Clinical outcomes of nonthermal ablation, thermal ablation, and surgical stripping for varicose veins

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ABSTRACT

Objective: The purpose of this study was to compare the clinical outcomes of radiofrequency ablation (RFA), cyanoacrylate closure (CAC), mechanochemical ablation (MOCA), and surgical stripping (SS) for incompetent saphenous veins and to determine a suitable treatment modality for a specific clinical situation.

Methods: We retrospectively reviewed the data of patients with varicose veins who underwent RFA, CAC, MOCA, or SS from January 2012 to June 2023. The clinical outcomes, including postoperative complications and the Aberdeen Varicose Vein Questionnaire score, were assessed.

Results: During the study period, 2866 patients with varicose veins were treated. Among them, 1670 patients (57.9%) were women. The mean age was 55.3 ± 12.9 years. RFA, CAC, MOCA, and SS were performed in 1984 (68.7%), 732 (25.4%), 78 (2.7%), and 88 (3.0%) patients, respectively. The complete target vein closure rate after RFA, CAC, and MOCA was 94.5%, 98%, and 98%, respectively. The absence of a target vein after SS was 98%. Deep vein thrombosis developed in four patients: one in the RFA group and three in CAC group. Surgical or endovenous procedure-induced thrombosis occurred in 2.3%, 4.8%, 6.4%, and 2.3% of the patients after RFA, CAC, MOCA, and SS, respectively. Phlebitis along the target vein occurred in 0.2% and 3.8% of patients after RFA and MOCA, respectively. A hypersensitivity reaction occurred in 3.7% of patients after CAC. Readmission was required for two patients who had undergone SS. Transient nerve symptoms developed in five (0.3%), zero, one (1.3%), and two (2.3%) patients after RFA, CAC, MOCA, and SS, respectively. After treatment, the Aberdeen Varicose Vein Questionnaire score improved significantly in all groups.

Conclusions: The clinical outcomes with improvement in quality of life were comparable among the different treatment modalities. The proximity of the nerve or skin to the target vein is the most important factor in selecting a suitable treatment modality. (J Vasc Surg Venous Lymphat Disord 2024;12:101902.)

Keywords: Mechanochemical ablation; Nonthermal ablation; Radiofrequency ablation; Quality of life; Surgical stripping; Varicose vein

Varicose vein surgeries are one of the most performed vascular surgeries. The treatment of incompetent truncal veins has shifted from conventional surgical stripping (SS) to minimally invasive endovenous modalities, such as thermal and nonthermal ablation during the past 2 decades. Endovenous techniques are suggested as the primary treatment modality by many organizations, including the National Institute for Health and Care Excellence, Society for Vascular Surgery, American Venous Forum, and European Society for Vascular Surgery.

All these techniques have been reported to be similarly effective, with high closure rates.[1-3] However, each procedure has its own strengths and weaknesses. Thermal techniques, including radiofrequency ablation (RFA) and endovenous laser ablation, have a risk of heat-related nerve or skin damage and involve tumescent injection. Nonthermal, nontumescent techniques, including cyanoacrylate closure (CAC) and mechanochemical ablation (MOCA), are associated with thrombophlebitis or allergic reactions.[2,4,5]

Therefore, to select the treatment options that can yield the best clinical outcomes, the anatomic characteristics of the refluxing vein and the features of the different procedures must be considered concurrently. We aimed to compare the clinical outcomes of the selected treatment modalities of incompetent saphenous veins.

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METHODS

Study design. This retrospective, single-center, observational study was performed between July 2012 and January 2023. It included consecutive symptomatic patients with primary varicose veins with an incompetent saphenous veins, including the great saphenous vein (GSV), small saphenous vein (SSV), and/or accessory saphenous vein. The indications for treatment were clinical grade C2-C6 and subjective symptoms relevant to venous reflux. The institutional review board of Kyung Hee University Hospital (Gangdong, Seoul, Korea) approved the study (KHMNC 2022-07-026). The institutional review board waived the need for written informed consent because this study was retrospective and no changes were made in the treatment plan. This study complied with the principles of the Declaration of Helsinki.

