Compression therapy after invasive treatment of superficial veins of the lower extremities: Clinical practice guidelines of the American Venous Forum, Society for Vascular Surgery, American College of Phlebology, Society for Vascular Medicine, and International Union of Phlebology

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SUMMARY

Guideline 1.1: Compression after thermal ablation or stripping of the saphenous veins.

When possible, we suggest compression (elastic stockings or wraps) should be used after surgical or thermal procedures to eliminate varicose veins. [GRADE - 2; LEVEL OF EVIDENCE - C]

Guideline 1.2: Dose of compression after thermal ablation or stripping of the varicose veins.

If compression dressings are to be used postprocedurally in patients undergoing ablation or surgical procedures on the saphenous veins, those providing pressures >20 mm Hg together with eccentric pads placed directly over the vein ablated or operated on provide the greatest reduction in postoperative pain. [GRADE - 2; LEVEL OF EVIDENCE - B]

Guideline 2.1: Duration of compression therapy after thermal ablation or stripping of the saphenous veins.

In the absence of convincing evidence, we recommend best clinical judgment to determine the duration of compression therapy after treatment. [BEST PRACTICE]

Guideline 3.1: Compression therapy after sclerotherapy.

We suggest compression therapy immediately after treatment of superficial veins with sclerotherapy to improve outcomes of sclerotherapy. [GRADE - 2; LEVEL OF EVIDENCE - C]

Guideline 3.2: Duration of compression therapy after sclerotherapy.

In the absence of convincing evidence, we recommend best clinical judgment to determine the duration of compression therapy after sclerotherapy. [BEST PRACTICE]

Guideline 4.1: Compression after superficial vein treatment in patients with a venous leg ulcer.

In a patient with a venous leg ulcer, we recommend compression therapy over no compression therapy to increase venous leg ulcer healing rate and to decrease the risk of ulcer recurrence. [GRADE - 1; LEVEL OF EVIDENCE - B]

Guideline 4.2: Compression after superficial vein treatment in patients with a mixed arterial and venous leg ulcer.

In a patient with a venous leg ulcer and underlying arterial disease, we suggest limiting the use of compression to patients with ankle-brachial index exceeding 0.5 or if absolute ankle pressure is >60 mm Hg. [GRADE - 2; LEVEL OF EVIDENCE - C] (J Vasc Surg: Venous and Lym Dis 2019;7:17-28.)

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RATIONALE FOR GUIDELINES

The current practice of using compression therapy after invasive treatment of superficial veins is based on the clinical experience of generations of practitioners who used this modality after surgical stripping of saphenous veins, stab phlebectomies, and sclerotherapy. In the case of sclerotherapy, such practice is based on experimental evidence.[1] For other modalities, especially for thermal ablation of saphenous veins, the evidence has not been organized into a unified set of recommendations, making current clinical practice highly variable.

The Guidelines Committee of the American Venous Forum (AVF) tasked this writing group to review available evidence and to recommend practice guidelines.

METHODOLOGY

Previously described methodology used by the AVF and Society for Vascular Surgery (SVS) Joint Clinical Practice Guidelines Committee was used.[2]

The Compression Guidelines writing group was appointed by the AVF Guidelines Committee. Representatives from the SVS, Society of Vascular Medicine, American College of Phlebology, and International Union of Phlebology were invited and included in the writing group. The literature search (MEDLINE, Embase, Cochrane Library, Scopus, Google Scholar, Ovid) included the terms "lower extremity veins," "compression stockings," "compression bandages," "compression," "compression therapy," "sclerotherapy," "vein surgery," "high ligation," "stripping," "stab phlebectomies," and "vein ablation." The entire list was reviewed by the group, and publications that were found to be relevant were selected for preliminary review. This preliminary list was circulated among the writing group members with relevant expertise to identify any further relevant peer-reviewed publications. Each publication included in the final list was reviewed and graded independently by three writing group members.

Table. Grading of Recommendations Assessment, Development, and Evaluation (GRADE) recommendations based on level of evidence

Grade	Description of recommendation	Benefit vs risk	Methodologic quality of supporting evidence	Implications
1A	Strong recommendation, high-quality evidence	Benefits clearly outweigh risk and burdens, or vice versa	RCTs without important limitations or overwhelming evidence from observational studies	Strong recommendation, can apply to most patients in most circumstances without reservation
1B	Strong recommendation, moderate quality evidence	Benefits clearly outweigh risk and burdens, or vice versa	RCTs with important limitations (inconsistent results, methodologic flaws, indirect, or imprecise) or exceptionally strong evidence from observational studies	Strong recommendation, can apply to most patients in most circumstances without reservation
1C	Strong recommendation, low-quality or very low-quality evidence	Benefits clearly outweigh risk and burdens, or vice versa	Observational studies or case series	Strong recommendation but may change when higher quality evidence becomes available
2A	Weak recommendation, high-quality evidence	Benefits closely balanced with risks and burdens	RCTs without important limitations or overwhelming evidence from observational studies	Weak recommendation, best action may differ depending on circumstances or patients' or societal values
2B	Weak recommendation, moderate-quality evidence	Benefits closely balanced with risks and burdens	RCTs with important limitations (inconsistent results, methodologic flaws, indirect, or imprecise) or exceptionally strong evidence from observational studies	Weak recommendation, best action may differ depending on circumstances or patients' or societal values
2C	Weak recommendation, low-quality or very low-quality evidence	Uncertainty in the estimates of benefits and risk, and burdens; risk, benefit, and burdens may be closely balanced	Observational studies or case series	Very weak recommendations; other alternatives may be reasonable

