

Holistic Management of Venous Ulcers Especially With Endovenous Laser Treatment Using 980nm Laser in an Ethnically Diverse Society

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SUMMARY

Aim: Chronic venous ulcers usually occur as an occupational hazard due to venous insufficiency with venous hypertension. Endovenous laser treatment (EVT) is used to treat varicose veins with venous ulcers and outcome including demography assessed in the different races.

Procedure: 145 lower limbs (right 39.3%, left 60.7%) with venous ulcers involving reflux of the great saphenous (132 cases) and / or small saphenous (57 cases) veins underwent EVT with 980 nm diode laser for single (123 cases) or both (11 cases) legs intervention. Supplementary procedures required multiple avulsions and / or sclerotherapy. Holistic advice of multilayered bandaging, graduated compression stockings, weight reduction and lifestyle changes enforced.

Result: The average age with venous ulcers was 53.6 years. The mean BMI was 26.8 : the Chinese, Indian and Malay BMIs were 25.1, 28.1 and 31.3 respectively. Symptoms that included pain, swelling, heaviness and cramps assessed pre- and postsurgically were significantly reduced (<0.0001), using the Wilcoxon signed rank test. Of the occupations involved by race, the Chinese were mostly salespersons, Indians blue collar workers and Malays food-related workers. Young overweight Indians with sedentary occupations were most predisposed to venous ulcers. Gram negative organisms 63.4% and gram positive organisms 36.6% were isolated in the ulcers. Most ulcers 63.5% measured <2 cm and majority 73.8% localised in the gaiter area.

Discussion: Results of EVT in healing ulcers with no recurrences more than 2 years were successful in 89.7% (130/145). Complications included numbness foot 7.5% and DVT 1.4%. 10.3% (15 cases) had recurrence of venous ulcers within 2 years. In terms of satisfaction 32.3% experienced as very satisfied while 63.4% were satisfied and 4.3% unsatisfied. In conclusion EVT is a useful adjunct with minimal invasion in managing venous ulcers holistically.

KEY WORDS:

Chronic venous ulcers, Endovenous laser, Ethnicity

INTRODUCTION

Chronic venous disorders are common diseases of the lower limbs with obvious signs being varicose veins and venous ulcers¹. Chronic leg ulceration usually occurs as a result of venous insufficiency and affects approximately 0.2 – 1 percent of adults in the western world^{2,3,4,5,6,7}. A rising frequency in older age groups has been widely reported with a peak in prevalence for chronic venous ulceration in people aged about 70 years^{7,8,9,10,11,12}.

The risk factors associated with venous ulcer formation usually complicate its treatment or increase the likelihood of recurrence. Insufficiency of the superficial, perforating or deep veins of the leg is a risk factor for leg ulceration¹³. The greater the degree of venous insufficiency, the greater the risk of a venous ulceration developing¹⁴. Chronic skin changes secondary to inadequate treatment of chronic venous insufficiency or due to delayed treatment or to failure to control oedema have been suggested as a possible risk factors^{15,16,17,18}. Episodes of local trauma to the skin are also thought to play a contributory part in the development of an ulcer¹⁹.

A number of coexisting conditions also clearly aggravate the clinical situation. For example, degenerate arthritis, ankylosis related musculoskeletal disease are age-related problems that complicate venous ulcer treatment and predispose to recurrence because they severely limit the ability of the patient to participate actively in ulcer care. Various neuropathies (including diabetes), autoimmune diseases, infection, chronic oedema and obesity may predispose to venous ulceration although there is no clear evidence that they act as primary causes^{19, 20, 21, 22}.

Reducing venous hypertension at the site of stasis ulceration, hence promoting venous ulcer healing, is the mainstay of venous disease treatment. Traditional modalities used to treat venous diseases and subsequent stasis ulceration include compression bandaging,^{23,24} debridement,²⁵ skin grafting^{26,27,28} vacuum therapy^{29,30} or biological dressings³¹ and ablative or corrective vein surgery (stripping, ligation, valvuloplasty and subfascial perforator ligation)³². Although open procedures have proved to be effective, they can leave associated morbidities, such as post operative pain, limited mobility,

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wound infection and dehiscence, as well as missed varicosities and/or incompetent perforator veins, resulting in additional invasive procedures³². As such, Endolaser Vein Treatment (EVT), an alternative minimally invasive modality is used.