Preoperative evaluation. The preoperative evaluation included physical examination, duplex ultrasound, CEAP (clinical, etiological, anatomical, pathophysiological) assessment, and the Aberdeen Varicose Vein Questionnaire (AVVQ). A preoperative duplex ultrasound scan was used to measure the presence of reflux, lowest part of reflux, and depth from the skin to the saphenous vein. Reflux was defined as a reversed flow lasting for >0.5 second after manual compression of the calf in the standing position, visualized by duplex ultrasound.[4] Reflux was measured at four sites of the GSV (saphenofemoral junction, midthigh, lower thigh, and below-knee [BK]) and near the saphenopopliteal junction, midcalf, and lower calf for the SSV. Patients with congenital vascular malformations, current deep vein thrombosis (DVT), or non-saphenous varicosities were excluded from this study. Patients with post-thrombotic syndrome were also excluded because the clinical outcome of superficial vein treatment in these patients might be different from that of those with primary varicose veins. Venous ulcer patients with primary superficial venous incompetence were included, excluding ulcer patients with post-thrombotic syndrome.

Procedures. The selection of the procedure was primarily based on a predetermined process at our center, and patient preferences were also considered after a discussion about the advantages and disadvantages of each modality (Fig 1). All procedures were performed by two vascular surgeons. For SS, all types of anesthesia were used. SS was performed using a horizontal incision in the groin, with division and ligation of the GSV at the junction and division of all tributaries. The GSV was removed using an intraluminal stripper. All endovenous procedures were performed according to the manufacturer's instructions, with no modifications (as shown in the Appendix, Online only). The access site was at the most distal possible point of reflux. If the distal point of reflux was located <5 mm from the skin on ultrasound before tumescent injection, the saphenous vein was accessed from below the saphenous fascia, and the remaining part was removed by micro-phlebectomy. All types of anesthesia, including general, spinal, regional block, and local anesthesia, were used, depending on the patient's condition or preference. Concomitant phlebectomies were performed at the time of surgery in accordance with the disease pattern and the patient's desire. Compressive stockings were used for all patients, except for those treated with CAC without concomitant phlebectomy. When removing enlarged tributaries near the saphenous or sural nerve territory at the calf, phlebectomy was performed either with intraoperative ultrasound examination of the nerve or through a larger incision to visually inspect the nerve attached to the vein directly, thus preventing nerve injury.

ARTICLE HIGHLIGHTS

- **Type of Research:** A single-center, retrospective cohort study
- **Key Findings:** The Aberdeen Varicose Vein Questionnaire score improved significantly in all 2866 patients with varicose veins treated with radiofrequency ablation, cyanoacrylate closure, mechanochemical ablation, and surgical stripping. The postoperative clinical outcomes, including procedure-induced thrombosis in adjacent junctions, transient nerve symptoms, and target vein closure rate, were comparable among the different treatment modalities.
- **Take Home Message:** Clinical outcomes with improvement in quality of life were comparable among the different treatment modalities. The proximity of the nerve or skin to the target vein is the most important factor in selecting a suitable treatment modality.

Postoperative evaluation and outcome measures. The postprocedural evaluation included physical examination of the occurrence of adverse events (AEs), ultrasound examination of recanalization or procedure-induced thrombosis, and completion of the AVVQ at 2 weeks and 3 to 6 months postoperatively. A postoperative ultrasound examination was performed to assess the treated truncal vein and the deep venous system from the common femoral vein to the popliteal vein at 2 weeks and 3 months postoperatively, and as needed thereafter. When a procedure-induced junctional thrombus on routine postoperative ultrasound or symptoms suggestive of DVT were found during follow-up, all the lower extremity veins were scanned. Postoperative follow-up was performed within 2 weeks, 6 months, and 12 months after surgery. The primary outcome measure was the incidence of postoperative AEs and

