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The Effect of Saphenous Vein Ablation on Combined Segmental Popliteal Vein Reflux

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Background: This study examined the role of superficial vein surgery in patients with combined superficial venous reflux and segmental popliteal vein reflux. **Methods:** We retrospectively reviewed 42 limbs in 38 patients with combined superficial venous reflux and segmental popliteal vein reflux who underwent saphenous vein ablation between January 2014 and February 2017. Patients underwent outpatient follow-up duplex ultrasonography at 3, 6, and 12 months postoperatively. Resolution of deep vein reflux was defined as reversed blood flow in a popliteal segment for less than 1.0 second and a decrease in the reflux time of more than 20% of the preoperative reflux time. **Results:** The mean follow-up period was 9 months (range, 3–23 months). Saphenous vein ablations were performed by stripping in 24 limbs and radiofrequency ablation in 18 limbs. Preoperative segmental popliteal vein reflux resolved in 21 of the 42 limbs (50%). **Conclusion:** This study demonstrated that superficial venous surgery corrected segmental popliteal vein reflux in 50% of limbs with combined superficial venous reflux and segmental popliteal vein reflux. Other prospective studies are necessary to elucidate the etiology of the non-reversible cases.

Key words: 1. Popliteal vein
2. Saphenous vein
3. Duplex ultrasonography
4. Venous insufficiency

Introduction

Chronic venous disease (CVD) is caused by long-standing increased venous pressure. The etiology of increased venous pressure can be deep vein reflux (DVR), superficial vein reflux (SVR), and incompetent perforator veins, alone or in combination. In the literature, SVR alone has been reported to be the main etiology of venous ulceration in up to 57% of cases and to be combined with DVR in up to 32% of cases [1]. However, McEnroe et al. [2] reported that deep venous insufficiency alone was the leading cause of venous hypertension, accounting for 72% of patients with venous ulceration, while 13% had superficial venous insufficiency alone and the remaining 15% had both deep and superficial venous insufficiency. Chronic deep venous insufficiency has been shown to hasten the progression of venous disease, leading to an increase in the rate of venous ulceration formation and, when coexisting with SVR, it has been found to be an additional factor influencing clinical status, as well as DVR [3]. Therefore, resolution of DVR along with SVR is important for preventing chronic venous insufficiency.

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Several pieces of evidence have shown that segmental DVR can be resolved after ablation of the combined incompetent greater saphenous vein (GSV) [4-7]. However, most studies have investigated the impact of ablation of the GSV on coexisting femoral vein reflux, but not on popliteal vein reflux (PVR). The venous severity scoring system allots higher scores to reflux in popliteal veins, because it is thought to be more critical in the process of chronic venous insufficiency than DVR above the knee [8]. Furthermore, PVR was reported to be strongly associated with delayed and failed healing of venous ulcers [9].

The aim of this study was to examine the effect of saphenous vein ablation on combined segmental PVR.

Methods

This study complied with the Declaration of Helsinki and was approved by the Institutional Review Board of National Health Insurance Service Ilsan Hospital (IRB approval no., 2015-04-011). Since this was a retrospective study, patients were not required to provide informed consent.

Patients who underwent saphenous vein ablation between January 2014 and February 2017 with a diagnosis of saphenous vein reflux combined with segmental PVR were included in this study. The following exclusion criteria were used: (1) limbs with deep axial reflux; (2) a history of previous varicose vein treatment in the ipsilateral limb, including surgery, endovenous thermal ablation, or sclerotherapy; and/or (3) a history of deep venous thrombosis.

During the physical examination, the clinical severity of venous disease was graded from C1 to C6, according to the Clinical Class, Etiology, Anatomy, and Pathophysiology Classification.

At baseline and at each follow-up visit, disease severity and disease-related quality of life were appraised by the Venous Clinical Severity Score (VCSS) and the Aberdeen Varicose Vein Questionnaire (AVVQ) score.

