

# Sclerotherapy: Introduction to Solutions and Techniques

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Over the past decade, there has been a renewed interest in venous disease by the vascular community. This is predominantly because of new advances in endovenous treatment and practice economics. To broaden the services provided, vascular surgeons want to learn about sclerotherapy. Most commonly used for cosmetic concerns, it also plays a role in the broad spectrum of venous pathology treatment. The supplies and equipment

needed with an overview of available sclerosants are discussed. Basic techniques and compression therapy are reviewed. This article will serve as a basic primer for successfully adding sclerotherapy to your practice.

**Keywords:** sclerotherapy; sclerosants; endovenous treatment, vein injection, spider veins, varicose veins, phlebology

Sclerotherapy has been performed for decades to successfully treat spider and varicose veins. Although the Food and Drug Administration (FDA)-approved sclerosants are limited in the United States compared with European countries, the outcomes still remain excellent. The goal of sclerotherapy is to cause endothelial and vein wall damage in a controlled fashion. The result is removal of abnormal vessels that carry retrograde flow without damaging adjacent vessels that carry normal antegrade flow. The sclerosant effect results in a fibrous cord that is absorbed over time. The visual attributes of these veins fade often over months, enhancing cosmetic appearance and potential improvement in leg symptoms.

Sclerotherapy has been used to treat all types and sizes of varicosities. This therapy is considered the gold standard treatment for leg telangiectasias, venulectasias, and reticular veins.<sup>1-4</sup> Sclerotherapy has been used for large varicosities as well as direct injection into the saphenous vein at the saphenofemoral junction. For large varicosities, microphlebectomy results in less frequent complications particularly hyperpigmentation and blood trapping. Immediate direct compression and duration of graduated compression therapy for 3 weeks or more are possible variables of more importance for good results in these larger vessels.<sup>5-8</sup> The treatment outcome for

sclerotherapy for saphenous reflux with junctional incompetence has been varied.<sup>9-11</sup> Presently there is no consensus in the medical literature supporting direct sclerosant injection into the greater saphenous vein as effective treatment.

## Getting Started

In starting a sclerotherapy practice, a basic list of supplies includes the following:

- Alcohol for leg prep with nonsterile 4 × 4s
- Protective gloves—latex free
- 1-mL and 3-mL syringes for sclerosant
- 3-way stopcock to create foam
- 3-mL and 10-mL syringes for foam creation
- 25G, 27G, 30G, and 32G (G = gauge) disposable needles
- Multiple types of sclerosants
- ± Compression-foam pads, cotton balls, dental roll
- Coban or Medirip short stretch leg wrap
- Compression stockings
  - Class I (20-30 mm Hg) for spider and reticular veins
  - Class II (30-40 mm Hg) for varicose veins

The workhorse needle for the phlebologist is the 30 G ½ inch needle. This can be used for all vessel types but most commonly for reticulars, venulectasias, and telangiectasias. For superficial visible varicosities, a 27G or 30G ½ inch needle is recommended. If delivering foam, the 27G needle allows for quicker

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instillation of larger foam volumes in veins of this size. In performing ultrasound-guided sclerotherapy, the 25G needle is advantageous for its length of 1½ inches. With fine hair-like telangiectasias, matting or marked skin sensitivity a 32G ½ inch gauge needle is beneficial to cannulate these small vessels and decrease pain.

Additional equipment recommended but not needed to get started includes a hydraulic treatment table. This allows for optimal practitioner comfort particularly when performing multiple sclerotherapy sessions. I prefer standing and raising the table height to avoid back strain. A worthwhile table option is the ability to place a patient in Trendelenberg. Vein emptying is enhanced in this position, which decreases sclerosant dilution by blood. In Trendelenberg, the air composition of foam will potentially result in caudal distribution of the sclerosant thus delayed emptying and increased vein wall contact time. This expensive piece of equipment can be easily justified when used for other vein procedures—office microphlebectomy and endovenous ablation.

