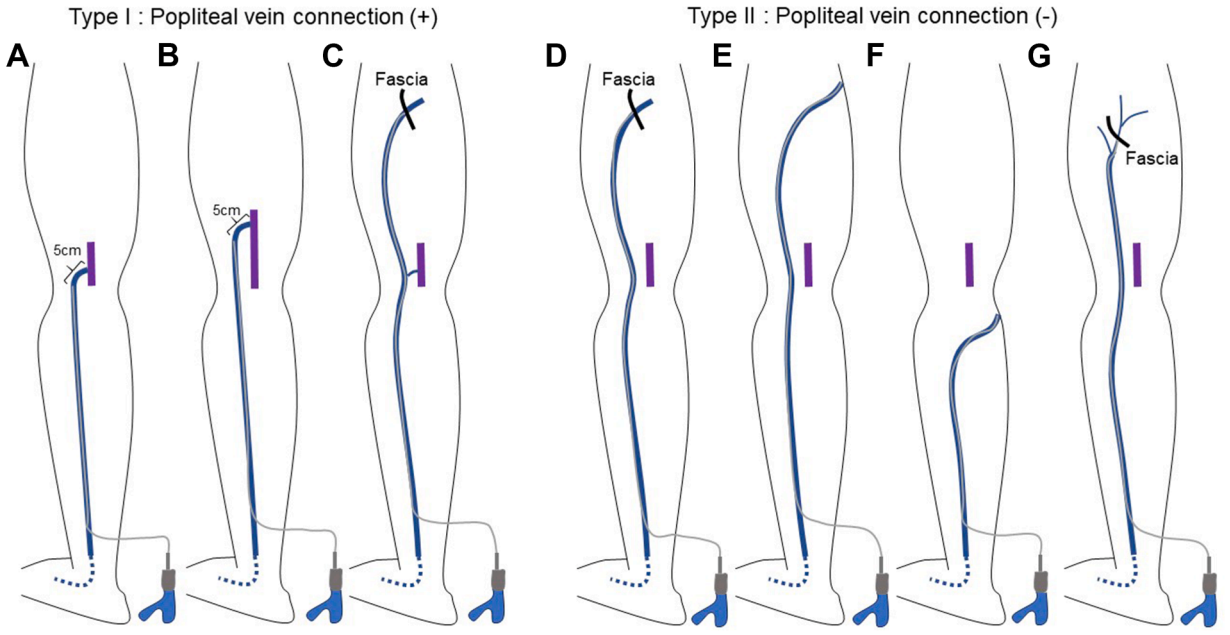


Fig 2. Procedure details about the starting point during cyanoacrylate closure (CAC) of SSV. The starting points were selected depending on the anatomical variations with/without popliteal vein connection. Vein access was at the lowest point with reflux. **(A)** Normal anatomical connection: glue injection was started 5 cm distal to the saphenopopliteal junction (SPJ). **(B)** High connection: glue injection was started 5 cm distal to connection between SSV and deep vein. **(C)** Cranial extension combined with popliteal vein connection: glue injection was started from the fascial level and injection twice at the level of popliteal connection. **(D)** Cranial extension without popliteal vein connection: glue injection was started from the fascial level. **(E)** Cranial extension with connected to the AK GSV: glue injection was started from the level of GSV connection. **(F)** Cranial extension with connected to the BK GSV: glue injection was started from the level of GSV connection. **(G)** Cranial extension with connected to nerve vein or venous network: glue injection was started from the fascial level. *AK*, above the knee; *BK*, below the knee; *GSV*, great saphenous vein; *SSV*, small saphenous vein.

altered termination, injection commenced at the fascial level or connected tributary. Most procedures were performed under local or spinal anesthesia, and concomitant ambulatory phlebectomy was conducted at the surgeon's discretion.