All patients scheduled to undergo varicose vein surgery underwent duplex ultrasound (DUS) before surgery. A LOGIQ5 PRO (5–12 MHz linear probe; GE HealthCare, Seoul, Korea) was used. Following routine manual DUS, all patients underwent evaluation of the GSV, small saphenous vein (SSV), perforator vein, common femoral vein, and popliteal vein. Patients were assessed in the standing position, and their non–weight-bearing limb was investigated. The superficial and deep venous systems were examined. Venous reflux was defined as reversed blood flow for more than 0.5 seconds for the saphenous vein and more than 1.0 second for a deep vein on release of compression distal to the segment of the vein under examination. Segmental PVR was defined as an incompetent segment of deep vein below the knee with a competent common femoral vein.

The treatment options available to patients were either conventional surgery or radiofrequency ablation (RFA). Although RFA was considered preferable, conventional surgery was performed if the patient requested the treatment to be covered by insurance, as RFA was not covered by the National Health Insurance Service. In the conventional operations, high ligation and stripping of the GSV or SSV combined with stab avulsions of tributaries were performed. While stripping of the GSV was performed from groin to knee level, the procedure for the SSV was performed from the knee crease to the mid-calf level. RFA was performed from 2 cm distal to the saphenofemoral junction to the knee level for the GSV and from 2 cm distal to the saphenopopliteal junction to the mid-calf level for the SSV, combined with stab avulsion phlebectomy or sclerotherapy of tributaries.

After conventional surgery or RFA, a compression bandage was applied for 1 day. Once the compression bandage was removed, the patient was required to wear compression stockings 24 hours a day for 1 week and then during the daytime for the following week.

Patients underwent outpatient follow-up DUS at 3, 6, and 12 months postoperatively. Resolution of DVR was defined as reversed blood flow in a popliteal segment for less than 1.0 second and a decrease in the reflux time of more than 20% of the preoperative reflux time. Aggravation of DVR was defined as reversed blood flow in a popliteal segment for more than 1.0 second and an increase of reflux time for more than 20% of the preoperative reflux time. Postoperative changes in the range of 20% of the preoperative reflux time were considered to be in the range of technical error.

The data were analyzed using IBM SPSS ver. 21.0 (IBM Corp., Armonk, NY, USA). The Student t-test,

Table 1. Demographic data and CEAP classification

Characteristic	Value
No. of patients	38
No. of limbs	42
Duration of follow-up (mo)	11 (3–34)
Sex	
Male	18
Female	24
Age (yr)	58 (27–83)
CEAP classification	
C1	1
C2	39
C4	1
C6	1
E_PA_S, ${}_DP_R$	42
Incompetent saphenous vein	
GSV	21
SSV	4
GSV and SSV	17

Values are presented as number or mean (range).
CEAP, Clinical Class, Etiology, Anatomy, and Pathophysiology Classification; GSV, great saphenous vein; SSV, small saphenous vein.

Table 2. Management of incompetent superficial veins (N=42)

Type of treatment	No. of patients
Type of truncal vein ablation	
High ligation and stripping	24
Radiofrequency ablation	18
Management of tributary varicose veins	
Phlebectomy	34
Sclerothreapy	7
Truncal vein ablation only	1

chi-square test, and Fisher exact test were used to assess the statistical significance of differences between groups. All p-values <0.05 were considered to indicate statistical significance.

Results

Overall, saphenous vein surgery was performed in 467 limbs in 303 patients during the study period. Among them, 44 limbs from 40 patients fulfilled the inclusion criteria, and follow-up was performed in 38 patients (follow-up rate, 95%). Demographic data are listed in Table 1. The distribution of treatment options is presented in Table 2.

The mean preoperative and postoperative reflux times of the incompetent popliteal vein were 1.88 seconds (range, 1.01–5.24 seconds) and 1.23 seconds (range, 0–3.91 seconds), respectively. On postoperative DUS, resolution of segmental PVR was noted in 21 of 42 limbs (50%). In the remaining 21 limbs, 3 demonstrated improvement of PVR, and aggravation of PVR occurred in 6 (14%).

