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Title

Comparison between radiofrequency ablation and CHIVA procedure in patients with varicose veins.

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Short title: Comparison between RFA and CHIVA

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Conflicts of Interest

The authors declared no conflicts of interest

Abstract

Objective: Conservatrice et Hémodynamique de l'Insuffisance Veineuse en Ambulatoire, the French acronym for CHIVA, is a strategy aimed to convert a venous reflux into a physiological drainage. We compared CHIVA with radiofrequency ablation and determined its possible advantages.

Methods: We retrospectively analyzed the clinical recurrence, ultrasound recurrence, quality of life scores, and complications. They were compared after propensity score matching.

Results: 212 limbs of 166 patients were included: 42 limbs underwent radiofrequency ablation and 170 limbs underwent CHIVA. The hospital stay was shorter in the CHIVA group. There was no difference in clinical, ultrasound recurrence, quality of life scores and complications between the two groups. The preoperative saphenous vein diameter was larger in the recurrence cases.

Conclusions: CHIVA showed comparable results to radiofrequency ablation. There was more ultrasound recurrence with larger vein diameters. The CHIVA appears to be a simple and more efficient treatment method when performed on select patients.

Keywords: Chronic venous disease, Radiofrequency ablation, Doppler ultrasound, CHI VA, Varicose veins

Introduction

The most frequently used treatment modalities for varicose veins include endovenous treatment or surgical stripping as a way to ablate or remove incompetent saphenous veins.*(1,2)* More than a decade, endovenous non-thermal ablation has become popular and has shown excellent performance.*(3)* However, in the real world, one treatment method cannot be applied to all cases of varicose veins, and variable treatment modalities are needed for a patient-tailored approach.

While most physicians have been developing technologies to effectively ablate incompetent veins, some have maintained their efforts to develop a hemodynamic correction strategy for varicose veins while preserving the saphenous veins. Blood flow observation and the understanding of hemodynamics has increased with the development of Doppler ultrasound (DUS). The *Conservatrice et Hemodynamique de l'Insuffisance Veineuse en Ambulatoire* (CHIVA) strategy was later introduced, which stands for the ambulatory conservative hemodynamic correction of venous insufficiency.*(4)* However, it is not yet a globally popular procedure, with relatively fewer research reports on the CHIVA procedure than on conventional surgery or endovenous treatment.*(5-7)* The guidelines recommend that CHIVA should only be performed on patients selected by experienced physicians (Level II-B).*(8)* In the contrary, endovenous thermal ablation has relatively more research studies that show effective results in terms of recurrence rates and complications.*(9,10)*

The CHIVA method is an attempt to preserve both the saphenous vein and normal venous drainage of superficial tissues of the limb. It is a strategy aimed to convert a venous reflux into a physiological drainage for varicose vein surgery. Studies conducted in Europe have shown lower rates of recurrence and complications for the CHIVA procedure than in stripping.*(11,12)* There have not been many studies comparing CHIVA to endovenous treatment. Only one

prospective study from Spain has compared the outcomes of CHIVA with radiofrequency ablation (RFA). Based on the study hypothesis, they concluded that RFA was not inferior to the CHIVA procedure or to stripping *(13)*. A recent review reported that CHIVA may make little or no difference to clinical recurrence when compared with RFA (RR 2.02, 95% confidence interval[CI] 0.74 to 5.53; 1 study, low-certainty evidence).*(14)* Based on the above-mentioned results, our hypothesis was that the results of CHIVA would be comparable to those of RFA. This study aimed to investigate the effectiveness and safety of the CHIVA procedure versus RFA, which is the mainstay of endovenous treatment for varicose veins.

Methods

A single-center, retrospective analysis comparing CHIVA with RFA to treat patients with reflux of the greater saphenous vein was performed. Patients who received CHIVA or RFA for varicose veins from January 1, 2016 to December 31, 2019 were studied. Treatment methods for varicose veins were explained to patients with varicose veins accompanied by symptoms, and then the patients selected the treatment method. Patients who underwent RFA and CHIVA procedure during the study period were included in the study. A vascular surgeon with a certificate in registered vascular technology performed and interpreted all ultrasounds and performed surgery.