Postoperative follow-up was routinely scheduled at 1 week, 6 months, and 12 months, and annually thereafter when possible. For patients who could not attend scheduled annual visits, follow-up information regarding symptoms, recurrence, and any additional interventions was obtained through structured telephone interviews. In this study, long-term was defined as at least 12 months. The primary outcomes were technical success (defined as occlusion of the treated SSV), recurrence (stump length >2 cm for RFA or >5 cm for CAC from the deep vein confluence or fascia level). Secondary outcomes included procedural time, postprocedural pain, and changes in VCSS and AVVQ scores, deep vein thrombosis, thrombus extension into the deep vein (endovenous heat-induced thrombosis or endovenous glue-induced thrombosis), sural nerve injury, and complex hypersensitivity and irritation reaction (CHAIR) phenomenon. The CHAIR phenomenon was evaluated only in the CAC group, because this reaction is specific to CAC and does not occur with thermal ablation procedures such as RFA. It was defined as any symptoms or signs from pruritus and/or erythema to recurrent severe inflammation, frank abscess formation, and systemic urticaria after CAC.

Descriptive statistics were used to summarize baseline characteristics and outcomes. Continuous variables were reported as means with standard deviations or medians with interquartile ranges, as appropriate. Categorical variables were presented as frequencies and percentages. Categorical variables were compared using the chi-square test, while continuous variables with normal distribution were analyzed using the independent *t* test. To assess changes in AVVQ and VCSS scores before and after treatment within each group (RFA and CAC), the difference was compared with the independent *t* test. A *P* value of less than .05 was considered statistically significant. All analyses were conducted using SPSS version 22.0 (IBM).

RESULTS

A total of 452 limbs with suspected SSV insufficiency were initially assessed. Of these, 33 limbs were excluded owing to concomitant GSV reflux, previous