RCTs, Randomized controlled trials.
Adapted from Guyatt G, Gutterman D, Baumann MH, Addrizzo-Harris D, Hylek EM, Phillips B, et al. Grading strength of recommendations and quality of evidence in clinical guidelines: report from an American College of Chest Physicians task force. Chest 2006;129:174-81.

The Grading of Recommendations Assessment, Development, and Evaluation (GRADE) system (Table) was used throughout the entire process of review and synthesis.[2,3] The quality of evidence was rated high when additional research was considered very unlikely to change confidence in the estimate of effect; moderate when further research was likely to have an important impact on the estimate of effect; or low when further research was very likely to change the estimate of the effect. When the benefits of an intervention outweighed its risks, a strong recommendation was noted. However, if benefits and risks were less certain, either because of low-quality evidence or because high-quality evidence suggested that benefits and risks were closely balanced, a weak recommendation was recorded. Guideline developers used the terms "we recommend" to denote strong recommendations, whereas for weak recommendations, they used the less definitive wording "we suggest." Following the methodology of previous AVF Guidelines, when evidence was lacking or there were no comparable alternatives to a recommendation, the recommendation was labeled [BEST PRACTICE]. These grades were reviewed and approved by the entire writing group and served as the basis for grading of the recommendations. The entire Guidelines Committee has reviewed and approved the final document.

GENERAL CONSIDERATIONS FOR COMPRESSION THERAPY

Presently, five categories of compression therapy of the extremities are available: compression bandages, compression stockings, self-adjustable Velcro devices, compression pumps, and hybrid devices. Compression bandages and compression stockings are most commonly used for short-term application after varicose vein interventions.

Compression bandages are available in a wide spectrum of materials and weaves with different elastic properties.[4] Training for proper application is essential.[4] To make bandaging easier, safer, and more effective, most modern bandages combine different material components. Because of friction between these components and the use of adhesive surfaces, multicomponent bandages provide nonyielding cuffs of high stiffness around the leg, even when their individual components are elastic. This stiffness of elastic textiles results in an increase of sub-bandage pressure when patients stand up or when they walk.[5] Examples are "multilayer bandages" like Profore (Smith & Nephew, Memphis, Tenn), Comprifore (Jobst, Charlotte, NC), and Coban 2 (3M, St. Paul, Minn) as a "two-layer" version. In fact, every bandage is composed of more than one layer and therefore the term *multilayer bandage* is misleading. Such multicomponent bandages should be applied with a pressure of approximately 50 mm Hg on the lower leg and >30 mm Hg on the thigh.[6] The main advantage of this type of bandage is that it provides even higher sub-bandage pressures in the upright body position and when the patient is walking, whereas the pressure is tolerably low during rest.[7] The effects of the intermittent pressure peaks during walking are comparable to those of intermittent pneumatic compression pumps, for which there is more evidence concerning hemodynamic efficacy published than for bandages.[5] The main disadvantage of such bandages is that there is a risk of applying them too loosely or that the pressure starts to drop immediately after application because of edema removal, after which the bandage falls loose.

Compression stockings are the most popular form of compression devices. To facilitate self-donning by the patient over the heels, they must be adequately elastic. Their main disadvantage is that they produce less pressure increases compared with compression bandages when standing up and when walking.[7] They are therefore less effective with respect to their hemodynamic effects. However, compression stockings have been shown to be effective in reducing edema and pain vs no stockings[8,9] and seem to have anti-inflammatory properties.[10]

DOSE OF COMPRESSION AND COMPRESSION PROFILE

A major goal of compression after procedures on superficial veins is to maintain occlusion of the treated vein to prevent bruising and recanalization, as shown in an animal model.[11] To achieve this goal, the external pressure should exceed the intravenous pressure. The intravenous pressure depends mainly on the body position, corresponding to the height of the blood column between the point of measurement and the right side of the heart. The pressure in leg veins is very low when patients are lying horizontal. In this position, magnetic resonance imaging has confirmed that a compression pressure of <10 mm Hg can narrow the great saphenous vein (GSV).

Much higher pressures are needed to narrow veins of the lower extremity when patients are in the sitting or standing position. Observations using duplex ultrasound and magnetic resonance imaging confirm that in the standing position, a compression pressure of >50 mm Hg on the lower leg and of >30 to 40 mm Hg at thigh level is required to occlude a vein. Using inelastic compression material applied by expert hands, such pressures are well tolerated and effective. This is the most likely reason that recent studies comparing different compression devices have recommended starting with compression bandages during the initial few days after the procedure, with the goal of compressing the recently treated veins. A limitation of these reports is that the pressure of effective compression in these recommendations has not been reported.

