Duplex Guided Injection Foam Sclerotherapy for Incompetent Perforators Combined with Skin Grafting in Venous Leg Ulcer

Ahmed Mohamed El-Mahdi, MD;[2] Mahmoud Amir Youssef, MD;[1,2] Wael Omar Khalifa, MD;[1] Barakat Abd-Elrahem Mahmoud, MD;[3] Ahmed M. A. Elsayed, MD[2]

[1]General Surgery Department, Faculty of Medicine, Helwan University, Egypt
[2]Vascular Surgery Department, Faculty of Medicine, Helwan University, Egypt
[3]Plastic Surgery Department, Faculty of Medicine, Helwan University, Egypt

Introduction: Seventy percent of leg ulcers are venous leg ulcers (VLUs), one of the most common consequences of chronic venous insufficiency.

Aim of work: To evaluate the clinical efficacy of duplex-guided foam sclerotherapy combined with skin graft.

Patients and methods: This prospective follow-up (cohort) study was conducted on 20 patients with venous leg ulcers and incompetent perforator veins who were referred to the Vascular and Plastic Surgery Department at Helwan University Hospitals.

Results: The mean percentage of healing in the ulcer surface area post-injection was 82.5% after 1 week; this was reduced to 79.5% and 81.5% after 2 and 4 weeks, respectively. The total mean size of the ulcer was 5.60 ± 14.73 cm². These changes in the size of the ulcer were significantly different ($p<0.001$). At the last follow-up visit, 17 patients (85%) were still ulcer-free, while three ulcers (15%) recurred. After 6 months, all perforator veins were ablated in 90% of patients, while multiple perforators showed reflux in two (10%) patients. Half of the patients encountered complications.

Conclusion: Duplex-guided sclerotherapy with skin grafting is a simple procedure without suffering from compression therapy or daily dressing. Also, the patient can return home after 1 day with the ability to do daily work, and the sick leave period is a maximum 1 week. So, the evident success of this procedure and its relative freedom from serious complications make it one of the most important lines of treatment for venous ulcers, especially large ulcers.

Key words: Venous leg ulcer, duplex guided injection sclerotherapy, skin grafting.

Introduction

Chronic venous insufficiency (CVI) and ambulatory venous hypertension are late indicators of venous leg ulcers (VLUs).[1] Under normal circumstances, prograde flow is facilitated and blood reflux is prevented by contraction of the calf muscle and intraluminal valves.[2] However, the vascular and dermatological issues that arise in the creation of VLUs are caused by chronic venous insufficiency when retrograde flow, blockage, or both exist.[3]

VLUs are a prevalent medical disease that affects 1% to 3% of the global population. The main cause of this is veins that consistently have excessive blood pressure. As people age, VLU is more common.[4] When VLUs have full wound re-epithelization, healing is frequently sluggish. Ulcer recurrence is common.[5] Compression therapy and direct wound management are the two strategies that determine the standard of care for VLUs.[6]

A Cochrane review indicates that multilayer systems improve venous ulcer healing rates in comparison to single-layered systems.[7] The Ankle and Brachial Pressure Index (ABPI) indicates when mild or substantial peripheral vascular disease is present, at which point light, cautious compression can be applied. Arterial occlusive disease, ABPI<0.5, severe uncontrolled hypertension, heart failure, suspected or confirmed thrombosis, significant thrombophlebitis, erysipelas, etc. are absolute contraindications for compression therapy.[8]

Leg venous ulcers are known to be highly associated with IPV(Incompetent perforators vein), both in their initial development and recurrence.[9]

Regarding the most effective course of action or indication for treating IPV, there is no unambiguous agreement. The SVS (Society for Vascular Surgery) and AVF(American Venous Forum) clinical practice guidelines offer a variety of options for treating IPV, including thermal ablation (Laser and radiofrequency), ultrasound (US)-guided foam sclerotherapy, and surgery like subfascial endoscopic perforator surgery (SEPS).[10]

One of the key techniques used in plastic surgery is skin grafting. Skin grafts can be used to treat burns, congenital skin defects, deformities following oncologic excision, traumatic wounds, scar contracture release, and rebuilding of the nipple and areola.[11]

This study aimed to evaluate the success of Duplex-guided injection foam sclerotherapy for incompetent perforators combined with skin grafting in venous leg ulcers.