Inclusion and exclusion criteria

Patients aged > 18 years with primary varicose veins, reflux of greater saphenous vein (GSV) > 0.5 seconds, and levels C2 to C6 in the CEAP (Clinical, Etiologic, Anatomic, and

Pathophysiologic) classification were included.

Patients with malignancy, pregnancy, recurrent varicose veins, previous sclerotherapy, previous deep venous thrombosis, or hematologic disorders were excluded. Additionally, those with reflux from the saphenopopliteal junction and small saphenous vein, deep vein insufficiency, varicose vein without reflux through GSV, lymphedema, and CEAP levels C0 and C1 were excluded.

RFA procedure

A 7 cm electrode, 60 cm-long catheter (VNUS ClosureFast; Medtronic, Dublin, Ireland) was used in all cases. The catheter was inserted into the GSV below the knee under local or general anesthesia. The catheter tip was positioned 2 cm below the sapheno-femoral junction (SFJ) using ultrasound guidance. Tumescent solution was injected around the GSV. Segmental energy at 120 °C was delivered in 20-second cycles. Two cycles were applied to the initial segment of the GSV. The next segments of the GSV were ablated in one cycle. Concomitant phlebectomy was performed to treat tributary veins.

CHIVA procedure

All procedures were performed under local anesthesia. Ultrasound mapping was performed at an outpatient clinic. An ultrasound test was performed again just before surgery for a second check and surgical site marking. The CHIVA strategy was performed according to the instruction by Dr. Claude Franceschi.*(15)* Concomitant phlebectomy was not used for conservative hemodynamic collection.

Postop management

Patients who chose general anesthesia were hospitalized the day before surgery, and patients under local anesthesia were either hospitalized on the day of surgery or operated on an outpatient basis. In some patients, prophylactic anticoagulation was used for 2 weeks when there was a possibility of thrombosis due to stasis due to insufficient saphenous vein drainage after surgery. Anticoagulation was not performed after any of the RFA cases. All patients received compression stockings (23–32 mmHg) for 2 weeks. Early ambulation was encouraged in all patients. Venoactive drugs were not used after surgery in any cases.

Definition

New and palpable varicose veins > 4 mm due to neovascularization or technical errors were regarded as clinical recurrences in both groups. Different definitions of ultrasound recurrence were needed for both groups due to different treatment concepts, according to previous reports.*(13)* For the RFA group, a patent segment of ablated GSV > 5 cm in length was considered as an ultrasound recurrence. In contrast, persistent reflux at the GSV with re-entry into the deep vein was not an abnormal finding after the CHIVA. Therefore, new incompetent primary reflux point development from the SFJ, perforator vein, or pelvic collaterals or a new incompetent secondary reflux point development from the GSV into the tributary veins was considered an ultrasound recurrence in the CHIVA group.

Statistical analysis

Kaplan–Meier analysis for clinical and DUS recurrence was performed by comparing the groups using a log-rank test for overall and pairwise comparisons. Propensity score matching (PSM) was used for demographic variables to minimize bias and compensate for the shortcomings of the retrospective study. PSM with the nearest neighbor matching method was performed in a 1:1 ratio, using shunt types as covariates. Statistical analyses were performed using R version 3.6.3 (R Foundation for Statistical Computing, Vienna, Austria). Statistical significance was set at $p < 0.05$.

Ethical issues

The present trial was conducted in accordance with the Declaration of Helsinki and principles of good clinical practice. This study was approved by the local institutional review board. The requirement for consent from individual patients was waived because of the retrospective nature of the analysis.

Results

A total of 212 cases in 166 patients were included in the study: 42 cases in 35 patients who underwent RFA, and 170 cases in 131 patients who underwent CHIVA. Seven patients underwent RFA on both legs and 36 patients underwent CHIVA surgery on both legs. Both procedures were never combined in one patient. All ultrasound and surgery were performed by a single surgeon. A comparison of the baseline characteristics of the patients is presented in Table 1. The mean length of hospital stay was shorter in the CHIVA group than in the RFA group (1.08±2.47 days vs. 2.23±0.49 days, $p < 0.001$). The average operation time was

76.12±33.33 minutes for CHIVA, and 89.03±37.09 minutes for RFA (p=0.060). Most of the CHIVA procedures (92.37 %) were performed under local anesthesia, and 20% of the RFA group underwent surgery under local anesthesia (p<0.001).