By using specially formed pads, such pressures can be achieved locally over the treated vein, even when using compression stockings. This is due to the artificial reduction of the local leg radius (law of Laplace). The compression could be eccentric,[12,13] eccentric and concentric,[14] or tangential.[15,16]

The concept that compression needs to be graduated, providing a pressure decrease from distal to proximal, seems to be less important after vein procedures in mobile patients. Even a foot-sparing compression bandage may be considered, which promotes ankle mobility and walking, preventing edema in the noncompressed parts.[17]

COMPLIANCE

One major problem with compression therapy is poor adherence by the patient, especially when long-term management is planned.[18] The main complaints reported by patients are difficulties during the process of donning (pulling up) and doffing (removing) compression stockings, problems with slipping of fixed bandages down the leg, and concerns with hygiene because these must be worn for prolonged periods. The pain relief and other benefits experienced by patients when the devices accomplish proper compression is the best argument for improved compliance.

1. COMPRESSION VS NO COMPRESSION AFTER THERMAL ABLATION OR STRIPPING OF THE SAPHENOUS VEINS

Guideline 1.1: Compression after thermal ablation or stripping of the saphenous veins.
When possible, compression (elastic stockings or wraps) should be used after surgical or thermal procedures to eliminate varicose veins. [GRADE - 2; LEVEL OF EVIDENCE - C]
Guideline 1.2: Dose of compression after thermal ablation or stripping of the saphenous veins.
If compression dressings are to be used postprocedurally in patients undergoing ablation or surgical procedures on the saphenous veins, those providing pressures >20 mm Hg together with eccentric pads placed directly over the vein ablated or operated on provide the greatest reduction in postoperative pain. [GRADE - 2; LEVEL OF EVIDENCE - B]

A total of 13 relevant publications were identified,[12,13,19-29] of which 1 was a systematic review[19] and 2 were guidelines produced by other groups.[20,21] The remaining 10 manuscripts included 9 randomized controlled trials (RCTs)[12,13,22-27,29] and one case-control study.[28]

Neither the RCTs[12,13,22-27,29] nor the case-control study[28] included a group of patients that did not receive compression therapy. Most practitioners routinely recommend compression therapy after surgical or thermal ablation of varicose veins, with the tacit assumption that patients will derive benefit from compression. In the published studies, investigators did not test whether compression was beneficial and only tested different levels of compression that should be maintained after a procedure. Similar findings are evident in the two previously published guidelines. The guidelines of the European Society for Vascular Surgery[20] made the following recommendation: "Post-procedural compression is recommended after superficial venous surgery, endovenous truncal ablation, and sclerotherapy [Class I, Level A]." The National Institute for Health and Care Excellence guidelines[21] stated: "As there was no convincing evidence for using or not using compression therapy the GDG [Guideline Development Group] felt they could not make a recommendation not to use stockings at all post intervention and the consensus was that in their clinical experience some people post-surgery did feel benefit from wearing stockings. However, the GDG, taking into account the cost of compression therapy, felt they could not recommend its long term use." Their recommendation was, "If offering compression bandaging or hosiery for use after interventional treatment, do not use for more than 7 days."[21]

Based on these findings, any extrapolation of the available data in an attempt to answer the primary question must be considered speculative. However, it would also be imprudent to recommend against the use of compression after saphenous ablation or stripping. Taking the evidence as a whole, one might conclude that some compression is better than none. The recommendation of this committee is as follows: When possible, compression (elastic stockings or wraps) should be used after surgical or thermal procedures to eliminate varicose veins. [GRADE - 2; LEVEL OF EVIDENCE - C]

Five studies addressed the dosage and modality of compression after saphenous vein ligation/stripping or thermal ablation.[12,13,23,25,28] Four of these, representing a total of 237 patients, compared outcomes associated with different compression modalities and doses after various types of saphenous vein surgery.[13,23,25,28] The fifth study compared outcomes using different compression modalities after endovenous ablation in 200 patients.[12] Four were randomized trials,[12,13,23,25] whereas one was a case-control study.[28] In one of the randomized trials, the authors clearly stated that treatment was blinded[25]; in the others, this was not specified.

Compression was achieved using a variety of stockings of different strengths, wraps, and "eccentric" foam pads or "bulk dressings," placed directly over the treated saphenous vein sites. The compression pressures of the different modalities were reported in three studies,[13,25,28] partially reported in one,[12] and not reported in another.[23] Compression pressures ranged from a low of 18 mm Hg with a single stocking to a high of almost 100 mm Hg with a combination of two stockings and an eccentric pad in the standing position.[13] Outcomes reported

included postoperative pain at the end of 7 days, edema, complications (hematoma, bleeding through the dressings, skin irritation, phlebitis, and deep venous thrombosis [DVT]), and quality of life. Pain was assessed in all five studies, various combinations of complications in three,[13,25,28] and quality of life in one.[28]

