Subfascial Endoscopic Perforator Surgery Using Screw-Type Ports Is a Very Useful Component of a Comprehensive Treatment Program for Chronic Venous Insufficiency

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Background: Subfascial endoscopic perforator surgery (SEPS) with a two-port system utilizing screw-type ports, CO₂ insufflation and an ultrasonic coagulation system, is a useful procedure that does not require burdensome apparatus and techniques. SEPS was accepted as a national advanced medical system by the Japanese Ministry of Health, Labor and Welfare in May 2009.

Patients and Methods: Forty-one limbs of 35 patients with 10 active ulcers (C6) and 2 healed ulcers (C5) were treated by SEPS between February 2010 and December 2011. Thirty-three limbs had concomitant superficial vein surgery. SEPS alone was performed on 8 limbs, in 6 of which the superficial veins had already been ablated. In 2 limbs, incompetent perforating veins (IPVs) existed under the affected skin, around the scars of past surgery.

Results: All stasis ulcers of the 10 C6 limbs healed between 1 week and 14 months after SEPS (mean 2.9 months), with no ulcer recurrence during the follow-up period (2 to 24 months). IPVs under the scars were easily and safely interrupted by SEPS.

Conclusion: SEPS is a very useful component of a comprehensive treatment program for chronic venous insufficiency, especially in patients with venous stasis ulcers and IPVs under the scars of past surgery.

Keywords: SEPS, two-port system, national advanced medical system, screw-type ports, ulcer healing

INTRODUCTION

Patients with varicose veins and chronic vein insufficiency (CVI) have different presentations, varying from slight to severe symptoms. Hence, surgeons require many options for the treatment of these patients. Recently, severing incompetent perforating veins (IPV) by a direct approach in an area with already compromised skin is less commonly performed because of excessive invasiveness of the procedure itself. Since its first description by Hauer in the 1980s,¹ SEPS has been accepted as an improved treatment modality in the surgical treatment of perforating vein insufficiency, particularly in cases with advanced skin changes. SEPS is performed in some facilities in North America²–⁵ and Europe⁶–¹⁰ as a component of the comprehensive treatment program for venous insufficiency. These previous studies presented favorable results with SEPS. However, SEPS has not been widely adopted because of the technical difficulty and burdensome apparatus involved in its performance. In Japan, the two-port system utilizing screw-type ports (EndoTIP®,
Karl Storz, Tuttlingen, Germany) was introduced by Haruta in the beginning of the 21st century, which made the performance of SEPS simpler and easier.\textsuperscript{11,12} SEPS was accepted as a national advanced medical system by the Japanese Ministry of Health, Labor and Welfare in May 2009. In this paper, we present the early results of SEPS at our facility and demonstrate and discuss suitable candidates for SEPS.

\section*{Patients and Methods}

Forty-one limbs of 35 patients were treated by SEPS between February 2010 and December 2011. Bilateral SEPS during a single surgery were performed in six patients. During the same period, the total number of surgeries for varicose veins including SEPS, performed at our institution was 283 legs in 207 patients. Of the 35 SEPS patients, 14 were men and 21 were women, ranging in age from 35 to 86 (average 68.0) years. CEAP classification (Clinical, Etiological, Anatomical and Pathophysiological) was C6 in 10 limbs, C5 in 2 limbs, C4b in 19 limbs, C4a in 9 limbs and C3 in 1 limb. All limbs showed 1 to 6 IPVs but no limbs had deep venous incompetence containing deep vein thrombosis in the finding of the venous echo. Concomitant superficial vein surgery (26 great saphenous veins, 5 small saphenous veins, and 2 both veins) was performed on 33 limbs. SEPS alone was performed in 8 limbs, in 6 of which the superficial veins had already been ablated. In 2 limbs, IPVs existed under inflamed skin, accompanied by strong pain around the scars of previous surgery.

SEPS was performed by the two-port procedure utilizing the screw type ports, EndoTIPs\textregistered, introduced by Haruta\textsuperscript{11,12} (\textbf{Fig. 1}). Briefly, a 7-mm skin incision was made in the healthy upper medial part of the lower leg, from where the first port, a 6-mm EndoTIP\textregistered, was inserted into the subfascial space of the superficial posterior compartment by twisting off subcutaneous tissue and fascia, under the guidance of a 5-mm endoscope inserted through the port. Then, CO\textsubscript{2} at a pressure of 10 mmHg was insufflated into the space through the port and the subfascial space was bluntly dissected by the tip of the endoscope in order to obtain the working space containing the part into which the second port was inserted afterward. The second port was positioned under the guidance of the endoscope inserted through the first port, and it was inserted into the space in the same way as the first port. One port was used for endoscopic observation, while dissection of soft tissue adhesions and interruption of IPVs were performed by an ultrasonic coagulation system and special dissecting forceps through the other port.