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Patients and methods

This prospective follow-up (cohort) study included patients with venous leg ulcers and incompetent perforator veins in the vascular and plastic surgery departments of Helwan University hospitals for 9 months. From January 2023 to September 2023.

Inclusion criteria

Patients >18 years, no sex preference, competent saphenofemoral and saphenopopliteal junctions, stripping of the great saphenous or small saphenous vein in cases of incompetent saphenofemoral and saphenopopliteal junctions, patients with incompetent perforator veins, and patients with a venous leg ulcer.

Exclusion criteria

Individuals younger than 18 , high-risk patients with poor ejection fraction, congestive heart failure, or skin pathologies. Not removed or ablated incompetent saphenofemoral and saphenopopliteal junctions. Individuals declined surgery.

Ethical consideration

The Academic and Ethical Committee at Helwan University granted approval for the project. Written, informed consent was obtained from each participant. The Declaration of Helsinki, the World Medical Association's code of ethics for human subject research, has been followed in the conduct of this work.

Study procedures

Every patient had their complete medical history examined, which included their age, sex, any note-worthy behaviors, history of ulcers, and past ulcer treatments. The patient's problem as it is presented. Previous medical history, including chronic illnesses, wound infections, and surgery problems such as breathing issues.

During the first scheduling, the patient underwent a vascular assessment for evidence of chronic venous insufficiency, any signs of lower limb ischemia, and measuring ankle brachial index.

Ulcer assessment: The ulcer was thoroughly examined (during the initial appointment and every two weeks thereafter) in the following ways: digital pictures of the ulcer were taken, the surrounding skin was examined for signs of infection or inflammation, and ulcer management was carried out.

Investigation

The detection of perforator vein width, reflux in perforator veins, and skin-marked perforator vein sites was achieved using duplex mapping to the lower limb venous system.

Pre-treatment duplex ultrasound mapping

Using a sensosite Micromax limited with a 10 MHZ transducer in the conventional manner. Both superfascial and deep systems were examined.

Every vein was checked for patency and compressibility. Reflux was defined as backward flow lasting more than 0.5 seconds and was created by manually squeezing the calf. A perforating vein was deemed incompetent if the flow reversal (Towards the superficial veins) lasted longer than 0.4 seconds, the vein's size at the fascial orifice was greater than 3.5 mm, or the two criteria were met.

During the duplex scan, sites with skin damage and ulcers, those associated with corona phlebectatica, or clusters of varicose veins, were shown to have incompetent perforating veins. The construction of a sclerotherapy plan and the choice of how to treat each incompetent perforator depended on this information.

Ulcer management protocol

In order to eliminate any exudate, the ulcer was first carefully debrided and cleaned in the operating room using a saline solution. Next, incompetent perforators underwent duplex-guided foam sclerotherapy in conjunction with skin grafting.

Technique of duplex-guided injection of foam sclrotherapy

Retrograde flow from the deep to the superficial venous system was prevented during therapy using the foam injection technique, which was guided by duplex ultrasonography, using a longitudinal or transversal probe scan to image the target vein. Often a transducer at 10 MHz. Syringes with 5 or 3 cm needles placed in the transducer's sagittal plane near the transducer tip was used for cannulation. When the needle tip touched the target vein, an indentation appeared on the vein wall. A little more pressure was then applied to puncture the vein wall and reveal the tip inside the lumen. To stop the sclerosing foam from spreading to the deep venous system, a tiny amount of the foam was injected, and compression using a transducer or digital technique was used. Next, skin grafts were applied to ulcers once donor and recipient sites were prepared.