The classification of varicose veins is shown in Table 1. The CEAP C classification did not differ between the two groups. However, type III shunts according to the Teupitz classification was the most common in the RFA group at 76.19%. In the CHIVA group, 41.76% were type I+II, 33% were type III, and 18.24% were type II, which was different between the two groups (p<0.001). To reduce the bias due to shunt types, PSM was performed using the Teupitz shunt classification, and the difference in the shunt type was corrected when 42 cases in the CHIVA group were compared with 42 cases in the RFA group.

Clinical recurrence rates did not differ before and after PSM. (Figure 1) Clinical recurrence at 12 months was 0% for both groups after PSM. Ultrasound recurrence in the CHIVA group was higher than that in the RFA group; however, the difference was not statistically significant after PSM (Figures 2). Ultrasound recurrence-free rates in the RFA group were 96.9% at 6 months and 96.9% at 12 months. In the CHIVA group, they were 90.2% at 6 months, 84.2% at 12 months, and 95% after PSM analysis (Figure 2).

In comparing changes to quality of life scores and hemodynamic measures, there were no statistical differences before or after PSM (Table 2). Both groups showed improved venous clinical severity scores (VCSS), Aberdeen varicose vein questionnaire (AVVQ) scores, venous reflux time (VRT) and reduced GSV diameter after treatment.

The RFA group had nine cases of complications, with 6 in the CHIVA group. There were no differences between the two groups after PSM analysis (Table 3).

However, there were more DUS recurrences in the CHIVA group before PSM. Subgroup

analysis was therefore performed to compare DUS recurrence with no recurrence in the CHIVA group. 27 limbs showed DUS recurrence, and the preoperative GSV diameter was larger than in the 185 limbs without DUS recurrence (5.57±1.4 mm vs. 6.27±1.17, p=0.027, Table 4).

Discussion

The CHIVA strategy, which is based on hemodynamics, is considered the most ideal procedure for varicose vein surgery and is known to be effective and safe.*(12)* The clinical research on CHIVA is still less than that on RFA. The guidelines recommend a Class IIb (Level of evidence B) grade for CHIVA, and mention that CHIVA may be considered in select patients by experienced physicians.*(8)*

A Spanish group reported a randomized controlled noninferiority trial comparing RFA with high ligation/stripping (HL/S) and CHIVA in 2021.*(13)* They evaluated whether clinical and DUS recurrence for RFA at 2 years was non-inferior to CHIVA or HL/S. A total of 225 limbs were included in this study. There were 74 RFA cases, 75 HL/S cases, and 76 CHIVA cases. There were no differences in postoperative complications and pain among the three groups. The clinical recurrence (an estimated difference of -7.5%, 95% CI -17% to 3%, noninferiority $p < .001$) and DUS recurrence (an estimated difference of -34%, 95% CI -47% to -20%, noninferiority $p < .001$) were compared between the two groups. The study group concluded that RFA was non-inferior to CHIVA. However, the clinical recurrence 2 years after RFA was 7.2%, and DUS recurrence was 13%. In the CHIVA group, clinical recurrence was 14.7%, and DUS recurrence was 46.7%. DUS recurrence after CHIVA was approximately 4 times higher than that after RFA. In this study by González Cañas et al.*(13)*, patients with shunt type III

accounted for 72% of the overall CHIVA group, which needed the CHIVA 1+2 or CHIVA 2 procedure and might show poor outcomes. The non-drained strategy CHIVA 1+2 is a conservative but non-hemodynamic technique that leads to worse outcomes than the drained CHIVA strategy *(16)*. In some cases of shunt type III, devalvulation is performed to change the non-reflux segment to a drained vein, but this may increase the risk of thrombosis.