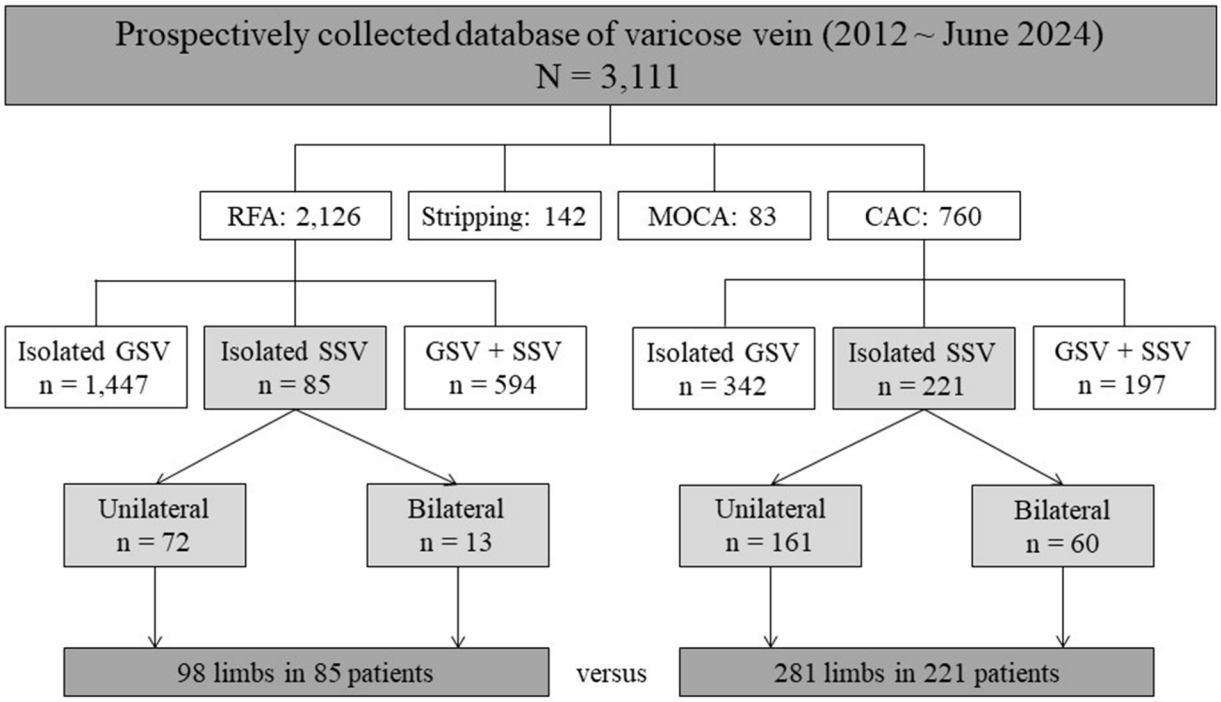


Fig 3. CONSORT diagram of the study cohort. *CAC*, cyanoacrylate closure; *GSV*, great saphenous vein; *MOCA*, mechanochemical ablation; *RFA*, radiofrequency ablation; *SSV*, small saphenous vein.

venous intervention, or incomplete clinical data. The remaining 419 limbs underwent endovenous treatment. After excluding 40 limbs without available follow-up duplex ultrasound examinations, 379 limbs in 306 patients were included in the final analysis. Among them, 85 limbs underwent RFA and 294 CAC (Fig 3). The median follow-up duration was 12 months (range, 6-24 months).

Baseline characteristics are summarized in Table I. The mean patient age was 54.7 ± 12.3 years, and 48% of patients were female. There were no significant differences in age, sex, or body mass index between the RFA and CAC groups. However, limbs treated with CAC had significantly higher preoperative VCSS and AVVQ scores than those treated with RFA (Table I). The mean diameter of the treated veins was 5.4 ± 2.1 mm (median, 5.0 mm; interquartile range, 3.9-6.3 mm).

Procedural details are presented in Table II. The mean procedure time was significantly longer in the CAC group compared with the RFA group (53.5 ± 22.9 minutes vs 41.2 ± 18.6 minutes; $P < .001$). Local anesthesia was more frequently used in the CAC group (76.9% vs 2.4%; $P < .001$). The access site and target segments varied according to individual anatomical patterns. Notably, upper calf access was more commonly used in the RFA group, and lower calf access was predominantly used in the CAC group. Concomitant phlebectomy was performed in 77.8% of treated limbs.

Both groups showed significant improvements in VCSS and AVVQ scores after the procedure (Table III). The mean VCSS decreased from 4.0 ± 1.9 to 1.0 ± 1.2 ($P < .001$), and the AVVQ score improved from 10.1 ± 8.4 to 6.7 ± 5.8 ($P < .001$), with no significant differences between treatment groups in the magnitude of improvement. Postprocedural pain also decreased significantly, from 1.9 ± 0.5 to 0.3 ± 0.7 ($P < .001$).

Recanalization occurred in 4 limbs (1.1%) within the first month, 6 limbs (1.6%) by 3 months, and 14 limbs (3.7%) by both 6 and 12 months. At both 6 and 12 months, recanalization was significantly more frequent in the RFA group (8.2%) than in the CAC group (2.1%) ($P = .011$ and $P = .006$, respectively).

Complications are summarized in Table IV. Sural nerve injury occurred in two limbs treated with RFA (2.0%) and was not observed in the CAC group ($P = .016$). Thrombus extension into the deep vein was observed in 10 limbs (2.6%), mostly grade I, without a significant difference between treatment groups ($P = .307$). One case of CHAIR was reported in the CAC group. One patient with a prior history of traumatic deep vein thrombosis in the left leg developed a new, very focal thrombus confined to the left popliteal vein at a segment with chronic post-thrombotic change after CAC. The lesion showed no progression on short-term follow-up ultrasound examination, and the patient's swelling improved. Anticoagulation was not initiated, and at the 6-month follow-up,

Table III. Clinical outcomes (n = 306)