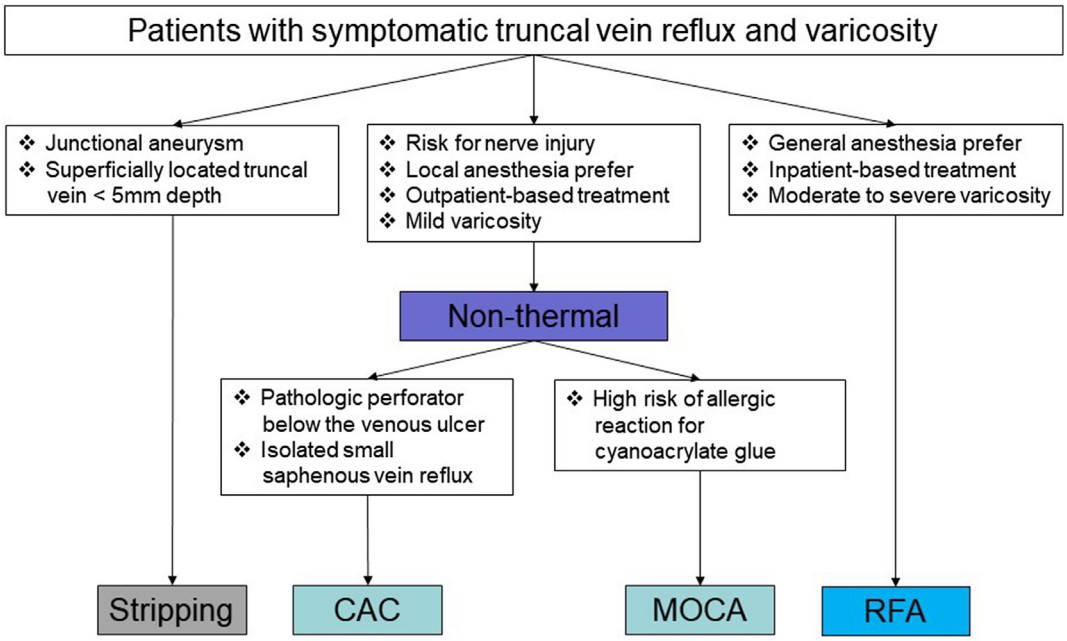


Fig 1. Procedure selection. *CAC,* Cyanoacrylate closure; *MOCA,* mechanochemical ablation; *RFA,* radiofrequency ablation; *SS,* surgical stripping.

recanalization or recurrence. Serious AEs included death, pulmonary embolism, DVT, myocardial infarction, transient ischemic attack or stroke, visual symptoms, anaphylaxis, hemorrhage requiring transfusion or surgery, permanent neuralgia, surgical or endovenous procedure-induced thrombosis, and any events that require readmission.

Minor AEs included wound infection, superficial thrombophlebitis, paresthesia (numbness or hyperesthesia), erythema, pigmentation, lymphatic complications (edema or lymphocele), hematoma not requiring treatment or transfusion (ecchymosis along the ablated veins, erythema, bruising, and groin hematoma), and complex hypersensitivity and irritation reaction (CHAIR).[6] The secondary outcome measure was the quality-of-life score. The procedural time, access site for truncal ablation, and actual stump length immediately after the endovenous procedure and 6 months postoperatively were reviewed to compare each procedure. Recanalization was defined as reopening of an area that was previously closed or when the saphenous trunk stump length was longer than the immediate postoperative stump length.

Statistical analysis. Categorical variables are presented as numbers and percentages. Continuous variables are expressed as the mean ± standard deviation after the normality test (Kolmogorov-Smirnov test). If data were not normally distributed, the median and interquartile range (IQR) were reported instead. These results provide a detailed interpretation of the characteristics of the study population. Statistical analysis was performed using two-way repeated measures analysis of variance, and Tukey's b test was used for post hoc analysis to compare the pre- and postoperative AVVQ scores. Statistical significance was set at $P < .05$. All statistical analyses were performed using SPSS, version 2e (IBM Corp).