Donor site preparation

The recipient ulcer site's length, width, and depth were taken into consideration along with the wound size measurement.

Recipient site preparation

All non-viable tissues were removed from the recipient bed.

The process of transplanting a skin graft to the

recipient bed began as soon as excellent vascularity and clean wound margins were discovered.

Procedural approach

For patients with venous ulcers, injectable foam sclerotherapy and skin grafting were performed in a single session. The patient was wheeled into the operation room and laid out supine on the table. After that, an inadequately perforated vein were injected with sclerotherapy. The ulcer bed were then prepared by removing hypertrophied tissue and using saline and adrenaline to create a well-vascularized bed.

At the graft harvest site, dimensions were measured using a marking pen, and the wound bed measurements were used to select a dermatome template. The authors' preferred size for the lower extremities was 0.018 of an inch, and the graft size was now chosen on the dermatome. Several slits were cut into the graft to stretch it out, harvest less skin from the donor site, and enable fluid to drain from under the skin transplant in a split-thickness graft. A buildup of fluid beneath the graft could lead to its failure.

Fixation graft using staples or sutures, followed by compression bandaging, Vasiline gauze, and sterile gauze. Following the surgery, the surgeon applied a non-stick bandage to the donor location. **(Fig. 1)**.

Follow up and outcome measures:

The chosen outcome measures were grafts taken and complete occlusion or ablation of reflux. All patients were followed up for 6 months after treatment. Venous duplex after operation and after 6 months to confirm ablation of all perforators.

In the first few days, the skin may appear purple or red. After about a week, when the dressing was removed, the skin should appear pink. In time, the skin color should match the color of the surrounding skin. First, dressing was done after 3-5 days from the operation with saline and betadine, then dressing day after day with saline and cream, promotes healing.

Following surgery, we followed up the patient, checked vital signs, and administered painkillers as needed. The patient underwent a split-thickness transplant and was hospitalized for several days to ensure proper healing of both the donor site and the graft. **(Fig. 2).**

Fig 1: (A) Venous leg ulcer before operation. (B) After operation.

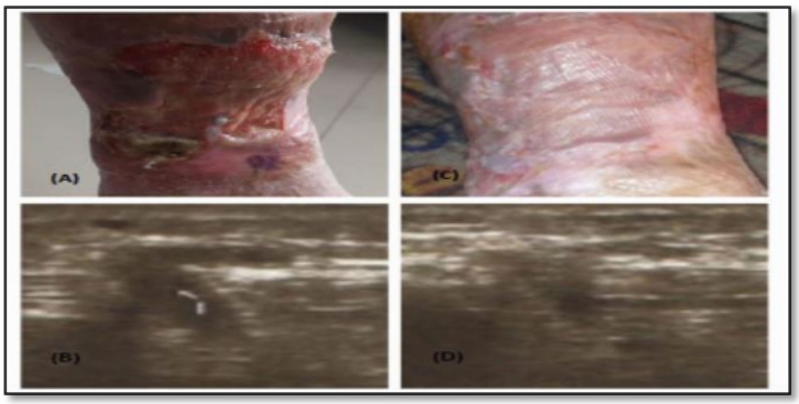

Fig 2: (A) Venous ulcer before sclerotherapy. (B) Duplex of Perforator vein before sclerotherapy. (C) Venous ulcer after sclerotherapy and graft,(D) Duplex of Perforator vein after sclerotherapy.

Statistical analysis

Data was analyzed using Microsoft Excel software. Data were then imported into the Statistical Package for the Social Sciences (SPSS version 20.0) software for analysis. According to the type of data, qualitative represents a number and percentage, and quantitative continues group represents the mean ± SD. The following tests were used to test differences for significance: difference and association of qualitative variables by the Chi square test (X2). Differences between quantitatively independent groups were measured by the t test or Mann-Whitney, paired by the sign test. The P value was set at <0.05 for significant results and <0.001 for highly significant results.