Currently there is very limited data on the incidence as well as treatment sequelae of varicose veins with venous ulcers from East Asia (Far East). This paper aims to evaluate differences in the demography as outcome with EVT for treatment where appropriate of varicose veins (GSV or/and SSV) with venous ulcers. Specific lasering of the truncal tributaries of the venous ulcer in the peri-ankle area mainly is instituted as an adjunct to other modalities of holistic care.

MATERIALS AND METHODS

All patients who presented to the outpatient clinic (Jan 2010 –Dec 2011) of our surgical department that have venous ulcers with saphenofemoral junction (SFJ) and/or saphenopopliteal (SPJ) reflux associated with incompetence of the great saphenous vein (GSV) or small saphenous vein (SSV) respectively, underwent EVT with a 980nm diode laser (Ceralas™ D980 diode laser; BioLitec® AG, Jena, Germany). 123 cases underwent single leg intervention and 11 cases were treated bilaterally (total legs treated 145 cases).

Exclusion criteria included non-palpable pedal pulses or peripheral arterial disease, inability to ambulate, deep venous thrombosis, general poor health, pregnancy, nursing or plans to become pregnant during the course of investigation and extremely torturous GSVs.

The severity of the varicose veins was assessed according to the descriptive Clinical, Etiological, Anatomical and Pathophysiological (CEAP) classification^{33,34}. All patients in CEAP 5 (20 cases) and 6 (125 cases) were selected for the study.

All venous ulcers (CEAP 5 and 6) are assessed to have wound swabs to isolate the offending organism(s). Only aerobes and facultative anaerobes were being isolated. Many other anaerobic species are only cultured occasionally. All ulcer infections often with septicaemia are treated with systemic or oral antibiotics before EVT or other procedures. The venous ulcers are managed with povidine iodine and silver-based dressings.

In the EVT cases with venous ulcers, the power utilized for treatment ranged from 13-15 W in the thigh (GSV) to 10-12 W in the leg (anterior GSV and posterior calf areas SSV). An average of 80-90 J per centimeter was delivered to the thigh and 50-60 J per centimeter to the leg. Thus, apart from lasering the GSV in the thigh, the GSV and/or SSV in the leg, the perforators in the ankle area just deep to the ulcer are also burnt, hence obliterating any tributaries to the ulcer. Any other tributaries or perforators besides the truncal GSV or SSV, are likewise lasered or ligated directly or indirectly. Access below the ankle will almost always ensure that the venous ulcer tributaries or perforators mostly in the medial or lateral malleoli areas are also accessed and occluded before the GSV or SSV are obliterated proximally at the lower one-third leg.

All EVTs were performed under sedation, or spinal anaesthesia/general anaesthesia.

Supplementary procedures of multiple avulsions or sclerotherapy were performed on the same or separate times. Holistic care of multi-layered bandages or graduated compression stockings, weight reduction and life style changes are impressed upon. Dietary advice and job changes always advised. Nucleus or extended families roped in for support and care whenever possible.

Patients' data were collected in a retrospective manner from hospital, including clinic, medical notes and/or chart reviews. Baseline demographic and clinical data, inclusive of preoperative, postoperative and follow-ups were recorded in standardized case report forms.

Standard descriptive statistic is used to present the covariates collected. The Wilcoxon sign rank test was used to determine the differences between pre and post clinical presentation, as the covariates are non-parametric in nature. In addition, the logistic regression was applied to identify the possible factors associated with the clinical outcome. Statistical analyses were conducted using Stata Version 11 and considered as statistically significant if the p-value <0.05.

All patients were followed up at 10 days, 1 month, 6 months, 1 year and 2 year after EVT. A duplex ultrasound examination was performed to check the SFJ/SPJ incompetence and GSV/SSV reflux at 1 month, 1 year and 2 years.

Satisfaction is assessed in personal interviews or by telephone 2 years after receiving EVT therapy.

RESULTS

In the multiracial society, the Chinese (84 limbs) was the most affected race with venous ulcers followed by the Indians (51 limbs) and Malays (9 limbs) (Table I). The most common foreigners that sought treatment were Indonesians (35 limbs). The origins of the latter were also Chinese, Malays or Indians. Incidentally, Indonesian Malays included Bataks, Achenese, Jawanese and many other subgroups from Sumatra to Celebes.