RESULTS

Baseline characteristics. The baseline patient characteristics are summarized in Table I. During the study period, 2866 patients with varicose veins were treated. The mean age was 55.3 ± 12.9 years. The most common symptom was pain (n = 2099; 72.7%), followed by heaviness (n = 1849; 64.1%), and swelling (n = 553; 19.2%). The mean diameter of the treated GSV was 5.8 ± 1.4 mm and that of the SSV was 3.4 ± 1.2 mm. The mean procedural time was the longest for CAC and the shortest for MOCA ($P < .001$). In the CEAP classification, C2 and C3 patients accounted for the majority; however, the ratio of C5 and C6 patients in the CAC group was higher. All active ulcers had completely healed after the procedure within 6 months; however, perforator ligation was required in one patient who underwent RFA owing to a postoperative recurrent ulcer after 1364 days. In 2568 patients (89.0%) with GSV reflux, the lowest part of reflux was the upper thigh in 77 patients (3.0%), midthigh in 316 (12.3%), lower thigh in 913 (35.6%), and BK in 1262 patients (49.1%). The depth of the GSV was >5 mm in the upper thigh segment only in 88 patients (3.4%), from the junction to the midthigh in 213 (8.3%), to the lower thigh in 356 (13.9%), to the BK in 527 (20.5%), and the entire length of the leg in 1384 patients (53.9%). The lower thigh

Table I. Baseline characteristics

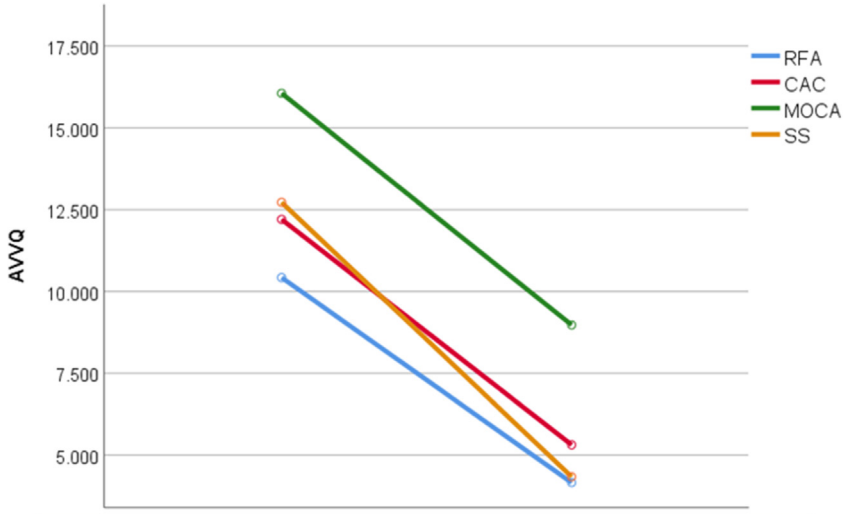
Characteristic	RFA	CAC	MOCA	SS
Patients	1984 (68.7)	732 (25.4)	78 (2.7)	88 (3.0)
Age, years	54.8 ±13.2	56.6 ± 12.0	44.4 ± 10.2	56.7 ± 11.6
Female sex	1083 (54.6)	482 (65.8)	73 (93.6)	30 (34.1)
Both legs	1280 (64.5)	313 (42.8)	37 (48.7)	13 (15.7)
Treated veins, No.				
1	634 (32.0)	365 (49.9)	37 (48.7)	70 (84.3)
2	983 (49.5)	287 (39.2)	39 (51.3)	13 (15.7)
3	282 (14.2)	61 (8.3)	0 (0.0)	0 (0.0)
4	84 (4.2)	19 (2.6)	0 (0.0)	0 (0.0)
Clinical CEAP class				
C2	1609 (81.1)	538 (73.5)	67 (85.9)	66 (79.5)
C3	260 (13.1)	117 (16.0)	11 (14.1)	11 (13.3)
C4	107 (5.4)	48 (6.6)	0 (0.0)	5 (6.0)
C5	8 (0.4)	13 (1.8)	0 (0.0)	1 (1.2)
C6	0 (0.0)	16 (2.2)	0 (0.0)	0 (0.0)
AVVQ score	12.4 ± 8.7	2.4 ±1.2	9.5 ± 6.6	5.6 ± 6.1
Procudure time, minutes	62.3 ± 28.8	61.2 ± 29.8	43.6 ± 16.8	65.3 ± 33.0
Anesthesia				
General	1180 (59.5)	125 (17.1)	4 (5.3)	47 (56.6)
Spinal	761 (38.4)	43 (5.9)	2 (2.6)	27 (32.5)
MAC	19 (1.0)	0 (0.0)	0 (0.0)	0 (0.0)
Local	24 (1.2)	563 (77.0)	70 (92.1)	9 (10.8)
Concomitant phlebectomy	1976 (99.6)	701 (95.8)	72 (92.3)	87 (98.9)