Results

The age of the included patients ranged from 22 years to 66 years, with a mean of 38.30±11.57 years. There were 13 (65%) males and 7 (35%) females, with a male-to-female ratio of 1.86:1. Most cases (70%) were from rural areas **(Table 1).**

The left leg was the most common affected site, as venous ulcers were found in more than half of cases (55%). 15% of ulcers were on the lateral side, 35% on the medial aspect, and 5% on the medial and posterior aspects. The right leg was affected in 45% of cases; 20% of ulcers were on the medial side, 15% on the posterior aspect, and 10% on the lateral aspect **(Table 2).**

The mean percentage of healing in the ulcer surface area post-injection was 82.5% after 1 week; this was reduced to 79.5% and 81.5% after 2 and 4 weeks, respectively. This changed to 82.5% and then 82% at 6 weeks and 12 weeks of follow-up, respectively. At 24 weeks. The total percentage of healing was 82%. These changes in percentage of healing were significantly indifferent at different time periods (p > 0.05) **(Table 3).**

The mean size of the ulcer (surface area) at the time of diagnosis was 50.35±29.30 cm2, but this was reduced to 9.40± 15.79 cm2 after one week. This changed to 11.80±21.88 cm2 and then 8.88±17.15 cm2 at 2 weeks and 4 weeks of follow-up, respectively. Then it changed to 6.99±15.52 cm2 and then 5.15±14.47 cm2 at 6 weeks and 12 weeks of follow-up, respectively. At 24 weeks. The total mean size of the ulcer was 5.60 ± 14.73. These changes in the size of the ulcer were significantly different at different time periods (p<0.001) **(Fig. 3).**

The studied patients were followed up by duplex. Postoperative results showed that all perforator veins were ablated in most (90%) patients, while multiple perforators showed reflux in two (10%) patients. Also, after 6 months, all perforator veins were ablated in most (90%) patients, while multiple perforators showed reflux in two (10%) patients **(Table 4).**

During follow-up, complete healing of the ulcer (closure) was observed in 13 (65%) by the 24 weeks post-injection, while two ulcers (10%) failed to heal. Five cases showed incomplete healing with secondary intentions. At the last follow-up visit, 17 patients (85%) were still ulcer-free, while three ulcers (15%) recurred. The median time for ulcer complete healing (closure) was 2 weeks, ranging between 2 and 24 weeks **(Table 5, Fig. 4).**

Half of patients (50%) encountered complications; seven patients (35%) suffered from infection; 2 of them received 5% of the graft; 2 cases received 10% of the graft; one case received 30% of the graft; and one case received 50% of the graft. Two patients (10%) developed venous hypertension. One patient (5%) had a suspected malignancy ulcer **(Fig. 5).**