The most consistent finding from these studies was that patients treated with higher levels of compression reported much less pain at 7 days compared with those treated with lower levels of compression. This was observed in four of the five studies.[12,13,25,28] In one single-center study,[25] 88 patients undergoing a variety of stripping procedures were randomized to low (18-21 mm Hg) vs moderate (23-32 mm Hg) compression therapy, applied daily (8 hours/d) for 6 weeks. Follow-up was obtained at 1 week and 6 weeks. This included a questionnaire (nonstandard), clinical examination, ultrasound assessment of edema, and duplex ultrasound evaluation for phlebitis. At 1 week, there was less pain, tightness, discomfort, and edema in the moderate compression group compared with the low compression group. At 6 weeks, there were no longer any differences in tightness, discomfort, or edema, although a reduction in pain was still present. The authors concluded that more compression was better than less, particularly during the early (1-week) postoperative period.

Two studies evaluated the benefits of stockings together with thigh pads placed "eccentrically" over the site of the saphenous vein in patients undergoing ligation and stripping.[13,28] In a case-control study performed in three European centers, 36 patients were treated with two compression stockings with a thigh pad and 17 with two stockings alone. By postoperative day 3, there was significantly reduced pain measured by a visual analogue scale (VAS) in the group receiving both the stockings and the pad compared with the group receiving only the stockings (31 vs 19; $P = .05$). The physical domain score of the 12-Item Short Form Health Survey quality of life questionnaire also demonstrated better results in the stockings and pad group, whereas overall pain was reduced by 49% compared with stockings alone. There were no differences in adverse events. In the second study investigating the use of eccentric pads after saphenous stripping procedures, 54 patients were randomized to three different groups: group 1, compression stockings only (23-32 mm Hg at ankle); group 2, adhesive bandages (Porelast and Panelast; L&R, Rengsdorf, Germany); and group 3, compression stockings and an eccentric pad on the thigh GSV site. All devices were worn for 7 days. Outcomes included pressures achieved (supine and standing, day 1 and day 7), major adverse events at day 7 (VAS pain score >6, extensive hematoma, bleeding through bandage, superficial venous thrombosis, or DVT), minor adverse events by day 7 (VAS score 3-5, discomfort, skin irritation, clot in stripping canal), and duplex ultrasound at day 7. Higher pressures were obtained in group 2 vs group 1 and in group 3 vs groups 1 and 2. There were more major adverse events in group 1 and more minor events (skin irritation) in group 3. No superficial venous thrombosis or DVT occurred in any patient. The authors concluded that higher pressures were better, although the pad had to be taped in place and caused more skin irritation.[13]

In a single-center study of patients undergoing endovenous laser ablation of the saphenous vein, 200 subjects were randomized to stockings alone (35 mm Hg) vs stockings plus "eccentric" compression focused over the ablated vein (cotton wool bulk under the stocking to provide additional localized compression directly over the ablated vein). Patients were assessed at 7 days for their level of pain using a VAS pain score (0, no pain; 10, maximum pain). The results demonstrate a highly significant reduction in pain at 7 days in patients treated with additional bulk (pain score of 1.4 with bulk plus stocking vs 4.9 with stocking alone). The authors concluded that additional focused eccentric compression directly over the treated vein greatly reduces postablation pain at 7 days.[12]

In the fifth study, Bond et al[23] investigated the effects of three different compression stockings (TED [Cardinal Health, Waukegan, Ill], Medi-Tech [Danbury, Conn], Panelast) on postoperative pain in 48 patients undergoing ligation and stripping of the GSV. In each patient, each leg was randomized to one of the three types of stockings. There were no significant differences in pain scores at 1 week after the procedure, measured using a numerical scale, among any of the stockings applied.

The overall quality of published studies is inadequate because of small sample size, lack of blinding, lack of randomization, lack of data addressing compression strengths, and inconsistent outcomes. However, taken together, they suggest that postoperative pain in the first 7 days after saphenous surgery or thermal ablation can be reduced with the use of higher compression modalities and eccentric compression.

2. SHORT-TERM COMPRESSION (<2 WEEKS) VS LONGER TERM COMPRESSION AFTER THERMAL ABLATION

Guideline 2.1: Duration of compression therapy after thermal ablation or stripping of the saphenous veins.

In the absence of convincing evidence, we recommend best clinical judgment to determine the duration of compression therapy after treatment. [BEST PRACTICE]

A total of eight relevant publications were identified[21,22,25-27,30-32]; one was a guideline,[21] four were RCTs,[22,25-27] and three were nonrandomized observational studies.[30-35] None of the included studies was sufficiently powered or appropriately designed to definitively

address the question of optimal duration of compression therapy. Included studies were heterogeneous in regard to timing for measured outcomes, modality of vein ablation, and modality and dose of compression.

One study compared 4 hours of leg compression with 72 hours of leg compression after radiofrequency ablation of the GSV.[22] This trial of 101 patients excluded Clinical, Etiologic, Anatomic, and Pathophysiologic (CEAP) C5 and C6 disease, bilateral radiofrequency ablation, small saphenous vein ablation, and preoperative noncompliance to compressive therapy. The study demonstrated that patients with the shorter duration of compression had a greater reduction in leg volume and experienced a lower number of complications. Postoperative pain and time to full recovery did not differ between the groups. The study concluded that wearing compression stockings for a shorter time was not inferior to compression for a longer time. It was not reported in this study how many (if any) patients had underlying deep venous insufficiency.