AVVQ, Aberdeen Varicose Vein Questionnaire; *CAC*, cyanoacrylate closure; *CEAP*, clinical, etiological, anatomical, pathophysiological; *MAC*, monitored anesthesia care; *MOCA*, mechanochemical ablation; *RFA*, radiofrequency ablation; *SS*, surgical stripping.
Data presented as number (%) or mean ± standard deviation.

Table II. Postoperative complications

	RFA	CAC	MOCA	SS
Follow-up, months	6.0	6.6	1.0	24
Deep vein thrombosis	1 (0.1)	3 (0.4)	0 (0.0)	0 (0.0)
Procedure-induced junctional thrombosis	NA	NA	NA	2 (2.3)
Endovenous procedure-induced thrombosis[a]	47 (2.3)	35 (4.8)	5 (6.4)	NA
Grade I	35 (1.8)	25 (3.4)	5 (6.4)	NA
Grade II	8 (0.4)	9 (1.2)	0 (0.0)	NA
Grade III	4 (0.2)	1 (0.1)	0 (0.0)	NA
Grade IV	0 (0.0)	0 (0.0)	0 (0.0)	NA
Minor complication	41 (2.1)	32 (4.4)	5 (6.4)	67 (76.1)
Phlebitis along target vein	4 (0.2)	NA	3 (3.8)	NA
CHAIR	0 (0.0)	27 (3.7)	0 (0.0)	0 (0.0)
Recanalization/recurrence[b]	124 (6.3)	28 (3.8)	2 (2.6)	1 (1.2)

CAC, Cyanoacrylate closure; *CHAIR*, complex hypersensitivity and irritation reaction; *GSV*, great saphenous vein; *MOCA*, mechanochemical ablation; *NA*, not applicable; *RFA*, radiofrequency ablation; *SS*, surgical stripping; *SSV*, small saphenous vein.
Data presented as median or number (%).
[a]Endovenous procedure-induced thrombosis includes endovenous heat-induced thrombosis for RFA, endovenous glue-induced thrombosis for CAC, and endovenous sclerosant-induced thrombosis for MOCA.
[b]Recanalization defined as partial or total recanalization along treated saphenous vein.



AVVQ [mean (SD)]	Preoperative	Postoperative
RFA	10.4 (6.7)	4.2 (4.2)
CAC	12.2 (8.6)	5.3 (5.4)
MOCA	16.1 (10.5)	9.0 (3.8)
SS	12.7 (9.1)	4.3 (4.8)

- Treatment method, p<0.001
- AVVQ, p<0.001

Fig 2. Pre- and postoperative Aberdeen Varicose Vein Questionnaire (*AVVQ*) score. *CAC,* Cyanoacrylate closure; *MOCA,* mechanochemical ablation; *RFA,* radiofrequency ablation; *SD,* standard deviation; *SS,* surgical stripping.