Unlike the study by González Cañas et al., our study included various shunt types in the CHIVA group: type I (5.88%), type II (18.24%), type I+II (41.76%), type III (33%), type IV (0.59%), and type V (3.53%). The CHIVA method applies different treatment strategies depending on the shunt type, so it was thought that there would be differences in the surgical results depending on the shunt type.*(17)* Due to the nature of the retrospective study, there was also a possibility that RFA was selected for cases in which CHIVA was thought to be difficult. Therefore, PSM was performed, and variables were controlled. After PSM, the difference in shunt type disappeared between both groups, and we analyzed the results both before and after PSM (Table 2). The distribution of shunt type III after PSM was 76.19%, similar to that of previous studies by González Cañas et al.*(13)* We found no difference in clinical recurrence or DUS recurrence in the comparison between RFA and CHIVA. Unlike that in the study by González Cañas et al, the CHIVA group in this study did not undergo phlebectomy; however, it showed similar results to the RFA group that underwent phlebectomy. In addition to the conclusion that RFA is not inferior to CHIVA, it was confirmed that there was no statistically significant difference in the recurrence of CHIVA and RFA, although more than 70% of type III patients were included.

However, when CHIVA, including all types before PSM, showed a significantly higher DUS recurrence than RFA (DUS recurrence at 12 months was 3.1% in RFA and 22.3% in CHIVA group, $p<0.001$) (Figure 2). Among the CHIVA groups, subgroup analysis was performed for

DUS recurrence. When 185 cases without DUS recurrence and 27 cases with DUS recurrence were compared, there was no difference in shunt types, and the preoperative GSV diameter was larger in the DUS recurrence group (mean GSV diameter, 5.57±1.4 mm in no DUS recurrence vs. 6.27±1.17 mm in DUS recurrence, Table 5). The mean GSV diameter in the study by Pare et al. was 6.83±2.02 mm and the recurrence was 40.1% at 5 years.*(11)* The mean GSV diameter in the study by González Cañas et al. was 7.18 mm and the recurrence was 46.7% at 2 years.*(13)* J. M. Escribano et al. performed CHIVA 2 in 58 patients. Reflux recurred in 53 patients after the initial surgery. The GSV diameter was categorized into four steps: <5 mm, 5.1-6 mm, 6.1-7 mm, and >7 mm. The smaller the diameter, the less additional SFJ ligation was required.*(18)* Massimo Cappelli et al. compared 33 cases of no recurrence and 58 cases of recurrence among patients who underwent non-drained CHIVA. The GSV diameter in the no recurrence group was 6.8±1.6 mm and that of the recurrence group was 7.6±2.1 mm, but there was no statistical significance.*(16)* Perhaps, Regardless of shunt type, DUS recurrence may be likely to increase in varicose veins with a large GSV diameter. Several methods for preserving saphenous vein in large caliber veins have been introduced, further studies are needed to confirm the association between the venous diameter and recurrence.*(19,20)*

The mean hospital stay was 2.23±0.49 days for RFA, while that of the CHIVA group was 1.08±2.47 days, which was significantly shorter ($p<0.001$). There was no difference in the operating time or postoperative pain between the two groups, but there was a difference in the methods used for anesthesia. Only 20% of RFA was performed under local anesthesia, whereas 92.37% CHIVA was performed under local anesthesia, which is associated with significantly shorter hospital stays (Table. 1). Because multiple phlebectomy for tributary veins was performed simultaneously in the RFA group, many patients wanted general anesthesia due to fear of pain. On the other hand, in the CHIVA group, multiple phlebectomy was not required, and local anesthesia alone was sufficient. The VCSS and AVVQ scores, VRT, and GSV

diameter improved after surgery in both groups, with no significant difference between the groups (Table 2).

One of the known advantages of CHIVA is that it is associated with fewer complications. Specifically, it has the advantage of less nerve damage because the saphenous vein is not removed or ablated. In a previously published study comparing stripping to CHIVA, there were no cases of nerve damage in 167 CHIVA procedures compared to 15 cases (4.49%) of nerve damage in 334 stripping procedures.*(11)* The Cochrane group compared complications between RFA and CHIVA. They reported that CHIVA may make little or no difference to the rates of complications but may cause more bruising (RR 1.15, 95% CI 1.04 to 1.28; low-certainty evidence).*(14)* In our study, there was no difference in complications, including bruising (Table 4). Another expected advantage is the value of preserving the GSV for potential subsequent vital arterial bypass surgery in an ever-aging population.*(21-23)*

Study limitations

This retrospective analysis was conducted at a single institution. All ultrasound and surgery were performed by a single surgeon. There was no other ultrasound technologist, and the surgeon had to perform the ultrasound himself. Because, how to identify and categorize shunts as performing ultrasound for CHIVA is more technologically challenging than performing an ultrasound for reflux alone.