There was a slight preponderance of females (74 cases, 51.0%) compared to males (71 cases, 49.0%), p-value 0.38). Left leg venous ulcers (88 cases, 60.7%) were more frequent than the right involvement (51 cases, 39.3%)". In the Chinese the right leg (33 cases, 39.3%) versus the left (51 cases, 60.7%) were almost equal with the Indians, right (20 cases, 39.2%) and left (31 cases, 60.8%) legs. The Malay had right (4 cases, 44.4% and left (5 cases, 55.6%) legs.

In the demography, referring to Table I, cases with venous ulcers ranged 20-89 years were analyzed. No significance difference was noted between age groups (p-value 0.8) (Table 1). A peak age incidence appeared in the 50-59 years (31.7%), followed by 40-49 years (22.1%) and 70-79 years (15.1%). The average age with venous ulcers is 53.6 years. There is a slight preponderance of females 75 limbs (51.1%) over male 71 limbs (49.0%) (p-value 0.38). Younger age

groups showed a preference of males (20-50 years) while the older age group (50-89 years) skewed to females. In the less than 50 years age population, by proportion of the races, the Chinese numbered 36 limbs (42.9%), Indians 20 limbs (37.3%) and Malays 7 limbs (77.8%).

Of the significant comorbidities, 9% have type II diabetes mellitus, 12.4% hypertension and 0.7% chronic pulmonary airway disease. 4.8% are smokers. 89.2% of the females (74 cases) had undergone pregnancy.

The mean Body Mass Index (BMI) was 26.8%, average male BMI 27.3 and female 26.4. The highest BMI recorded was 43 and lowest 15. The BMIs of the Chinese, Indians and Malays were 25.1, 28.1 and 31.3 respectively (Table I). Only 53 cases (36.6%) have BMIs less than 25, while the majority 92 cases (63.4%) possessed BMIs greater than 25. The BMIs were greater than 30 in the younger (<50 years) age group of Indians and Malays mainly. Conversely in the older age group of greater than 50 years old, the BMIs were almost similar among all races averaging 26.

In the presentation (Table II), infection was the commonest reason to seek treatment for its symptomatology of pain (98.6%), swelling (83.1%), cramps (69.7%), heaviness (66.4%), cellulitis (23.4%) or superficial thrombophlebitis (22.8%). Another relatively common but often urgent reason was bleeding venous ulcers (19.3%).

Following EVT all symptoms improved considerably. Comparing pre- and post-operatively, symptoms of pain, swelling, cramps, and heaviness were all statistically significant using Wilcoxon signed-rank test (p -value <0.0001)(Table II). As regards heaviness, there was statistical significance between Indians compared to Chinese with an Odds ratio of 2.1(95% confidence interval 1.02 to 4.32). Of course, lipodermatosclerosis (thickening caused by fibrosis of subcutaneous fat), eczema, hyper-pigmentation and induration remained post-EVT but well controlled with symptomatic treatment like aqueous or steroids creams and physical methods using stockings and bandages.

Post-EVT symptoms of pain (17.5%) and numbness (10%) were transient and last from few weeks to months. Non-steroidal anti-inflammatory drugs with opioids form a good combination for symptomatic relief as treatment.

Of the occupations related to venous ulcers (Table III), majority of the cases, in order of frequency, was housewives (29%), blue-collar workers (24.8%), salespersons (20%) and food-related workers (19.3%). The Chinese were mainly salespersons (18.6%) (sundry-shop or equivalent businesses), housewives (16.6%) and food related workers (11.7%). On the other hand, the Indians were mainly blue collar workers (15.1%) (factory workers, gardeners, factory technicians, security guards, supervisors, news-vendors and drivers), housewives (11.7%) and food-related workers (4.7%). The latter group was mainly Indian-Muslims. Most Malays were categorized as food-related workers. White collar workers and food related workers have less complaints pertaining to heaviness compared to housewives, odds ratio 0.05 (confidence interval 0.004-0.563) and 0.13 (confidence

interval 0.03-0.59) respectively. Likewise, white collar workers and food related workers have less cramps compared to housewives, odds ratio 0.042(CI interval 0.049-0.762) respectively. Incidentally the highest mean BMI occurred among white collar workers(27.8) followed by food related workers(27.4), housewives(26.9), blue collar workers(26.9) and salespersons(25.9). While sedentary occupations may mainly contribute to ulcers in the white collar workers, it was not always be so in the other groups.