An endovenous laser ablation study of 109 patients excluded those with deep venous insufficiency, venous ulceration, more than one insufficient vein per leg, anticoagulation therapy, and phlebectomies. Outcomes were compared for those using compression for 2 days vs those using compression for 7 days after the procedure. All patients were treated with the 810-nm diode laser with a bare-tip fiber. At 1 week, there was a significant difference in the pain score and in physical dysfunction and vitality in favor of the longer period of compression, but the advantages disappeared by 6 weeks. There was no difference in successful GSV occlusion between the groups. These authors recommended that at the end of 48 hours, the patient should be allowed to decide whether the inconvenience of wearing stockings outweighed the possible pain and reduced physical function associated with not wearing them.[27] In another study using the 810-nm diode laser, compression was applied for 1 week postoperatively using 20 to 30 mm Hg stockings. Complete resolution of varicosities was noted in 42% of patients at 1 month, with a reduction of varicose vein size in 56% of patients. There were no complications related to the compression therapy.[30] Another study used the 1470-nm laser. Patients were excluded from this study if they had an incompetent anterior accessory GSV, incompetent small saphenous vein, deep venous insufficiency, DVT, hypercoagulability, general poor health status, aneurysmal veins >2 cm in diameter, very tortuous veins, nonpalpable pedal pulses, and inability to ambulate or were pregnant or breastfeeding. The short-term occlusion rate was 99%, and the midterm rate was 100%. Induration or swelling was the most common complication (13%), with no major complications such as DVT or pulmonary embolism. The Venous Clinical Severity Score (VCSS) decreased significantly. In this study, patients wore a compression bandage for the first 24 hours and then an elastic full-length stocking (20-30 mm Hg) for 4 weeks. Although there was no comparison group, the study reported that 4 weeks of compression was well tolerated and was successful after ablation with the 1470-nm laser.[31]

The duration of compression stockings has also been evaluated after surgical ablation of varicose veins (stripping and ligation). One study evaluated 104 patients with GSV incompetence treated with inversion stripping after excluding patients unable to wear elastic compression stockings, those already wearing compression stockings, and those with venous leg ulcers. It was not defined whether patients with deep venous insufficiency were excluded. All patients were treated with compression bandaging for 3 days, then divided into a group treated for an additional 4 weeks and a group without additional treatment. Measured 4 weeks postoperatively, there was no significant difference in limb volume between the two groups, and in fact patients without stockings actually returned to work faster. The authors suggested that wearing an elastic compression stocking had no additional benefit after compression bandaging for 3 days after inversion stripping.[26] A contrary finding was observed in a study of female patients who were randomized into groups using compression therapy with low-strength (18-21 mm Hg) vs moderate-strength (23-32 mm Hg) compression stockings after undergoing vein ablation surgery. The patients wore compression for 6 weeks postoperatively. In this study, there were many exclusion criteria, although deep venous insufficiency was not specified. Surgical procedures included ligation and stripping of the great or small saphenous vein, phlebectomy of tributaries, ligation of perforating veins, phlebectomy of recurrent veins, and redo surgery at the saphenofemoral or saphenopopliteal junctions. One week after surgery, patients in the higher compression group had lower edema scores, reduced feeling of tightness, and greater reduction in discomfort. At 6 weeks, there was no difference in these outcomes between the two groups. There were no differences in rates of complications at either 1 week or 6 weeks postoperatively. The authors concluded that there was an advantage for moderate compression after vein ablation surgery, and they recommended compression under such circumstances.[25]

Finally, in one study, 979 limbs underwent procedures for varicose veins and venous insufficiency, with the majority of patients undergoing an ablation and a Trivex (LeMaitre Vascular, Burlington, Mass) powered phlebectomy.[36] The VCSS improved significantly more with ablation plus Trivex compared with ablation alone. In this study, all patients were wrapped with a short-stretch compression bandage immediately after the procedure and encouraged to ambulate. They were compressed for at least 2 weeks postoperatively, with long-term

compression determined by the status of reflux in the deep venous system. Using this algorithm, patients demonstrated a significant improvement in VCSS with a complication rate of 1.6% DVT, 3.7% endothermal heat-induced thrombosis, 0.82% infection, 5.1% hematoma, and 4.9% superficial thrombophlebitis.

The National Institute for Health and Care Excellence varicose vein guidelines have addressed the question of compression duration on the basis of two studies, one with foam sclerotherapy plus compression vs sclerotherapy alone and one with venous surgery plus compression vs venous surgery alone. The guidelines suggest, "If offering compression bandaging or hosiery for use after interventional treatment, do not use for more than 7 days." In addition, "As there was no convincing evidence for using or not using compression therapy the Guideline Development Group [GDG] felt they could not make a recommendation not to use stockings at all post intervention and the consensus was that in their clinical experience some people post-surgery did feel benefit from wearing stockings. However, the GDG, taking into account the cost of compression therapy, felt they could not recommend its long term use. Patients can be advised that in most instances they are able to return to work whilst wearing compression bandaging or hosiery."