Parameter	Total	RFA	CAC	*P* Value
VCSS				
Preoperative	4.0 ± 1.9	3.5 ± 0.9	4.4 ± 2.3	.415
Postoperative	1.0 ± 1.2	0.6 ± 1.2	1.3 ± 1.2	
Difference	2.9 ± 1.9	2.8 ± 0.4	3.1 ± 2.4	
P value	<.001	<.001	<.001	
AVVQ QoL score				
Preoperative	10.1 ± 8.4	6.9 ± 6.7	12.1 ± 8.9	.644
Postoperative	6.7 ± 5.8	3.4 ± 4.7	8.8 ± 5.5	
Difference	3.4 ± 7.3	3.5 ± 2.6	4.1 ± 9.5	
P value	<.001	<.001	.001	
Pain score				
Just after the procedure	1.9 ± 0.5	NA	1.9 ± 0.5	NA
Postoperative 7 days	0.3 ± 0.7		0.3 ± 0.7	
Difference	1.6 ± 0.9		1.6 ± 0.9	
P value	<.001		<.001	

AVVQ, Aberdeen Varicose Vein Questionnaire; *CAC*, cyanoacrylate closure; *NA*, not available; *QoL*, quality of life; *RFA*, radiofrequency ablation; *VCSS*, Venous Clinical Severity Score.
Values are mean ± standard deviation.

Table IV. Complications (n = 306)

Parameter	Total	RFA	CAC	*P* Value
Follow-up, days	220 ± 336	250 ± 363	146 ± 243	.016
Recurrence	n = 379	n = 98	n = 281	
Within 1 month	4 (1.1)	0	4 (1.4)	.355
Within 3 months	6 (1.6)	2 (2.0)	4 (1.4)	.651
Within 6 months	14 (3.7)	8 (8.2)	6 (2.1)	.011
Within 12 months	14 (3.7)	8 (8.2)	6 (2.1)	.006
Deep vein thrombosis	1 (0.3)	0	1 (0.4)	1.000
Thrombus extension	10 (2.6)	1 (1.0)	9 (3.2)	.307
Grade I	9 (2.4)	1 (1.0)	8 (2.8)	.457
Grade II	1 (0.3)	0	1 (0.4)	1.000
Grade III	0	0	0	NA
Grade IV	0	0	0	NA
Numbness (sural nerve)	2 (0.5)	2 (2.0)	0	.016
CHAIR	1 (0.3)	NA	1 (0.4)	NA

CAC, Cyanoacrylate closure; *CHAIR*, complex hypersensitivity and irritation reaction; *NA*, not available; *RFA*, radiofrequency ablation.
Recurrence was defined as the distance from the visible junction of deep vein or fascia level to the leading edge of occlusion that is longer than 2 cm and 5 cm after RFA and CAC, respectively.
Values are number (%) or mean ± standard deviation.

duplex ultrasound examination confirmed complete resolution.

DISCUSSION

This study presents long-term clinical and anatomical outcomes after endovenous treatment for iSSV insufficiency. Our findings demonstrate that both RFA and CAC are effective in achieving durable symptom relief and high vein occlusion rates, with low complication rates and acceptable recurrence profiles.

A significant difference in access site location was observed between the two treatment groups, reflecting differences in procedural technique. RFA typically requires upper calf access to enable safe catheter positioning and to minimize the risk of thermal injury to surrounding structures, particularly the sural nerve. In contrast, CAC, as a nonthermal, nontumescent (NTNT)

technique, permits more distal and flexible access site selection. This flexibility not only facilitates avoidance of nerve injury, but also allows more comprehensive treatment of all refluxing segments. Although this advantage is characteristic of NTNT techniques in general, the comparable occlusion rates achieved by CAC relative to RFA underscore its clinical effectiveness.[9,10]

Sural nerve injury is a known complication of SSV ablation, particularly with thermal modalities. In our cohort, sural nerve injury—presenting as sensory disturbance or numbness—was observed in 2.0% of RFA-treated limbs and in none of the CAC-treated limbs. This finding aligns with previous reports showing that the incidence of sural nerve injury after thermal ablation of the SSV ranges from approximately 1.4% to 6.6%, depending on technique and access level.[6,11,12] This difference underscores the importance of access site selection, because nerve injury risk increases in the mid-calf region, where the sural nerve lies in close proximity to the SSV. The absence of nerve injury in the CAC group likely reflects the procedural advantage of NTNT techniques, which allow greater flexibility in selecting safer, more distal puncture sites. Furthermore, avoiding thermal spread and ensuring precise anatomical planning are critical to minimizing nerve-related complications during endovenous treatment.