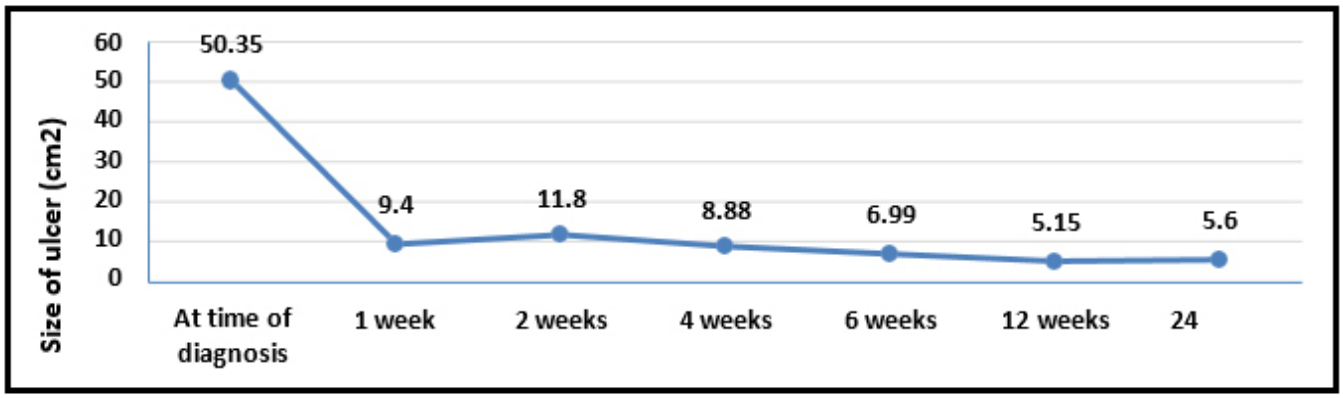

Fig 3: Mean size of ulcer at different follow up period.

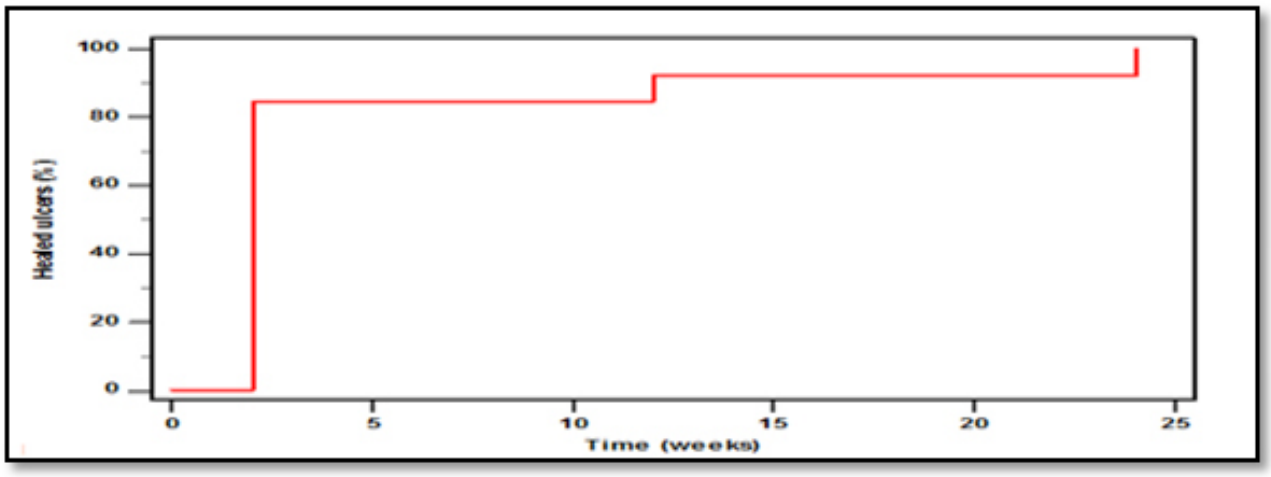

Fig 4: Kaplan-Meier curve for ulcer complete healing (closure) and recurrence rate.