Thus, it is clear that the real issue may not be compression after venous surgery but that the compression needs to be tailored to the overall status of the venous insufficiency. In a patient with only superficial venous reflux, compression may not be needed at all or may be needed only for the first few hours to days, whereas for patients with significant deep venous insufficiency and deep venous reflux, compression is likely to be needed not only in the postoperative period but also long term.

3. COMPRESSION AFTER SCLEROTHERAPY

Guideline 3.1: Compression therapy after sclerotherapy.
We suggest compression therapy over no compression therapy immediately after treatment of superficial veins with sclerotherapy to improve outcomes of sclerotherapy. [GRADE - 2; LEVEL OF EVIDENCE - C]
Guideline 3.2: Duration of compression therapy after sclerotherapy.
In the absence of convincing evidence we recommend best clinical judgment to determine the duration of compression therapy after sclerotherapy. [BEST PRACTICE]

A total of 18 relevant publications were identified[34,35,37-52]; 1 was a systematic review,[40] 2 were guidelines,[51,52] 1 was a consensus document,[50] 2 were opinion papers,[38,39] 4 were RCTs,[37,42,44,45] and 8 were nonrandomized observational studies.[34,35,41,43,46-49] Included studies were heterogeneous with regard to measured outcomes and the modality, duration, and dose of compression. The majority of observational studies did not have comparison groups. None of the included RCTs used outcome measures differentially for asymptomatic cosmetic and symptomatic medical patients.

Most physicians treating varicose veins advocate the use of compression after sclerotherapy. The duration and degree of compression are, however, controversial. Graduated compression therapy reduces the risk of DVT, edema, and superficial phlebitis; immediate compression allows more direct apposition of the treated vein walls, which in turn enhances sclerosis and decreases thrombus formation.[38] The physiologic effects of graduated compression include increased blood flow velocity in the deep veins, increased prostacyclin production, increased local capillary clearance, increased transcutaneous oxygen pressure, increased expelled capillary volume at exercise, and increased release of plasminogen activator. Graduated compression also decreases capacity and pressure in the veins, decreases visible superficial varicose veins, and decreases edema and lipodermatosclerosis.[39] All of these effects may justify the use of compression therapy in patients with chronic venous disease including after treatment with sclerotherapy.

A Cochrane collaborative review in 2013 evaluated the use of elastic compression vs conventional bandaging after sclerotherapy and concluded that no standard method of compression after sclerotherapy could be recommended.[40] Compression options reviewed included crepe bandaging, proprietary elastic bandaging, and compression stockings. Increasing the level of compression prevented dressings from slipping but also caused more discomfort. Increased elastic compression had no effect on the incidence of superficial thrombophlebitis or risk of skin staining. In addition, elastic compression had no significant effect on the disappearance of varicosities per their review.

In a prospective study of 100 patients, 120 limbs with primary varicose veins treated with polidocanol as a sclerosant were evaluated. The empty vein technique was used, and immediately after injection, a long cotton roll was placed over the entire vein and additional compression was applied with class I and class II medical compression hosiery.[41] This study reported good sclerosing results in all patients treated. The side effects were classified as early or late. There were minor side effects in 16 patients. Superficial venous blood clots and phlebitis occurred in three cases, which needed microthrombectomy. This study supported the effectiveness of cotton wool roll compression at the location of treatment by using the roll as part of the compression therapy. The result was that compression therapy was more effective and easier to perform. One RCT evaluated 124 limbs randomized to receive bandaging for 24 hours vs 5 days. It found no advantage to compression bandaging for >24 hours when thromboembolic

deterrent stockings were worn for 14 days after the initial bandaging.[42]

Raj et al[43] addressed the issue of compression bandaging and how long bandages maintain their pressure during ambulatory treatment of varicose veins. They recommended that compression bandaging be worn for 6 weeks after sclerotherapy. However, pressures under these bandages were measured during 8 hours, and the results showed that different surgeons applied bandages over a wide range of pressures. The initial pressures were also higher when standard compression pads were used, although the rate at which the pressure fell was about the same.

The question of short-term vs long-term standard bandaging after sclerotherapy was also addressed in the Cochrane review.[53] The duration of compression (short vs standard time) after sclerotherapy was the subject of four randomized trials. The following assessed outcomes favored short-term application of bandages: cosmetic and symptomatic improvement[54]; recurrent varicose veins[55,56]; complications such as phlebitis, staining, pain, blistering, and ulceration[33]; and discomfort, slipping, foot swelling, and bandage intolerance.[33,56]