and the BK GSV were the most frequently accessed sites. For SSV ablation, the upper calf to mid-calf level was most frequently accessed for RFA or MOCA and the lower calf to ankle for CAC. Additional micro-phlebectomy to remove a superficially located truncal vein was performed in 713 patients (36.0%) in the RFA group, 78 (10.7%) in the CAC group, and 0 patients (0.0%) in the MOCA group. Depending on the access site, micro-phlebectomy of the truncal vein was performed in 34.7% of cases with lower thigh access and in 7.2% with BK access. Concomitant phlebectomy was performed in most cases (n = 2836; 98.9%): RFA, 1976 (99.6%); CAC, 701 (95.8%); MOCA, 72 (92.3%); and SS, 87 (98.9%).

Primary outcome. The postoperative complications are summarized in Table II. Overall, 265 patients (9.2%) experienced minor or serious AEs. None of the patients had pulmonary embolism, myocardial infarction, transient ischemic attack, or stroke. DVT developed in four patients: one in the RFA group and three in the CAC group. Readmission was required for two patients who had undergone the SS procedure: one patient with cellulitis and one patient with hematoma. Surgical or endovenous procedure-induced thrombosis developed in 47 patients (2.3%) in the RFA group, 35 (4.8%) in the CAC group, 5 (6.4%) in the MOCA group, and 2 patients (2.3%) in the SS group. Most of the thrombosis did not extend into the deep vein, except for 22 patients. It extended into the deep vein >50% in four patients in the RFA group and one patient in the CAC group. Phlebitis along the target vein developed in four patients (0.2%) in the RFA group and three patients (3.8%) in the MOCA group. Among the patients with endovenous heat-induced thrombosis, those with grade I and II were simply followed up without anticoagulation. Those with grade III were treated with anticoagulation until the thrombus had retracted. Transient hyperesthesia or numbness owing to nerve injury developed in five patients (0.3%) in the RFA group, one (1.3%) in the MOCA group, and two patients (2.3%) in the SS group. CHAIR developed in 27 patients (3.7%) in the CAC group.

Follow-up outcome. The median follow-up periods were 181 days (IQR, 80–363 days), 198 days (IQR, 121–474 days), 29 days (IQR, 21–191 days), and 720 days (IQR, 180–720 days) for RFA, CAC, MOCA, and SS, respectively. The complete target vein closure rate after RFA, CAC, and MOCA was 94.5%, 98%, and 98%, respectively. Serially measured AVVQ scores are presented in Fig 2. After treatment, the AVVQ score improved significantly in all groups compared with the preoperative score ($P < .001$).

The AVVQ score for the MOCA group showed improvement; however, it remained worse than that of the other groups both at baseline and at follow-up, despite the

lower CEAP class ($P < .001$). The stump length measured immediately after the procedure and during follow-up was 16.4 ± 6.8 mm and 14.0 ± 9.6 mm in the RFA group, 24.8 ± 16.6 mm and 23.6 ± 15.8 mm in the CAC group, and 1.4 ± 0.4 mm and 10.4 ± 10.7 mm in the MOCA group, and the difference was statistically significant ($P < .001$). The stump length in the CAC group was significantly longer than that in the other groups ($P < .001$).

DISCUSSION

Various options are available for the treatment of incompetent saphenous veins, and the efficacy of each of the modalities is known to be similar.[7] This study was aimed to define selection hierarchy of each treatment modality in certain clinical situations by comparing the treatment outcomes selected according to the criteria set by the operators.