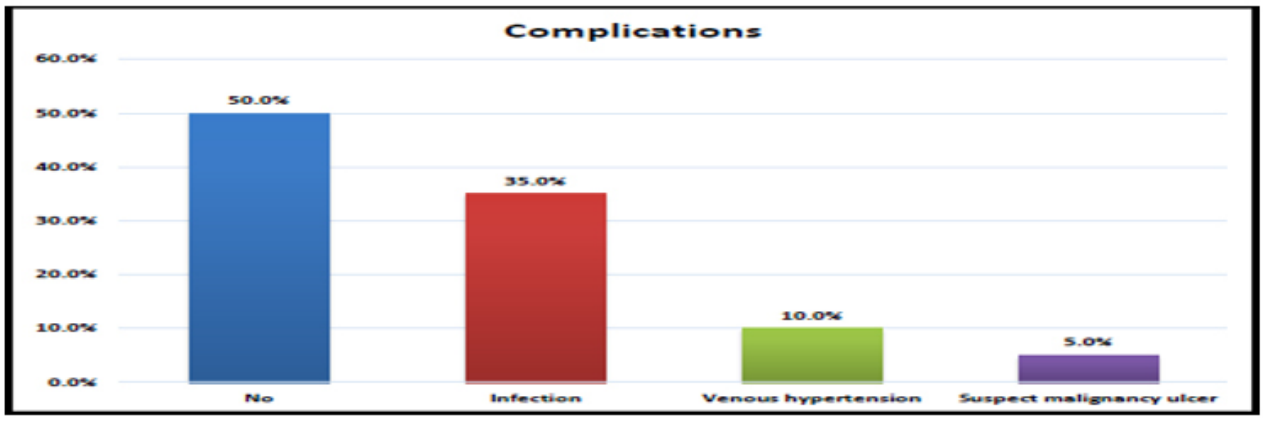

Fig 5: Distribution of the studied cases as regards complications.

Table 1: Demographic characteristics of the studied patients

Parameters		Studied patients (N= 20)	
		N	%
Gender	Male	13	65.0%
	Female	7	35.0%
Age groups	18- 40 years	12	60.0%
	40-60 years	7	35.0%
	> 60 years	1	5.0%
Age (years)	Mean± SD	38.30± 11.57	
	Median	36.0	
	Range	22.0 – 66.0	
Residence	Rural	14	70.0%
	Urban	6	30.0%

SD= standard deviation, n: number, %: percentage.

Table 2: Distribution of studied patients regarding site of venous ulcer

		Studied patients (N= 20)	
		N	%
Site of venous ulcer	**Right leg**	9	45.0%
	Lateral aspect	2	10.0%
	Medial aspect	4	20.0%
	Posterior aspect	3	15.0%
	Left leg	11	55.0%
	Lateral aspect	3	15.0%
	Medial aspect	7	35.0%
	Medial &Posterior aspect	1	5.0%

Table 3: Distribution of studied patients regarding graft taken and rate of healing atdifferent time periods

		Studied patients (N= 20)						
		Mean	±SD	Median		IQR		Range
Graft taken and rate of healing	1 week	82.5%	±31.7	100.0%	80.0%	100.0%	0.0%	100.0%
	2 weeks	79.5%	±36.5	100.0%	80.0%	100.0%	0.0%	100.0%
	4 weeks	81.5%	±32.8	100.0%	80.0%	100.0%	0.0%	100.0%
	6 weeks	82.5%	±31.7	100.0%	80.0%	100.0%	0.0%	100.0%
	12 weeks	82.0%	±32.2	100.0%	80.0%	100.0%	0.0%	100.0%
	24 weeks	82.0%	±36.0	100.0%	90.0%	100.0%	0.0%	100.0%
p-value*		0.935						

P value< 0.05 is significant, P value< 0.01 is highly significant, SD: Standard deviation, *Analysis done by Friedman's ANOVA test.

Table 4: Follow up duplex post-operative and after 6 month in the studied cases

		Studied patients (N= 20)	
		N	%
Follow up duplex post- operative	All perforators vein is ablated	18	90.0%
	Multiple perforators show reflux	2	10.0%
Follow up duplex after 6 month	All perforators vein is ablated	18	90.0%
	Multiple perforators show reflux	2	10.0%

Table 5: Distribution of studied patients regarding outcome

		Studied patients (N= 20)	
		N	%
Outcome	Complete healing	13	65.0%
	Incomplete healing with 2ry intention	5	25.0%
	No healing at all	2	10.0%
	Recurrence	3	15.0%
Time of complete healing (weeks)	Mean± SD	4.46± 6.49	
	Median	2.0	
	Range	2.0 – 24.0	

Discussion

The most frequent cause of chronic leg ulcers is venous ulcers which have significant negative influence on patients' quality of life and productivity. While VLUs typically do not result in limb loss, their chronic and refractory nature necessitates numerous trips to the doctor and the use of bulky dressings, which are typically malodorous due to extensive leaking.[12]