A large majority of venous ulcers are chronic, being large, indurated, superficial with fibrosed bases. Majority (69%) presented with single ulcer, 15.2% with two ulcers and 6.2% had three ulcers. A significant proportion of 27.6% had deep ulcers that were also very chronic and neglected. The ulcer sizes were approximately less than 10mm in 50 limbs (34.4%), 0-20mm 42 limbs (29%), 20-40mm 15 limbs (10.3%) and greater than 40mm 38 limbs (20%). Another ulcer characteristic, that is, medial malleolar or gaitor ulcer constituted 73.8% while lateral ulcers were 15.2%. Venous ulcers in the bimalleolar sites occurred 5.5%, the foot numbered 4.1%, and other unusual sites of the leg 5.5%.

Most patients neglected their wounds, oblivious of their foul-smelling odour, lacking proper cleansing or dressing and do not appreciate the importance of hygiene. Even after visiting a general practitioner or other medical institution bandaging or stocking was rarely instituted or applied optimally although they would have been strongly advised. Other medical advise or care like weight control, dietary discretion, foot elevation, exercises or job change were not always adhered.

Referring to Table IV, only those with clinical infection and increased bacterial burden or covert infection are subject to ulcer swabs for culture. Gram negative organisms numbered 63.4% compared to gram positive 36.6%. The commonest gram negative organisms include *Pseudomonas aeruginosa*(24.4%), *E. Coli* (12.2%), *Klebsiella* species (8.12%). Among the gram positive staphylococcal group, *Staphylococcal aureus* (16.2%) is the most frequent isolated followed by *Eenterococcus* species (6.5%), *Streptococcus* (5.7%), *Methillin Resistant Staphylococcal Aureus (MRSA)* (4.1%), *Staphylococcal epidermis* (3.3%) and others. Fungal infection (3.3%) was sometimes seen, mainly in combination with bacterial infection. Multiple combination antibiotics, inclusive of third and fourth generation Cephalosporins, Carbopenams, Metronidazole and Aminoglycosides are often required usually for about 2 weeks parentally or orally.

For the EVT delivery in Table V the GSV in the thigh (132 limbs) is the most frequent truncal vein lasered. In the anterior leg the GSV (122 limbs) and posteriorly in the calf the SSV (57 limbs) were lasered. Various ranges of power, watt (W), utilization was employed depending on the amount of energy required. In the thigh 3,000-4,000 Joules at 13W are employed commonly, compared to 11-12 W in the anterior leg (1,000-1,500 J) and 11 W for the calf (500-1500 J) posteriorly.

The success rate of venous ulcer healing via EVT in 2 years was 89.7%. Incidentally the results of EVT success rate obliterating the GSV as evidenced in duplex scan follow-up in

Table I: Demography of cases with venous ulceration treated with EVT

Variables	No.	Male/Female	Percentage (%)	Av. BMI.*
a). Ethnicity				
Chinese	84	37/47	57.9	25.1
Indians	51	26/25	35.2	28.1
Malays	09	7/2	6.2	31.1
Others	01	1/0	0.7	-
Total	145	71/74	100.0	
b). Age Range (Mean age: 53.6 years)				
20-29	08	8/0	5.5	
30-39	14	9/5	9.7	
40-49	32	18/14	22.1	
50-59	46	18/28	31.7	
60-69	21	7/14	14.5	
70-79	22	10/12	15.1	
80-89	02	1/1	1.4	
Total	145	71/74	100.0	
c). Body Mass Index* (Mean 26.8)				
15-20	11	7/4	7.6	
20-25	42	19/23	29.0	
25-30	54	20/34	37.2	
30-35	29	20/09	20.0	
35-40	06	03/03	4.1	
40-45	03	02/01	2.1	
Total	145	71/74	100.0	

Table II: Comparison of pre- and post- EVT symptoms and complications of lower limbs*

Variable	Pre EVT (%)	Post EVT (%)
Pain	98.6	17.5
Swelling	83.1	9.4
Cramps	69.7	10.2
Heaviness	66.4	13.5
Dermatosclerosis	62.8	NA
Eczema	42.8	20
Cellulites	23.4	0
Superficial thrombophlebitis	22.8	0
Bleeding Ulcer	19.3	0
Bruising	-	25.2
Numbness	-	7.5
Venous ulcer recurrence	-	10.3
DVT	-	1.3
Laser skin burn	-	0.6

Note:
NA: Not Applicable
P-value 0.0001.

the thigh and legs were 97.7% (126/129) while that for the SSV in the calf was 98.2% (54/55).