Thrombosis-related events were infrequent in our cohort. One patient with a history of traumatic deep vein thrombosis developed a new, very focal thrombus confined to the popliteal vein at a segment with preexisting post-thrombotic change after CAC. The thrombus was stable on serial duplex ultrasound examinations and resolved spontaneously by 6 months without anticoagulation. In addition, thrombus extension into the deep vein was observed in 2.6% of limbs, mostly grade I, with no significant differences between RFA and CAC. These findings indicate that although thrombotic events may occur after SSV ablation, they are generally limited in extent and self-limiting with careful surveillance.

Interestingly, in the long-term follow-up of our cohort, postoperative recanalization was observed more frequently in the RFA group, a finding that contrasts with prior literature reporting similar long-term occlusion rates with RFA compared with CAC.[9,13] This discrepancy may reflect procedural nuances, particularly in treating iSSV, where the anatomical variability and need for precise segmental coverage are critical. In our experience, the ability of CAC to cover the full length of the refluxing segment without reliance on segmental heating or the need for multiple catheter pullbacks may have contributed to more durable closure. Complete and consistent treatment of the diseased segment seems to be essential in preventing late recanalization, especially in anatomically challenging regions like the SSV.

In our cohort, the prevalence of CHAIR was notably low, with only one case observed after CAC. This result is favorable compared with previous studies, where the reported prevalence of CHAIR or hypersensitivity reactions has varied widely, ranging from 0.3% to 25.4%, depending on diagnostic definitions and patient selection.[14] For instance, a retrospective Thai study involving 126 limbs reported hypersensitivity reactions in 15.0% of treated limbs, most of which were self-limited and resolved within 1 week using nonsteroidal anti-inflammatory drugs or antihistamines.[15] Importantly, more than 80% of the treated veins in that study were GSVs, which generally require longer treatment segments and therefore greater volumes of cyanoacrylate. This result contrasts with findings from our cohort, which was composed exclusively of patients with iSSV insufficiency, where the shorter anatomical length of the treated segment likely allowed for smaller volumes of cyanoacrylate injection. This procedural difference may contribute to the lower incidence of CHAIR observed in our study. However, it should be noted that no robust studies have established a direct correlation between the volume of cyanoacrylate used and the likelihood or severity of hypersensitivity reactions. Although smaller volumes seem intuitively less immunogenic, current evidence remains anecdotal.

Additionally, a large multicenter study from the United States reported type IV hypersensitivity reactions in 13% of patients (10.4% of procedures) after cyanoacrylate treatment, with some cases requiring corticosteroid therapy.[16] Taken together, these findings suggest that, although CHAIR is a recognized and relatively frequent complication in GSV treatment, it may occur less commonly in iSSV patients owing to anatomical and procedural differences. Nevertheless, clinicians should remain vigilant, because hypersensitivity reactions, although less frequent in this subgroup, are not entirely avoidable.

It is also noteworthy that the CAC group exhibited higher VCSS and AVVQ scores both preoperatively and postoperatively compared with the RFA cohort, although the CEAP clinical class remained similar between groups. This finding suggests a discrepancy between physician-assessed disease severity and patient-reported symptom burden. Previous studies have demonstrated only moderate correlation between CEAP class and VCSS (Spearman's $r \approx 0.49$; $P < .0001$), indicating that clinical examination may not fully capture the subjective experience of disease severity.[17] Even though baseline symptom burden may have been greater in the CAC group, both modalities achieved significant and comparable improvements, underscoring the effectiveness of RFA and CAC in treating iSSV insufficiency.