Two different studies addressed the effectiveness of compression stockings and their duration for sclerotherapy treating reticular veins and telangiectasia in similar patients. Weiss et al[34] studied 40 patients, 30 of whom received compression therapy and 10 of whom did not. The compression group consisted of 3 subgroups of 10 patients each, receiving compression for 3 days, 1 week, or 3 weeks. The patients were evaluated at 1 week, 2 weeks, 6 weeks, 12 weeks, and 24 weeks for the degree of improvement and side effects. All three compression subgroups showed significantly greater improvement at 6 weeks compared with controls. Patients treated with compression for 3 days and 1 week showed better improvement than the control patients, but patients treated for 3 weeks of continuous compression had the most improvement. In terms of side effects, the 1-week and 3-week compression groups experienced the least amount of hyperpigmentation after sclerotherapy.[34] In another study by Kern et al,[44] 100 female patients seeking treatment for telangiectasia and reticular veins were randomized to wear medical compression stockings (23-32 mm Hg) daily for 3 weeks vs no compression after a single session of liquid sclerotherapy. The outcomes were compared on the basis of a patient satisfaction analysis and a quantitative evaluation of photographs taken before the procedure and at a mean of 52 days after sclerotherapy by two blinded expert reviewers. Wearing compression stockings of 23 to 32 mm Hg for 3 weeks enhanced the efficacy of sclerotherapy by improving vessel disappearance. Three weeks of continuous compression led to the best results, although even 3 days of compression resulted in greater improvement compared with no compression. Compression also led to a statistically significant reduction in hyperpigmentation after sclerotherapy.[44]

Two studies compared thigh-high compression stockings vs bandaging after liquid sclerotherapy. The first was an RCT by Scurr et al.[45] Efficacy was evaluated on the basis of a need for successive injections, complications of treatment, and patient satisfaction. In the patients receiving stockings, 144 of 156 injections were successful compared with 117 of 147 in the bandaged group. The incidence of superficial vein phlebitis and thrombosis was also reduced in the stocking group. In a second study of high-compression stockings alone by Shouler and Runchman,[46] it was concluded that bandaging after sclerotherapy was not required if high-compression stockings were going to be used.

Nootheti et al[35] looked at results of sclerotherapy after 3 weeks of graduated compression with class I (20-30 mm Hg) stockings compared with 1 week of class II (30-40 mm Hg) compression stockings. This was a small study with 29 patients being treated for reticular and telangiectatic veins. One leg was assigned to wear a class II stocking for 1 week, and the contralateral leg was assigned to 3 weeks of class I graduated compression. Pigmentation and bruising after sclerotherapy were significantly less in the group with 3 weeks of class I graduated compression.

Fentem et al[47] studied healthy volunteers comparing bandaging using a large flat compression pad vs a small narrow pad. Different surgeons achieved different degrees of compression. The use of a foam pad over the injection site was successful as long as fibrinous occlusion in the vein took place. This study suggested the need to measure pressures under the bandaging.

Some studies have questioned the need for compression after sclerotherapy. The effectiveness of compression bandaging or stockings in patients undergoing foam sclerotherapy was studied in a randomized trial of 124 limbs with 24 hours vs 5 days of bandaging.[37] There was no significant difference between the two groups in the incidence of superficial thrombophlebitis after 2 weeks or skin discoloration after 6 weeks. There was no significant difference in the change of the Buford pain score from baseline to 2 weeks or in the change of the 36-Item Short Form Health Survey score from baseline to 6 weeks. In a randomized controlled study performed at two centers, 60 patients with incompetent GSV and short saphenous veins underwent ultrasound-guided foam sclerotherapy.[37] One group was treated with compression stockings (15-20 mm Hg) for 3 weeks and the other group was treated without compression.

The efficacy of sclerotherapy and side effects were assessed. On days 14 and 28, clinical and duplex ultrasound assessments were performed by independent experts; the patients also completed a quality of life questionnaire and reported satisfaction scores. The study found no difference between compression and control groups in comparing treatment efficacy, side effects, satisfaction scores, symptoms, and quality of life scores. The authors recommended further studies to establish the role of compression in sclerotherapy and to evaluate other compression strategies.

Thomasset et al[49] designed a prospectively collective database of ultrasound-guided foam sclerotherapy. They evaluated 126 patients who had undergone targeted ultrasound-guided foam sclerotherapy of the GSV (n = 75), the small saphenous vein (n = 13), and the anterior accessary saphenous vein (n = 9). They had a mean follow-up of 3 months and used duplex ultrasound scans for evaluation of complete occlusion of the target vessel. The only factor associated with vessel outcome was compliance of postprocedure compression therapy. The only factor associated with complications after foam sclerotherapy was female sex. Their data suggested that compliance with postprocedure compression therapy and sex were important factors in successful outcome. Patients were treated with foam pads that were applied over the treated vein, and then class II thigh-length graduated compression stockings with a waist extension were applied over the foam pads after the procedure. Foam pads were worn for 1 week, and stockings were then worn for a total of 6 weeks.