A recent study showed that reflux from the groin to the ankle is best controlled with both above-knee and BK GSV ablation, and a lower incidence of saphenous nerve injury was observed with thermal ablation than with BK stripping.[8] However, intervention on the GSV has traditionally been limited to the above-knee segment because of the high chance of saphenous neuralgia with BK segment ablation.[9] Despite persistent incompetence demonstrated in the BK segment, adequate symptomatic relief can be achieved with above-knee ablation in most patients.[10] Therefore, consideration balancing the symptomatic relief against the risks, such as nerve injury, is the most important factor in selecting the proper treatment modality and extent, which can maximize patient satisfaction with good clinical outcomes. In our study, treating all axial veins with reflux was our strategy to reduce the chance of recurrence and symptoms, and the GSV or SSV segments adjacent to the nerve were carefully removed using micro-phlebectomy under direct vision. In addition to the possibility of nerve injury, the depth of the truncal vein related to cutaneous injury was another important factor to be considered. Except in SS, treatment of superficially located truncal veins with thermal ablation can result in complications, including skin burn, pigmentation, and a palpable cord of the treated vein, especially when it is located suprafascially.[11-13] In our study, a superficially located GSV over the entire length was an indication for SS. Even in cases of endovenous treatment, micro-phlebectomy of the shallow portion of the target vein was performed, along with endovenous ablation. Endovenous treatment of the superficially located truncal vein caused problems such as pigmentation or patient complaints of palpation of cord-like lesion.[14] Although the procedural time was longer than that in previous reports of endovenous ablation using concomitant phlebectomy and micro-phlebectomy of the superficial or suprafascial axial vein,[15] the postprocedural complication rate was relatively low. In our study, only about one half of the patients had an entire length of the GSV in the saphenous fascia on ultrasound, and the combined technique of endovenous ablation and surgical removal of the shallow vein can be a good option for many patients. Therefore, although the algorithm shown in Fig 1 cannot be applied in all centers or countries, SS is worth applying to treat the superficially located saphenous vein.

As it is considered to be the greatest advantage of the non-thermal technique, there was no nerve injury in the CAC group. In contrast, one patient in the MOCA group developed transient paresthesia near the ablated vein. For SSV reflux treatment, the access sites for the catheter in the CAC group were more distal than those in the other groups. Moreover, because glue has the advantage of being able to spread to nearby tributaries, CAC was used preferably in ulcer patients with a pathologic perforator, which resulted in excellent outcomes. Because the CAC technique was introduced relatively late, it could not be used for all patients with ulcers included in this study. However, since it became available in Korea, CAC has been considered first for patients with ulcers. Therefore, when the nerve is adjacent to a vein on preoperative ultrasound or in a patient with SSV reflux or stasis ulcer, CAC should be considered first.

In this study, vein size was not an important factor in selecting the treatment modality because there was no treatment failure related to the size of the vein, despite no modification to the manufacturer's instructions for use. Tortuosity was not an important factor when choosing a treatment method. Most of the tortuosity of the axial vein located in the fascial space could be overcome by changing the guidewire or the patient's position. In the case of suprafascial tortuous GSV, phlebectomy was often indicated, regardless of the tortuosity due to proximity of the skin. In our study, only 58% of cases showed the entire length of the GSV, with reflux located in the subfascial space. Nevertheless, SS is not typically considered as the first-line treatment due to the various advantages of endovenous treatment. Instead, combined micro-phlebectomy or other strategies should be used to prevent complications from ablating these veins or to prevent recurrence by leaving this segment. Therefore, the depth during the preoperative duplex ultrasound examination should be included in surgical planning.

The procedural time for the CAC technique was the longest in this study. This does not seem to make sense considering that the nonthermal technique removes the requirement for tumescent anesthesia, which is time consuming.[16] Moreover, the CAC procedure was considered first for patients with milder disease and requiring less phlebectomy in our study. The lengthy procedure time might have occurred because the number of truncal veins treated at the same time was higher than that of other treatment methods. The procedure

time was shortest for the MOCA group in our study because the number of treated truncal veins was relatively small, and MOCA was considered preferentially for those who needed less phlebectomy. RFA can be safely used in most patients, except for those with a high likelihood of nerve injury. The procedure time was comparable even with tumescent injection.