\section*{Results}

All 10 stasis ulcers of the C6 limbs healed between 1 week and 14 months (mean 2.9 months) after SEPS, with no recurrence observed during the follow-up period (from 2 to 24 months). The duration of symptoms of recalcitrant ulcers before SEPS varied from 3 months to 72 months (mean 23.8 months). The size of the ulcer was 0.5 to 8 (mean 3.5) cm in maximum diameter. There were 1 to 3 ulcers per limb (2 ulcers in 2 limbs, 3 ulcers in 1 limb). Four limbs had vacuum-assisted closure (VAC) therapy\textsuperscript{13,14} after the SEPS, following which one of them...
had skin grafting.

All of 2 C5 and 28 C4 limbs showed improvement of the skin changes and subjective symptoms. Currently, no new ulcers have been detected in this group.

Surgically intractable IPVs of two of the limbs, with skin changes under the scars of previous surgeries, were easily and safely interrupted by SEPS. The patients’ pain completely disappeared immediately after the SEPS.

No complications of SEPS were observed in any of the patients, although delayed wound healing and/or paresthesia due to concomitant superficial vein surgery was detected in 3 legs.

The following 4 cases highlight the utility of SEPS in the treatment of CVI.

**Case 1**

A 59 year-old woman had an 8 × 6 cm recalcitrant ulcer on her right lower leg since 6 years. Venous echo showed reflux of the great saphenous vein (GSV) and IPVs near the ulcer and skin pigmentation. GSV stripping, SEPS and foam sclerotherapy of the peripheral GSV were performed. The ulcer and pigmentation gradually resolved until the ulcer healing. She had 4 weeks of VAC therapy 5 months after the surgery. Finally, the ulcer completely healed 14 months after the surgery (**Fig. 2**).

**Case 2**

A 65 year-old woman had 3 ulcers 6 × 4, 5 × 5 and 2 × 1 cm in size on her right lower leg since 18 months. Although the dermatologist who referred her to us reported that she had had bilateral GSV stripping more than 20 years ago, venous echo showed reflux of a completely intact right GSV, together with IPVs near the ulcers and skin pigmentation. GSV stripping, SEPS and foam sclerotherapy of the peripheral GSV were performed. She had 4 weeks of VAC therapy 10 days after the surgery. Her ulcers healed completely 2 months after the surgery (**Fig. 3**).
CASE 3

An 81 year-old woman presented with an 8 × 7 cm ulcer on her right lower leg since 16 months. Venous echo showed reflux of the right GSV and IPVs near the ulcer and skin pigmentation. GSV stripping, SEPS and foam sclerotherapy of the peripheral GSV, together with 4 weeks of VAC therapy 10 days after the surgery, followed by skin grafting resulted in complete healing of the ulcer 2 months after the surgery (Fig. 4).

CASE 4

A 64 year-old woman had bilateral GSV stripping and varicectomy 15 years ago. She suffered from severe pain with edema and redness along the scar of the previous varicectomy on her left lower limb. Venous echo showed that IPVs existed under the skin at the site of the previous surgery. Performance of SEPS resulted in immediate and complete disappearance of the pain and inflammation (Fig. 5).

DISCUSSION

Since the hemodynamic abnormalities and clinical severity of CVI are extremely varied, vascular surgeons need to have a variety of treatment options available to them. When evaluating CVI with varicose veins, venous echo enables detailed analysis of the hemodynamics of leg veins. This enables surgeons to individualize treatment in each patient. A uniform treatment program cannot accomplish adequate results in every patient.

Incompetence of perforator veins that connect the superficial to the deep venous system has been implicated in the pathogenesis of venous ulcerations. Incompetence of perforator veins that connect the superficial to the deep venous system has been implicated in the pathogenesis of venous ulcerations. It was reported that the deteriorating CEAP grade of CVI is associated with an increase in the number and diameter of medial calf perforating veins, particularly those permitting bidirectional flow. The objective of SEPS is to interrupt incompetent medial calf perforating veins, so as to reduce ambulatory venous hypertension in critical areas above the ankle where venous ulcers most frequently develop. Exploration of the use of endoscopes that was begun...
by Hauer\(^1\) in the 1980s was soon followed by others in North America and Europe. Accessing the subfascial space and interrupting perforator veins through small skin incisions made in skin unaffected by the changes of severe CVI and remote from ulcerations is an attractive concept.\(^2\) Due to the avoidance of incisions in an area of already-compromised skin, wound complications can be dramatically reduced by SEPS as compared with transcutaneous surgery.

A systematic review of SEPS showed favorable results, with a reported ulcer healing rate of 88% and ulcer recurrence rate at a mean time of 21 months of 13%.\(^{16}\) For patients with severe CVI and active venous ulcers (C6), an intervention that improves healing and prevents recurrence has the potential to improve quality of life and reverse disability associated with this condition.\(^{16}\) The healing and recurrence outcomes after SEPS are, reportedly, much better than those in most trials of conservative

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Fig. 4  Case 3. The leg ulcer before the surgery (a), 1 month (d) and 2 months after the surgery. (b, c): VAC therapy combined with compression banding, which was started on the 10th postoperative day and was continued for 4 weeks. The patient underwent skin grafting between d and e.