It is appropriate to assume that compression after sclerotherapy maximizes venous wall apposition and contact with the intraluminal sclerosant, thereby allowing more effective panendothelial destruction and endosclerosis. Existing data suggest that compression after sclerotherapy improves the clinical disappearance of superficial veins and reduces pigmentation and bruising. The preponderance of evidence suggests that compression should be considered an integral part of management after sclerotherapy. However, despite several consensus statements, no conclusion can been reached on the basis of current data as to the best method, dose, or duration of compression that achieves optimal results after sclerotherapy.[19,50-52] A key component in all of the studies analyzing compression treatment for venous disease is the issue of compliance, and in most studies this outcome is not reported. Well-designed RCTs are needed to provide definitive information.

The impact of compression on the efficacy of foam sclerotherapy remains to be determined as this is only one of the confounding variables affecting outcomes. The evidence for compression recommendations is incomplete, but the standard of care and current medical practice of those treating varicose veins are to recommend and to perform some form of compression.

4. COMPRESSION AFTER TREATMENT OF SUPERFICIAL VEINS IN PATIENTS WITH VENOUS LEG ULCERS

Guideline 4.1: Compression after superficial vein treatment in patients with a venous leg ulcer
In a patient with a venous leg ulcer, we recommend compression therapy over no compression therapy to increase venous leg ulcer healing rate and to decrease the risk of ulcer recurrence. [GRADE - 1; LEVEL OF EVIDENCE - B]
Guideline 4.2: Compression after superficial vein treatment in patients with a mixed arterial and venous leg ulcer
In a patient with a venous leg ulcer and underlying arterial disease, we suggest limiting the use of compression to patients with ankle-brachial index exceeding 0.5 or if absolute ankle pressure is >60 mm Hg. [GRADE - 2; LEVEL OF EVIDENCE - C]

A total of seven relevant publications were identified,[57-63] of which one was a systematic review,[58] one was a guideline published by the AVF and the SVS,[57] and five were nonrandomized observational studies.[59-63] The AVF/SVS guidelines were published in 2014 and used the same methodology as the current report. We were not able to identify any additional studies that were published subsequent to that report and that have sufficient information to consider modification of the AVF/SVS guidelines.

The management of patients with venous ulcers is often complex and time-consuming and uses a variety of modalities including surgical procedures. A great deal of time, effort, and expense goes into the healing of these lesions. A variety of etiologic factors are associated with the development of these ulcers, and several such factors persist after treatment is completed. Attention must be directed toward the modification of these factors when possible, and neutralizing the increased venous leg pressure is a common goal in these patients.

Appropriate compression therapy using short-stretch bandages, multilayer bandages, Unna boots, and various forms of pneumatic compression is the keystone to correcting elevated venous leg pressure in patients with leg ulcers. Once ulcer healing has been achieved, it becomes less feasible to continue these types of compression modalities during patients' everyday lives. As a result, elastic stockings are prescribed for these patients once the ulcers have healed regardless of the underlying pathophysiologic process that initially led to the development of the ulcer.

Two important aspects that may determine the success of preventing ulcer recurrence using compression must

be considered. The first of these is the technical ability of the patient to actually don and doff the stocking properly. This may be difficult because of the patient's size, strength, or arthritic conditions that may make manipulation of the heavy stocking impractical. The second factor is the extent of the increase in venous pressure and resulting edema of the leg. This is particularly true for patients who are morbidly obese and in whom the leg venous pressure is very high because of increased intra-abdominal pressure from large abdominal girth. This pressure increase will overwhelm an elastic product and result in recurrent edema, with a high risk for recurrent ulceration. Aids for donning and doffing stockings are often awkward, and the techniques required can be difficult to master.

Velcro compression devices are an alternative to elastic stockings because their inelastic nature produces higher compression during ambulation, which in turn reduces venous stasis and edema. The adjustable nature of these devices also allows tightening as the leg volume decreases as well as loosening when discomfort occurs. Finally, these devices are easy to apply and remove, even in patients with physical limitations.[53,64-67]

Multiple studies have been published addressing different aspects of compression therapy in patients with open and healed venous ulcers. Current evidence supports using compression for ulcer healing.[57,58] None of the publications to date specifically address the role and effectiveness of compression after treatment of superficial veins in patients with venous ulcers. In the absence of such data, it is reasonable and safe to follow recommendations for the entire population of patients with venous ulcers, namely, that compression therapy should be recommended to increase venous leg ulcer healing rates and to decrease recurrence rates.

Leg ulcers frequently have mixed etiology. An important etiologic comorbidity that is relevant to compression therapy is peripheral artery disease, which can coexist in up to 25% of patients with venous ulcers.[59-62] Use of compression in patients with significantly compromised arterial perfusion of the limb is considered unsafe. Data supporting use of modified compression with reduced compression pressure for healing of mixed ulcers is limited to a few small studies.[57,62,63] Therefore, the preferred practice is to limit the use of compression to patients with an ankle-brachial index exceeding 0.5 or if absolute ankle pressure is >60 mm Hg.

After review of these data, we find that the published literature provides a low level of evidence. The need for further studies with level 1 data with larger data sets is clearly needed. In addition, the national databases that are being developed may add future possibilities to address some of these issues. Much of the literature does not include patient-centered quality of life assessments of these interventions when, in truth, these disease processes directly affect quality of life. These limitations offer opportunities for future research to help focus future guidelines.

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