The follow-up stump length was significantly longer in the CAC group, which seems to be due to the characteristics of the procedure itself, which leaves a longer stump compared with other techniques.[17] In the MOCA group, the follow-up stump length did not significantly shorten, unlike that after other endovenous techniques. In our study, all the patients who underwent MOCA were treated for GSV varicosities due to reflux at the saphenofemoral junction. A definitive conclusion could not be drawn because of the small sample size of the MOCA group and multiple factors affecting stump length other than the procedure type. Thus, further studies are needed to investigate the change in stump length with the MOCA technique in patients with junctional reflux and determine whether this is related to recanalization.

The AVVQ score improved in all groups. Contrary to the results of previous studies,[18,19] the improvement in the SS group was not inferior to that after the endovenous techniques. A recent systematic review revealed similar results to our finding.[20] In contrast, the MOCA group exhibited the poorest preoperative and postoperative AVVQ scores among the groups, despite the inclusion of patients with relatively milder varicosities. This result was different from those of other studies showing that the quality of life in the MOCA group was similar to that of other surgical groups.[15,21] It appears that the MOCA group in our study mainly comprised relatively younger female patients, with varicosity exerting a greater influence on their quality of life.

Postprocedural AEs occurred in 265 patients (9.2%); however, serious AEs occurred in relatively few patients. Serious AEs included two cases of DVT with endovenous techniques and cellulitis or hematoma with SS. Most of the minor AEs were related to ecchymosis at the surgical site after concomitant phlebectomy. CHAIR occurred in the CAC group. Although history taking of a hypersensitivity reaction to acrylic nails and the glue used for eyelash extensions was performed before treatment to avoid use of the CAC technique for high-risk patients, allergic reactions occurred in 27 patients.

This study has several limitations. Although this study had a relatively large sample size, it has limitations owing to the retrospective cross-sectional nature of the study. Because the time of availability for each technique differed, the patients in the earlier period of the study had fewer surgical options. In the earlier period, RFA was the only option for endovenous therapy, followed by CAC and MOCA. This explains the relatively small size and shorter follow-up period for the MOCA group, limiting our ability to draw meaningful comparisons regarding recurrence rates. Owing to the issue of insurance coverage in Korea, there were practical difficulties in implementing monitored anesthesia care, and general anesthesia was an alternative option. Situations will vary across countries and centers, and personal preferences could differ. Our treatment selection criteria were subjectively influenced by the realities of our country and the preferences of the surgeon, making it difficult to apply universally to all patients. Many data items were missing, such as the venous clinical severity score, and comparisons between the groups were not possible. In our center, regular follow-up of patients with postoperative varicose veins is not routinely performed. Therefore, long-term follow-up results, such as 5 years, were not available for comparison for all patients. Despite these limitations, the current study has several strengths. First, it was a large study investigating the selection hierarchy of treatment modalities for axial varicosities. Because the characteristics of the patients and techniques are different, randomization itself can be an ethical issue. We believe our study can be an alternative approach that can provide information on selection algorithms. Second, in the endovenous era, the indications and values of traditional techniques, such as SS and phlebectomy, were rediscovered. As in previous studies, the long-term efficacy in terms of the target vein closure rate or improvement in the quality-of-life score was similar in all groups. However, the observed differences in the characteristics and complications related to each procedure might provide clues for selecting the most appropriate treatment method, considering the characteristics of varicose veins.

CONCLUSIONS

The clinical outcomes with improvement in quality of life were comparable between the different treatment modalities, facilitated by surgeons' operative planning aimed at achieving optimal results. The proximity of the nerve or skin to the target vein is the most important factor in selecting a suitable treatment modality.

AUTHOR CONTRIBUTIONS

Conception and design: HK, JH
Analysis and interpretation: HK, NL, JH
Data collection: HK, SC, KL
Writing the article: HK
Critical revision of the article: HK, NL, SC, KL, JH
Final approval of the article: HK, NL, SC, KL, JH
Statistical analysis: HK
Obtained funding: Not applicable
Overall responsibility: JH

DISCLOSURES

None.

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