In their lifetime, about 1% of Europeans are expected to acquire chronic venous ulceration (CVU); the point prevalence of open ulcers is anticipated to be 0.1%. Health-related quality of life (HRQL) is significantly impacted by CVU, and the illness uses a large amount of medical resources.[13]

The primary pathogenic component causing the VLUs is ambulatory venous hypertension, which must be reversed in order to treat the condition. For venous ulcers, debridement and local wound care are common procedures. There are numerous approaches to wound debridement, such as mechanical, chemical, and autolytic debridement.[14]

The cornerstone of care is compression therapy, which works in tandem with innovative adjuvant therapies to supply the growth factors required to accelerate the healing process.[15] Raffetto and Marston,[16] found that compression therapy speeds up the healing of venous ulcers more quickly than it does without it. Low-pressure systems are not as effective at providing high-grade compression as three or four layers of bandage or short-stretch bandage. At 12 to 24 weeks, the healing rate is roughly 60–70%, depending on the sort of compression model used.

There have been suggestions that foam sclerotherapy may be more successful and less prone to problems since it uses less sclerosant to cover a larger surface area. Initially, limbs that had not responded to traditional treatment were treated with foam sclerotherapy. Then, as more people employed the technique, it became evident that patients should begin receiving treatment as soon as they were referred for it. This is the first line of treatment for venous ulcers due to its apparent efficacy, relative lack of major consequences, and ease of use when compared to surgical intervention.[17]

Foam sclerotherapy has been proposed as a potentially more successful and less problematic method since it uses less sclerosant to cover a larger surface area. Foam sclerotherapy was initially employed to treat limbs that had not responded to traditional medical care. As the approach was applied more often, it became evident that patients should begin receiving treatment using it as soon as they were referred for care. This is the first line of treatment for venous ulcers since it is less complicated than surgery, has fewer major side effects, and is clearly successful.[18]

Barwell et al.[19] observed that although there seemed to be no difference in healing rates, recurrence rates were considerably lower in the surgery group when patients with superficial venous reflux (SVR) and CVU were compared between compression alone and compression plus superficial venous surgery. At a median follow-up of 14 months, recurrence rates were 15% in the surgery and compression group and 34% in the compression alone group. Healing rates were 65% at 6 months and nearly 80% at 12 months.

Bergan et al.[20] indicated that in this frequently elderly and fragile group, ultrasound-guided foam sclerotherapy (UGFS) of SVR in patients with CVU may be a viable and appealing substitute for surgery.

In our study, patients were followed up by duplex. Postoperative results showed that all perforator veins were ablated in most (90%) patients, while multiple perforators showed reflux in two (10%) patients. Also, after 6 months, all perforator veins were ablated in most (90%) patients, while multiple perforators showed reflux in two (10%) patients.

Eweda and Zaytoun,[21] examined the use of foam sclerotherapy, with the use of duplex ultrasound guidance, to inject incompetent perforators into 40 patients, whose ages ranged from 20 to 62 (Mean age of 43.4 years), in order to treat venous ulcers.

Eweda and Zaytoun,[21] evaluated thirteen patients (32.5%) who had the damaged right lower limb identified, compared to 27 patients (67.5%) who had the affected left lower limb. Prior to evaluation, patients' complains ranged in duration from two to seven years, with a mean of two and a half years. Thirty limbs (75%) had primary aetiological findings, while ten patients (25%) had secondary instances with a history of deep vein thrombosis.

The results of our study showed the left leg was the most common affected side, as venous ulcers were found in more than half of cases (55%). 15% of ulcers were on the lateral side, 35% on the medial aspect, and 5% on the medial and posterior aspects. The right leg was affected in 45% of cases, 20% of ulcers were on the medial side, 15% on the posterior aspect, and 10% on the lateral aspect.