Concomitant phlebectomy was performed in 77.8% of our patients, a practice that aligns with existing

evidence suggesting enhanced patient satisfaction and quality of life when varicosities are treated alongside truncal ablation. A randomized trial comparing endovenous laser ablation with either concomitant ambulatory phlebectomy or staged phlebectomy demonstrated significantly better Short Form 36, AVVQ, and VCSS scores at early follow-up in the concomitant treatment group, without increased pain or complications.[18,19] Additionally, a recent survey of outpatient endovenous services reported high levels of patient satisfaction when phlebectomy was performed during the same session. Although our study was not designed to isolate the effect of phlebectomy, the high use likely contributed to the notable improvements seen in VCSS and AVVQ scores, suggesting that the comprehensive treatment of both truncal and tributary veins may yield optimal clinical and patient-reported outcomes.

In the Korean health care setting, monitored anesthesia care is not reimbursed by the national health insurance system. As a result, spinal anesthesia was more frequently used in the RFA group, whereas the CAC procedures were predominantly performed under local anesthesia. Although concomitant phlebectomy was performed at similar rates in both groups, CAC offered a procedurally simpler approach by eliminating the need for tumescent anesthesia. This allowed the entire procedure to be completed with local anesthesia alone, improving procedural efficiency and patient comfort. This practical advantage of CAC may be particularly relevant in health care systems with reimbursement limitations for anesthetic support. Current guidelines from the Society for Vascular Surgery, American Venous Forum, and American Vein and Lymphatic Society recommend endovenous thermal ablation as first-line treatment for SSV reflux.[3] According to the 2024 Society for Vascular Surgery, American Venous Forum, and American Vein and Lymphatic Society Part II guidelines, for patients with symptomatic axial reflux of the SSV, either thermal or nonthermal ablation from the knee to the upper or mid-calf is recommended, depending on available expertise.[20] However, these guidelines do not address iSSV insufficiency specifically or provide guidance on nonthermal techniques such as CAC. Our findings suggest that CAC, with its favorable safety profile and durable occlusion, may warrant consideration as a guideline-supported option for anatomically complex iSSV cases.

A key strength of this study is its focus on a relatively underexplored patient group—those with iSSV insufficiency—using a comparatively large cohort and real-world data from routine clinical practice. The comparison between RFA and CAC was based on standardized outcome measures including duplex ultrasound examination-confirmed occlusion, VCSS, AVVQ, and documented complications, enabling meaningful clinical interpretation. Anatomical variations were considered in procedural planning, reflecting practical decision-making in contemporary endovenous therapy.

However, this study has several limitations. First, although a cohort-matched or propensity score-matched analysis could have strengthened the statistical validity, the marked imbalance in group sizes (85 RFA vs 294 CAC) would have significantly reduced the analyzable sample. For this reason, we used subgroup analyses and standard statistical comparisons instead. Second, its retrospective design may introduce selection bias, despite the use of prospectively collected data. Third, a follow-up duplex ultrasound examination was available for only a subset of patients, potentially limiting the generalizability of detailed anatomical outcomes. Fourth, the decision to use RFA or CAC was not randomized but left to physician discretion, which may have introduced treatment selection bias. Finally, although we observed a low rate of hypersensitivity reactions in the CAC group, this finding is based on a small number of events and should be interpreted with caution.

CONCLUSIONS

Although both RFA and CAC were effective and safe for treating iSSV insufficiency, CAC was associated with lower recanalization rates and reduced anesthesia requirements, without the risk of sural nerve injury. These findings support the use of anatomically tailored approaches when selecting endovenous treatments for iSSV.

AUTHOR CONTRIBUTIONS

Conception and design: HK, SC, SK, JJ
Analysis and interpretation: HK, SC, SK, JJ
Data collection: JJ
Writing the article: HK
Critical revision of the article: HK, SC, SK, JJ
Final approval of the article: HK, SC, SK, JJ
Statistical analysis: JJ
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None.

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