Table 3. Correlations between clinical factors and the resolution of segmental PVR

Variable	Postoperative resolution of PVR		p-value
	No	Yes	
Sex			0.03
Male	5 (24)	13 (62)	
Female	16 (76)	8 (38)	
Age (yr)	60.8±10.9	57.3±8.3	0.25
Follow-up (mo)	9.0±4.5	8.7±4.9	0.80
Preoperative duration of PVR (sec)	1.92±0.67	1.84±1.03	0.78
The ablated segment in the superficial system			0.47
GSV	9	12	
SSV	3	1	
GSV and SSV	9	8	
Truncal vein management			0.76
High ligation and stripping	13 (54)	11 (46)	
Radiofrequency ablation	8 (44)	10 (56)	

Values are presented as number (%) or mean±standard deviation.
PVR, popliteal vein reflux; GSV, great saphenous vein; SSV, small saphenous vein.

The correlations between several clinical factors and postoperative resolution of the incompetent popliteal segment are presented in Table 3. The resolution of segmental PVR was statistically independent of age, follow-up duration, the preoperative duration of PVR, the ablated segment in the superficial system, and treatment modality. Although preoperative and postoperative VCSS scores were recorded for all patients (n=42), postoperative AVVQ scores were only recorded for 24 patients, because the AVVQ was not used during the early period of the study. The postoperative VCSS and AVVQ scores demonstrated significant improvements compared with the preoperative baseline scores (Figs. 1, 2). Based on a comparison of the differences in the mean scores, postoperative changes in the VCSS and AVVQ scores showed no correlation with the resolution of PVR (Table 4).

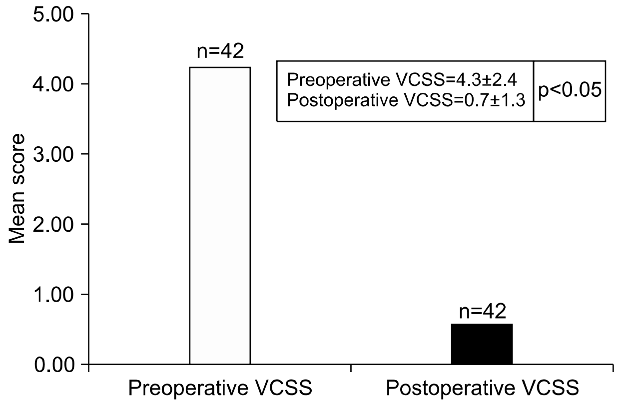

Fig. 1. Comparison of perioperative VCSS score. VCSS, Venous Clinical Severity Score.

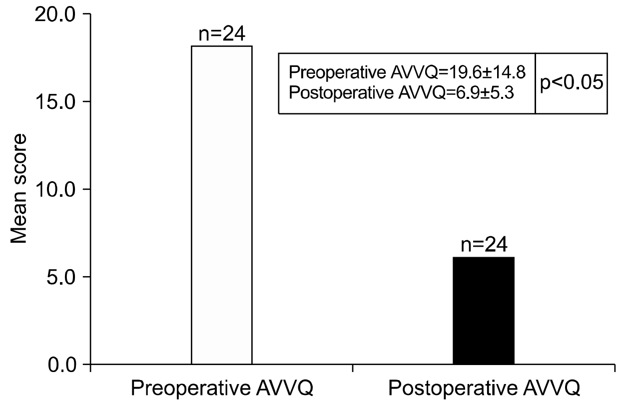

Fig. 2. Comparison of perioperative AVVO score. AVVO, Aberdeen Varicose Vein Questionnaire.

Discussion

Previous researchers have reported that SVR was present in approximately 90% of limbs with CVD, whereas DVR was detected in only 30% of limbs with CVD [10,11]. Labropoulos et al. [3] reported that the prevalence of DVR in limbs with combined superficial vein incompetence was 22%. While axial DVR is less likely to be abolished by superficial vein surgery, segmental DVR can be corrected after saphenous ablation in a substantial number of patients [4-7,12]. Puggioni et al. [7] reported complete disappearance of reflux in only 2 of 17 limbs (12%) with axial DVR after saphenous ablation. In addition, Maleti et al. [12] reported that preoperative axial DVR was not abolished in 81% of patients after saphenous ablation. In patients with segmental femoral vein reflux combined with SVR, Walsh et al. [4] and Sales et al. [5] reported that segmental femoral vein reflux was corrected after saphenous ablation in 27 of 29 limbs (93%) and 16 of 17 limbs (94%), respectively. Another study reported that nearly 50% of limbs with segmental DVR were corrected after superficial venous surgery [6]. However, Puggioni et al. [7] demonstrated that segmental femoral vein reflux was resolved in only 7 of 21 limbs (33%). Despite the considerable variation in results, most studies demonstrated that at least one-third of segmental femoral vein reflux cases could be corrected by ablation of a combined incompetent GSV.