Eweda and Zaytoun,[21] define the time to heal as computed from the date of the first UGFS treatment session. This describes the healing and recurrence rates after duplex ultrasound-guided foam sclerotherapy (UGFS). The date the ulcers healed was used to determine the time of recurrence. In this study, 40 patients had their leg ulcers treated for 1, 3, and 6 months. At these intervals, 5 ulcers (12.5%), 28 ulcers (70%), and 38 ulcers (95%), respectively, had fully healed. During the follow-up period, three ulcers (8%) recurred.

Our study showed the mean percentage of healing in the ulcer surface area post-injection with grafting was 82.5% after 1 week; this was reduced to 79.5% and 81.5% after 2 and 4 weeks, respectively. This changed to 82.5% and then 82% at 6 weeks and 12 weeks of follow-up, respectively. At 24 weeks. The total percentage of healing was 82%. These changes in the percentage of healing were significantly different at different time periods ($p > 0.05$).

Eweda and Zaytoun,[21] identified five patients with early problems. Three individuals experienced extravasation of foam during injection and required realignment of the needle tip before continuing with foam injection, while two patients experienced a tightness in their chest that was treated with intravenous short-acting corticosteroids and bronchodilators. Seven patients had late complications identified; four of these patients developed superficial thrombophebitis, which was treated locally with lead subacetate and glycerine, as well as increased echogenecity surrounding the treated site on duplex scanning, which demonstrated local erythema and oedema. By the end of the third month, the skin pigmentation in the remaining three patients had cleared up.

Jankunas et al.[22] foamed sclerosant can work directly on the microcirculation, the ultimate point of venous hypertension, as opposed to indirectly through superficial venous stripping, it may be more effective than superficial venous surgery in aiding in CVU recovery.

Kulkarni et al.[23] indicated that although the hazard ratio of developing ulcer recurrence by 3 years was 2.5 in those with residual below-knee GSV reflux, this did not reach statistical significance. Remaining reflux following saphenous surgery is not the most important predictor of venous ulcer recurrence.

Darvall et al.[24] outlined the rate of recurrence and healing of CVU in the year after UGFS of SVR. They proposed that using UGFS to eliminate SVR leads to better CVU results than just compression. When it comes to treating SVR, UGFS seems to be at least as effective as surgery. As a result, it seems like the better choice for this elderly patient population. Patients with DVR do not respond as well to UGFS treatment, as is perhaps to be expected, but this is also true with surgery and compression alone.

A significant number of the patients in our study would have had big, unhealed ulcers, and the majority would have needed adjuvant procedures (Skin grafting and foam sclerotherapy). Chronic venous ulcer patients are less likely to heal and are unable to pay for daily dressings. Thus, it makes sense to recommend that these patients receive quality alternative care wherever available.

Conclusion

A significant number of the patients in our study would have had big, unhealed ulcers and were unable to pay for daily dressings. Thus, it makes sense to recommend that these patients receive quality alternative care wherever available. This synergistic approach (skin grafting and foam sclerotherapy) can improve the quality of life by shortening the time needed for ulcer healing, decreasing the cost of daily dressing, and promoting rapid recovery for normal daily activity.

Duplex-guided sclerotherapy with skin grafting is a simple procedure without suffering from compression therapy or daily dressing. Also, the patient can return home after 1 day with the ability to do daily work, and the sick leave period is a maximum of 1 week. So, the evident success of this procedure and its relative freedom from serious complications make it one of the most important lines of treatment for venous ulcers, especially large ulcers.

Limitations of the study

- A single-center study may result in different findings than elsewhere.
- Small sample size that may produce insignificant results.
- The follow-up duration was relatively short, and a longer period is needed for gathering more accurate results regarding recurrence and complication rates.

Recommendation

- Further studies in other centers are needed to compare the findings.
- Further studies with a larger sample size produced significant results.
- Until further studies can determine the superior technique, it is advisable to individually design the approach to be used.

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