A direct comparison is limited because the concepts of the two treatment methods are different. Because CHIVA surgery requires an individualized strategy tailored to the patient, it may result in more tactical errors than RFA using a uniform procedure and phlebectomy. There was also a possibility that RFA might have been selected if CHIVA was considered a complex case. The

difference in shunt type between the two groups could have affected the outcome. The number of included cases was small, and the follow-up period was short. The follow-up of most patients has been suspended since 2020 owing to the COVID-19 pandemic.

Conclusions

There was no statistical difference between the two groups in terms of the clinical and DUS recurrence rates after PSM. The VCSS and AVVQ scores, VRT, and GSV diameter improved after surgery; there was no difference between the two groups, and there was no difference in the analysis of complications. Compared to RFA, CHIVA has the advantage that most patients are treated with local anesthesia, and the hospital stay is shorter. A disadvantage of this study was that DUS recurrence before PSM was higher for CHIVA than that of RFA, and the GSV diameter before surgery was larger in the recurrence group.

A single treatment method cannot be used to treat patients with various types of varicose veins; therefore, it is necessary to provide customized treatment for each patient. If CHIVA is selectively performed in patients with small blood vessel diameters, it could be a convenient and efficient treatment method when compared with the expensive catheter-using endovenous procedures. In addition, we can preserve saphenous veins for possible arterial bypass surgery in ever-aging population.

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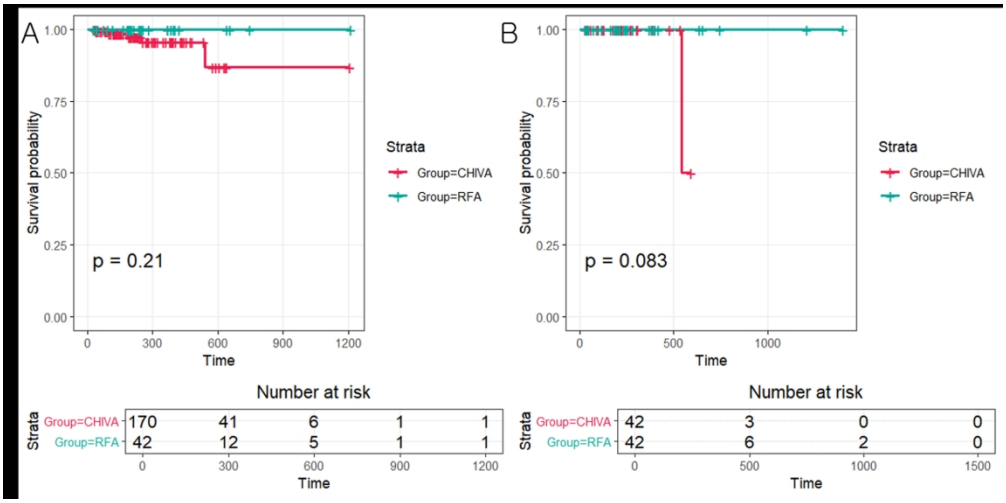

Figure 1. Clinical recurrence before and after propensity score matching
A) Clinical recurrence free rate before PSM, RFA 100% and 100% at 6mo and 12mo, CHIVA 98.5% and 95.5% at 6mo and 12mo, B) Clinical recurrence free rate after PSM, RFA 100% at 12mo, CHIVA 100% at 12mo

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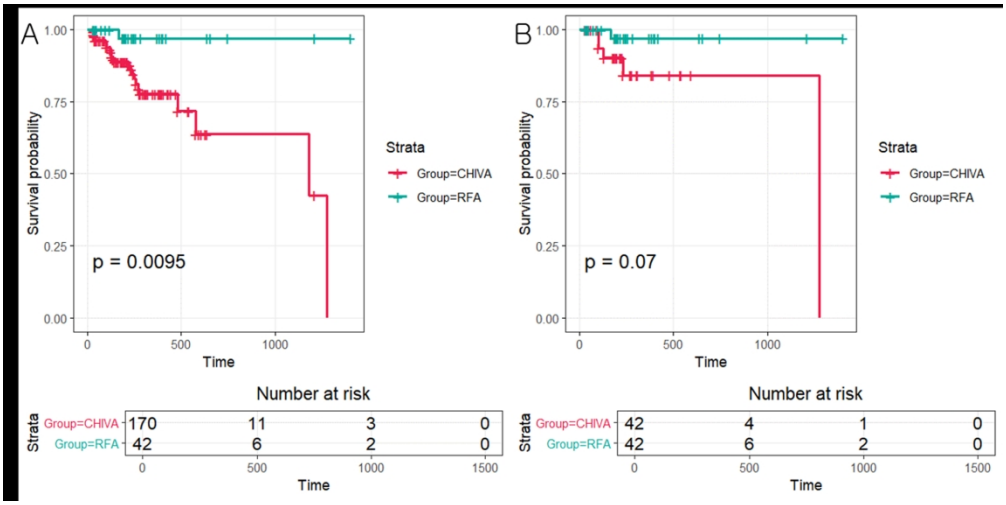