While most studies have focused on the resolution of segmental femoral vein reflux after the ablation of an incompetent GSV, we studied the resolution of segmental PVR after the ablation of coexisting incompetent saphenous veins. PVR is a significant risk factor for venous ulceration [13], and the frequency of PVR increases with the progression of clinical symptoms [14]. Stuart et al. [15] also found that an open or healed venous ulcer was strongly associated with PVR. In the present study, after ablation of the incompetent saphenous veins, segmental PVR was corrected in 21 of 42 limbs (50%), regardless of the treatment modality. This result demonstrates that a substantial portion of segmental PVR cases can be rectified after ablation of a coexisting incompetent saphenous vein, as with segmental femoral vein reflux in previous studies [4-7,12]. The results of this study could be explained through the hypothesis of the 'overload theory,' according to which SVR might cause increased venous return into the deep vein system through the perforator veins, which causes a volume overload in the deep veins, leading to an increased caliber of the deep veins, followed by incompetence of the valves of the deep veins. Two possibilities might explain why only 50% of the cases

Table 4. Perioperative changes in the VCSS and AVVQ according toresolution of segmental popliteal vein reflux

Variable	Postoperative resolution of popliteal vein reflux		p-value
	No	Yes	
VCSS (N=42)	4.0±1.6 (n=21)	3.4±2.1 (n=21)	0.32
AVVQ (N=24)	13.3±11.5 (n=11)	9.8±8.8 (n=13)	0.40

Values are presented as mean±standard deviation.
VCSS, Venous Clinical Severity Score; AVVQ, Aberdeen Varicose Vein Questionnaire.

of segmental PVR were resolved. First, long-standing volume overload in the deep vein might cause irreversible structural changes in the wall and valves of the deep vein. According to the overload theory, the diameter of the deep vein would decrease in patients with resolved DVR after saphenous ablation. However, the literature contains no definitive evidence that saphenous vein ablation does indeed reduce the diameter of the deep vein. We were not able to analyze perioperative changes in the diameter of the deep vein since we did not assess the width of the deep vein in routine DUS studies. Additionally, congenital abnormal anatomy of the valve could cause a non-reversible condition. Maleti et al. [12] reported that there are 2 different kinds of valve morphology, with either symmetrical or asymmetrical cusps. After correction of volume overload in the deep vein system, valve competence could be restored in valves with symmetrical cusps, but not in those with asymmetrical cusps. The possible causes of asymmetrical valve cups of the deep vein could include post-thrombotic changes or a congenital condition. An accurate preoperative evaluation of valve morphology is necessary to make a treatment plan based on the symmetricity of valve cusps.

Although Labropoulos et al. [3] reported that PVR was associated with SSV incompetence, we did not find such an anatomic association. In this study, the resolution of segmental PVR was not affected by the ablated segment in the superficial system. Nevertheless, the number of incompetent SSVs was too small to perform a meaningful analysis of their association with GSV incompetence. Hence, further study is required before making a generalization.

1) Limitations of the study

This study has the limitation of being a retrospective single-center study. In addition, although DVR is known to be closely associated with chronic venous insufficiency, as manifested by conditions such as venous ulcers, the majority of the patients in the study (93%) were classified as having C2 disease. Therefore, we were not able to assess the prognosis of venous ulcers according to whether PVR was resolved.

2) Conclusion

This study demonstrated that saphenous vein ablation corrected segmental PVR in 50% of limbs with combined SVR and segmental PVR, regardless of the treatment modality. Other prospective studies are necessary to elucidate the etiology of the non-reversible cases.

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Acknowledgments

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