Fig. 5  Case 4. (a) Venous echo demonstrated reflux through the IPVs under the inflammatory scar. (b): Endoscopic visualization of the IPV. (c): Appearance of the leg before the surgery, showing the inflammatory scar and IPVs (ink marks). (d): Appearance of the leg 2 months after the surgery.
therapies, even though the patient population in these surgical studies generally had severe venous disease and inadequate response to conservative therapies. In the ESCHAR study, one third of limbs with incompetent perforators became competent after superficial venous surgery and compression, but 12% of the legs developed new incompetent perforators. Two-thirds of patients, therefore, had residual incompetent perforating veins, suggesting that SEPS probably improves the outcome by leaving no residual IPVs. Recent meta-analysis demonstrated that SEPS is associated with a significantly lower rate of recurrent ulcers.

Yet, SEPS is not widely performed. The most important reason for this is technical immaturity. At the start of the 21st century, many surgeons stopped performing SEPS because of its technical difficulty, such as the needs for establishment of the working space and burdensome apparatus such as a tourniquet and dissecting balloon. With the single-port method, which was previously the main technique of SEPS, it was difficult to establish a multi-directional working space in spite of a larger skin incision. Hence, the two-port method was tried by some surgeons. However, in this method, disposable ports were used and the multi-directional working space couldn’t be established by this method either. Carbon dioxide insufflation, which replaced dissecting balloons, could not establish the working space when used with disposable ports, since the pressure in the subfascial space could not be maintained because of a leak of CO₂.

In Japan, the two-port system utilizing screw-type ports (EndoTIP®, Karl Storz, Tuttingen, Germany) was introduced by Haruta in the beginning of the 21st century, which made SEPS more simple and easier to perform. The screw-type ports allowed establishment of a multi-directional working space without leakage of insufflated CO2. Interruption of IPVs by an ultrasonic coagulation system eliminated the necessity for tourniquets. Thus, the time required for performance of SEPS became shorter, and the results became more favorable. With this technique, the primary ulcer healing rate was reportedly 97.0%, the ulcer recurrence rate was 9.9% and the provisional ulcer healing rate was 92.1% in 101 C6 legs whose mean follow up period was 3.95 years. As a result, SEPS was accepted as a national advanced medical procedure by the Japanese Ministry of Health, Labor and Welfare in May 2009.

However even in Haruta’s feasible method, inflammatory adhesion between the fascia and the muscle in a rare case makes SEPS more difficult. ReSEPS is actually difficult. Endovenous ablation and sclerotherapy seem to be alternative methods, although the risk of DVT in SEPS is much smaller than in those methods.

There are other reasons why performance of SEPS isn’t widespread. Specialized vascular surgeons tend to be relatively unfamiliar with endoscopic surgery, as compared to surgeons who also treat abdominal or chest diseases. Moreover, although most vascular surgeons are comfortable severing IPVs, they tend to hesitate when treating skin ulcerations by themselves owing to the lack of experience and knowledge. Some vascular surgeons conduct the interruption of IPVs, but don’t follow up the result of the surgery and don’t consult with dermato-plastic surgeon. Hence, treatment of stasis ulcers of the leg must be a collaborative effort between vascular surgeons and dermato-plastic surgeons. In this series, we performed VAC therapy after SEPS in 4 limbs, followed by skin grafting in one of them, under the guidance of dermato-plastic surgeons. Our successful results show that henceforth, VAC therapy and skin grafting should be adopted as essential components of the treatment program for stasis ulcers of the leg. Although a few previous papers have mentioned skin grafting after SEPS, none of them reported performing VAC therapy after SEPS. Thus, the efficacy of VAC therapy and skin grafting after SEPS remains a future clinical research subject.

In this paper, we presented intractable CVI cases who did not respond to the general treatment program of CVI, but whose stasis skin lesion healed after SEPS.

Although in our series, there were no cases coexisting with deep venous incompetence containing deep vein thrombosis, Haruta exhibited that the ulcers of all 10 such cases healed after SEPS and the recurrence of the ulcer was observed only in 1 case.

SEPS combined with superficial venous surgery leads to successful healing with a low recurrence rate in patients with open and healed ulcers. However, concomitant surgeries deemed necessary at the time of perforator interruption masked the effects of perforator vein intervention alone, as opposed to solitary ablation of superficial reflux. However, in a report from North America, during an average follow-up period of 5.4 months, ulcer healing was achieved in 21 of 27 C6 limbs (78%) in which the only manipulation was perforator interruption.

In our series, 2 of 10 C6 legs underwent SEPS without superficial vein ablation because they had had GSV stripping in the past (12 and 8 years before SEPS). Their histories of skin ulcerations before SEPS were
of 14 and 36-month durations, respectively, and their ulcers healed within 2 months after SEPS. The fact that both these patients already had lipodermatoscleroses with skin pigmentation (C4b) when the previous GSV stripings had performed, and continued compression therapies from the stripings until the SEPSs, highlights the efficacy of SEPS.

**Conclusion**

We suggest that patients with intractable stasis ulcerations and other skin lesions of the lower leg could benefit from SEPS performed with the use of screw-type ports, combined with ablation of superficial leg veins and ambulatory compression therapy.

**Disclosure Statement**

The authors don’t have conflict of interest.

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