The risk of iatrogenic laser skin burns is related to the power (w) utilization. There was one case with superficial burns which later formed an ulcer but healed. Other complication of EVT like paraesthesia is 7.5%, deep vein thrombosis 1.3% and persistent niggling pains 17.5%, bruising 25.2% and phlebitis 1.8% were transient lasting about 2 weeks. 15 cases (10.3%) had recurrences of venous ulcers at the new sites (5 cases) or same old sites (10 cases). Recurrences were higher in the Indians (11.8%) (5/51) compared to Chinese 8.3% (7/84). Among the Indians with recurrences, the BMI was always greater than 30 while the BMI in the Chinese was consistently less than 25.

Also the recurrence venous ulcers were not related to the limbs with incomplete obliteration of GSV or SSV (4 cases).

Table III: Ethnicity And Occupation with Venous Ulceration

Ethnicity	Housewife	Salesperson	White Collar Worker	Blue Collar Worker	Food Related Worker
Chinese	24 (16.6%)	27 (18.6%)	2 (1.4%)	13 (9.0%)	17 (11.7%)
Indians	17 (11.7%)	0	5 (3.4%)	22 (15.1%)	7 (4.8%)
Malays	1 (0.7%)	2 (1.4%)	1 (0.7%)	1 (0.7%)	4 (2.8%)
Others	-	-	1 (0.7%)	-	-
Total	42 (29%)	29 (20%)	9 (6.2%)	36 (24.8%)	28 (19.3%)

Note: Unknown 1 (Chinese)

Table IV : Percentage incidence of Pathogenic Bacteria In Venous Ulcers

Gram Negative	Gram Positive
Pseud aeruginosa (24.4%)	Staph aureus (16.2%)
E.coli (12.2%)	Ent. spp (6.5%)
Kleb spp (8.12%)	Strep spp (5.7%)
	MRSA (4.1%)
	Staph epid. (3.3%)

Fungal spp 3.3%

Most cases recurred probably due to persistent obesity, sedentary occupations (including prolonged standing) poor compliance to stockings and not performing adequate exercises.

In terms of satisfaction, 31.9% (30/94) expressed as very satisfied while 62.8% (59/94) are satisfied and 5.3% (5/94) are unsatisfied.

Table V: EVT Delivery in Lower Limbs with Venous Ulcers

Variables	No. Cases (%)	Power Utilization (W)					Av. Energy
		10	11	12	13	15	
GSV							
Thigh	132 (91%)	-	1	43	68	20	3,000-4,000
Leg	122 (84.1%)	-	65	48	4	5	1,000-1,500
SSV	57 (39.3%)	2	48	7	-		500-1,500

DISCUSSION

It is observed in the study that Chinese make up the main number of cases in comparisons to the Indians and Malays. This is a reflection of the population in Penang having Chinese as the majority race. The approximate ratio of local Chinese to Malays to Indians is 4:4:1 (Source: Penang Statistics-Socioeconomic Environmental Research Institute, <http://www2.seri.com.my/Penang%20statistics/2007/Q2-April-June-2007-1.pdf>). In this study the ratio was 12:1:7. The high number of Chinese (84) could possibly illustrate their economic superiority in Penang, having able to afford private practice. Contrary to the population statistics of the region the overwhelming number of Indians over the Malays points to the higher proportion of Indians afflicted by the varicose veins and its complications of venous ulcers. Incidentally foreigners appear as quite a significant number (35 cases) due to the region (Penang Island) being a popular medical tourism and holiday destination besides being a second home to many of them.

More male Indians (<50 years) have venous ulcers in the younger age group compared to females or other races because of the high BMR (Table I). Such association is not particularly present among the younger Chinese race. The increase in obesity among the Indian males in particular, does not necessarily mean that people in Penang are becoming better fed. In the name of development, people's diets change as more and more of them who are urbanized eat high fat and high sugar foods, often in western-style fast food restaurants. Urban life also tends to be more sedentary. As a result people put on weight making them more susceptible to chronic venous disease including venous ulcers. In the older age group of females, venous ulcers occur mainly in all housewives regardless of race. Incidentally a rising frequency in older age groups has been reported,^{8, 35} with a peak in prevalence for chronic venous ulceration in people aged about 70 years but this is not the case in the study as evidenced in Table I. In this study 83.5% of venous ulcers occur before 70 years of age.