Figure 2. Ultrasound recurrence before and after propensity score matching
A) Ultrasound recurrence free rate before PSM, RFA 96.9% and 96.9% at 6mo and 12mo, CHIVA 88.8% and 77.7% at 6mo and 12mo, B) Ultrasound recurrence free rate after PSM, RFA 96.9% and 96.9% at 6mo and 12mo, CHIVA 90.2% and 84.2% at 6mo and 12mo

219x108mm (300 x 300 DPI)

Table 1. Baseline characteristics

	RFA (N=42)	CHIVA (N=170) before matching	P value	CHIVA (n=42) after matching	p value
Female	26 (61.90%)	101 (59.41%)	0.905	32 (76.19%)	0.238
Age	55.79 ± 12.98	53.17 ± 12.13	0.219	55.07±10.57	0.783
DM	3 (7.14%)	6 (3.53%)	0.697	1 (4.55%)	0.638
HTN	6 (18.75%)	21 (12.35%)	1.000	6 (27.27%)	0.517
Weight (Kg)	62.55 ± 8.99	65.64 ± 11.46	0.189	63.11±9.16	0.481
Height (meter)	1.62 ± 0.07	1.65 ± 0.08	0.044	1.63± 0.07	0.590
BMI	23.88 ± 3.23	23.89 ± 2.92	0.983	24.11 ± 2.65	0.731
C classification			0.385		0.901
C2	27 (64.29%)	117 (68.82%)		26 (61.9%)	
C3	10 (23.81%)	23 (13.53%)		9 (21.43%)	
C4	5 (11.90%)	28 (16.47%)		7 (16.67%)	
C5	0	2 (1.18%)		0	
Shunt type			<0.001		>0.99
I	1 (2.38%)	10 (5.88%)		1 (2.38%)	
II	0	31 (18.24%)		0	
I+II	8 (19.05%)	71 (41.76%)		8 (19.05%)	
III	32 (76.19%)	51 (33.0%)		32 (76.19%)	
IV	0	1 (0.59%)		0	
V	1 (2.38%)	6 (3.53%)		1 (2.38%)	
Admission day	2.24 ± 0.48	1.04 ± 2.22	<0.001	0.9 ± 0.98	<0.001
Operation time	90.84 ± 37.90	75.07 ± 33.25	0.022	81.62 ± 34.56	0.337
Anesthesia			<0.001		<0.001
Local	15 (35.71%)	160 (94.12%)		40 (95.24%)	
Block	14 (33.33%)	4 (2.35%)		0	
Spinal	7 (16.67%)	4 (2.35%)		1 (2.38%)	
Endotracheal	6 (14.29%)	2 (1.18%)		1 (2.38%)	
FU duration	304.05±286.23	222.95 ± 175.93	0.081	204.14 ± 148.70	0.147

* RFA, radiofrequency ablation; CHIVA, *Conservatrice et Hémodynamique de l'Insuffisance Veineuse en Ambulatoire*; DM, diabetes mellitus; HTN, hypertension; BMI, body mass index; FU, follow up

Table 2. Changes in quality of life-quality scores and hemodynamic measures

	RFA (N=42)	CHIVA (N=170) before matching	P value	CHIVA (N=42) after matching	p value
NRS	1.22 ± 0.94	0.98 ± 1.23	0.347	0.94 ± 1.2	0.210
VCSS_Pre	4.32 ± 1.39	4.15 ± 2.00	0.669	4.19 ± 1.05	0.876
VCSS_Post	0.65 ± 0.61	1.04 ± 1.14	0.173	1.08 ± 0.64	0.077
AVVQ_Pre	16.53 ± 8.49	14.36 ± 10.00	0.338	17.15 ± 14.47	0.539
AVVQ_Post	6.55 ± 8.33	5.83 ± 6.88	0.686	6.64 ± 8.31	0.956
VRT_Pre	12.86 ± 10.40	13.16 ± 10.94	0.907	13 ± 10.58	>0.99
VRT_Post	18.79 ± 7.70	20.86 ± 13.62	0.314	25.45 ± 17.35	0.299
GSV diameter_Pre	5.66 ± 1.06	5.65 ± 1.44	0.984	6.26 ± 1.76	0.164
GSV diameter_Post	3.00 ± 0.62	3.81 ± 0.94	0.1446	3.72 ± 0.65	0.175

* NRS, numeral rating scale; VCSS, venous clinical severity score; AVVQ, Aberdeen varicose vein questionnaire; VRT, venous reflux time; GSV, greater saphenous vein

Table 3. Postoperative complication

	RFA (N=42)	CHIVA (N=170) before matching	P value	CHIVA (n=42) after matching	P value
Numbness	3 (7.14%)	2 (1.18%)	0.054	0	0.241
Ecchymosis	2 (4.76%)	4 (4.81%)	0.339	0	0.494
Matting	2 (4.76%)	2 (1.18%)	0.240	1 (2.38%)	>0.99
Superficial thrombosis	2 (4.76%)	13 (7.65%)	0.741	4 (9.52%)	0.677
Blanching skin	0	1 (0.59%)	1.000	0	NA
Ankle swelling	0	2 (1.18%)	1.000	1 (2.38%)	>0.99

Table 4. Comparison between USG recurrence and USG recurrence-free case

	No recurrence (N=185)	Recurrence (N=27)	P value
Female	112 (60.54%)	15 (55.56%)	0.777
Age	53.74 ± 12.29	53.33 ± 12.72	0.877
DM	7 (5.6%)	2 (11.76%)	0.294
HTN	26 (20.8%)	1 (5.88%)	0.196
Weight (Kg)	62.55 ± 8.99	65.64 ± 11.46	0.189
Height (meter)	1.62 ± 0.07	1.65 ± 0.08	0.361
BMI	23.88 ± 3.23	23.89 ± 2.92	0.983
C classification			0.240
C2	128 (69.19%)	16 (59.26%)	
C3	29 (15.68%)	4 (14.81%)	
C4	27 (14.59%)	6 (22.22%)	
C5	1 (0.54%)	1 (3.7%)	
Shunt type			0.219
I	10 (5.41%)	1 (3.7%)	
II	27 (14.59%)	4 (14.81%)	
I+II	65 (35.14%)	14 (51.85%)	
III	77 (41.62%)	6 (22.22%)	
IV	1 (0.54%)	0 (0%)	
V	5 (2.7%)	2 (7.41%)	
FU duration	229.42 ± 186.78	266.63 ± 198.29	0.438
NRS	0.98 ± 0.98	2.14 ± 2.19	0.228
VCSS_Preop	4.07 ± 1.31	4.89 ± 3.86	0.655
VCSS_Postop	0.79 ± 0.71	2.25 ± 2.01	<0.001
AVVQ_Preop	14.38 ± 9.78	18.22 ± 8.49	0.079
AVVQ_Postop	6.45 ± 7.63	2.59 ± 2.57	0.385
VRT_Preop	13.63 ± 11.22	9.31 ± 6.01	0.153
VRT_Postop	20.61 ± 12.83	18.17 ± 8.73	0.745
GSV diameter_Preop	5.57 ± 1.4	6.27 ± 1.17	0.027
GSV diameter_Postop	3.75 ± 0.96	4.02 ± 0.84	0.152

* DM, diabetes mellitus; HTN, hypertension; BMI, body mass index; FU, follow up; NRS, numeral rating scale; VCSS, venous clinical severity score; AVVQ, Aberdeen varicose vein questionnaire; VRT, venous reflux time; GSV, greater saphenous vein

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Sangchul Yun; Writing the article, Concept and design, final approval of the article, overall responsibility

Jihyoun Lee; Critical revision of the article, final approval of the article

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