The slight preponderance of females with venous ulcers as in the study is related to chronic venous disease being more prevalent among women, although in other studies the differences between sexes was shown to be small³⁶.

In the recurrence ulcers 10.3% (15 cases), the most important points of consideration are body mass index of greater than 30 in the Indians. Persistence of lifestyle relating to occupation, non-compliance of stocking application, increased weight gain and lack of exercises are among other specific reasons across the races. In the Chinese persistence of the same occupation (sundry shops, salespersons, hawkers), despite normal BMI 25.1, was the single most important cause of recurrent ulcers. Perhaps more cogent, underlying,

the secondary factors (weight/occupation) are primarily socioeconomic problems of poor education, urbanization (see above) and ignorance in all races that predispose to venous ulcers.

In terms of occupation historically in Malaysia the Chinese arose economically mainly from the business category (salesperson, food related workers) while Indians originated in the service category (blue collar workers). Incidentally a large percentage of housewives that constituted the Indians and Chinese races (Table II) spent their times in the kitchen, standing long hours cooking, cleaning and mopping floors much to the detriment of the bulging varicose veins. Being ignorant of their plight aggravated the nature of venous ulcers. Prolonged standing regardless of occupations resulting in venous stasis leads to deranged gravitational hydrostatic and hydrodynamic, muscular compartment forces. Static jobs (in homes, factories, sundry shops, restaurants) results in the weight of the blood column exerting pressure from the right atrium to the affected vein, through valveless conduits of the abdomen and pelvis of the lower extremities causing an increase of gravitational hydrostatic forces. Similarly, when valves in the perforating vein fail in the above group of cases, the pressure exerted by contracting muscle on adjacent veins -hydrodynamic forces- on unsupported subcutaneous veins and venules in the epidermis increases³. With a rise of venous hypertension as a result of disturbed hydrodynamic forces in the venous circulation, complications such as venous claudication, oedema, lipodermatosclerosis and static changes (induration, dermatitis, hyperpigmentation and ulceration)³⁸ develop more commonly in the above mentioned occupations.

A significant number of cases with venous ulcers presented in a state of neglect and ignorance. Often they were literally dragged to hospital by their loved ones. Chronicity of venous ulcerations is depicted by prolonged persistent infection, large or deep ulcers, multiple ulcerations simultaneously, isolating more than one organism(s) that are resistant to the usual antibiotics and occurring at the same or different sites recurringly (Table IV).

To top it all, abuse of antibiotics, late referrals and lack of understanding of the origins of varicose veins and its complications are some important reasons to account for the severity of venous ulceration. As a result the organisms isolated often require high-end antibiotics. These antibiotics are usually very expensive parenteral agents and only serve to increase costs of healthcare. Increasingly *Pseudomonas aeruginosa* (24.4%), *Klebsiella* species (8.1%), MRSA (4.1%) and *Acinetobacter* species (3.3%) are frequently isolated which are resistant to the usual antibiotics. Again patients having infections caused by expanded-spectrum β -lactam (ESBL) producing organism³⁹. are at an increased risk of

treatment failure. It is often the case that the microbial load as determined by swab analysis was predictive of non-healing as evidenced by Charlott *et al.*⁴⁰ As such subsequent targeting with the appropriate antibiotics, obliterating the superficial venous reflux via EVT, and a host of other procedures have maximum therapeutic effect for treatment of venous ulcers. Incidentally critical colonization also referred to an increased bacterial burden or covert infection is relatively common in the author's opinion. Signs of critical colonization are atrophy or deterioration of granulation tissue, discoloration of granulation tissue to deep red or grey, increased wound friability and increased drainage⁴⁰.

It is of the author's opinion that EVT is an important accompaniment in the holistic management of venous ulcers. The scope of primary prevention is limited. Specific measures suggested include weight control, reducing the amount of standing, greater physical activity and prophylaxis against deep venous thrombosis (for example, in surgical patients). The use of compression stocking⁴¹ after an acute deep venous thrombosis has been shown to reduce the incidence of chronic venous insufficiency and venous ulcer which can occur as post-thrombosis complications.

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