An equipment recommendation to enhance visualization of the venous network is the Veinlite or Syris polarizing headlamp. These pieces of equipment allow subdermal vein visualization. With the Veinlite, a fiberoptic ring transilluminator beams a circumferential glow through the skin allowing visualization of the reticular pattern and feeding veins to telangiectatic clusters. These veins often are not readily visible with the naked eye. It is an excellent tool to allow for accurate needle entry into veins of this size minimizing potential complications of extravasation. It is also beneficial to demonstrate these veins to patients, providing a better understanding of the treatment plan of sclerosing larger feeding vessels first prior to the more obvious and cosmetically displeasing telangiectasias and venulectasias. The Veinlite can additionally add accuracy allowing placement of small incisions for microphlebectomy. In supine positioning varicosities will be smaller and frequently shift in location. This can render the outline markings made during standing often inaccurate. Using the Veinlite while supine prior to surgery allows the varicose vein markings and incisions to be more accurate. This can decrease procedural time, which additionally justifies the cost of this piece of equipment.

The Syris glasses worn like a headlamp allow visualization approximately 1 mm below the skin's surface. This combines optical filters with cross-polarization technology and magnifying lenses. It allows visualization of the reticular network without having to hold a light source thereby allowing use of both hands.

## Sclerotherapy Solutions

The ideal sclerosant unfortunately does not exist. The available agents fall into three major categories—hyperosmolar, detergent, and chemical. Probably the best-known sclerosant in the United States is hypertonic saline—sodium chloride 23.4%. This is of the hyperosmolar class. Hyperosmolar solutions are nonspecific in cellular destruction affecting endothelial cells as well as red blood cells through dehydration. Frequently patients will ask for “saline injections,” which has become synonymous with injection sclerotherapy. It is probably the agent that has created more negative connotations associated with sclerotherapy because of its burning, stinging, and cramping pain on injection plus the potential for ulceration with extravasation. Although an FDA-approved drug, its use is off label for sclerotherapy. The drug is readily available, lacks allergenicity, and is inexpensive. In treating telangiectasias it can be diluted in half to 11.7% to minimize injection complications. For reticular veins it is used at full strength. The drug is rapidly diluted on injection, which means injections should be made at close intervals to assure effective treatment. The rapid dilution of this agent prevents effective treatment of larger veins beyond 3 to 4 mm in diameter. Hypertonic saline can be mixed with 1% lidocaine to minimize pain on injection.

Sclerodex, another hyperosmolar sclerosant, is produced in Canada by Omega Laboratories. It is a combination of 250 mg/mL glucose, 100 mg/mL saline, 100 mg/mL propylene glycol, and 8 mg/mL of phenethyl alcohol. It is essentially a 10% saline solution with the addition of 25% dextrose. In the United States it can be obtained through compounding pharmacies. This sclerosant is not approved by the FDA. Sclerodex has a low allergenicity and, like hypertonic saline, works within minutes on the endothelial vein surface. There is lower potential for hyperpigmentation from hemolysis, skin necrosis, and ulceration because of the lower saline concentration. There can be mild pain on injection, similar to 11.7% hypertonic saline attributed to the reduced salt concentration. Sclerodex is best used for small vessels like telangiectasias, venulectasias, and for matting.

Detergent solutions are the most versatile and effective sclerosants available with a capacity to treat all vein sizes. Their intravascular action causes cell surface membrane disruption and extraction of cell surface proteins within seconds and its effect continues on for minutes to hours. Unique to

this class of drugs is its micellular concentration, which can be enhanced with foaming. This foaming nature of detergent sclerosants results in potentially equal efficacy at lower concentrations. The best-known detergent solutions worldwide are polidocanol (Aethoxysklerol) and sodium tetradecyl sulfate (STS). Both are long-chain fatty acids.

Sodium tetradecyl sulfate is approved by the FDA for sclerotherapy and manufactured by Bioniche Pharmaceuticals, Ltd. Polidocanol, although probably the most commonly used sclerosant in the world, is not approved by the FDA and until recently was obtained in the United States only through compound pharmacies. With the threat of a “warning letter” from the FDA, this has caused most large compounding companies to halt production. At this time it is difficult to obtain polidocanol in the United States. Sodium morrhuate and ethanolamine oleate, although approved by the FDA have a safety profile and allergenicity not suitable for treatment of leg veins and therefore not reviewed in this article.

The advantages of STS and polidocanol detergent sclerosants are the absence of pain with intravascular injection and a very low incidence of allergic reactions. There is also no hemolysis as a direct effect of the drug and therefore the potential for less hyperpigmentation.<sup>12</sup>

The main disadvantage of STS is extravasation necrosis and ulceration. This, however, typically does not occur with low concentrations, 0.1% to 0.5% STS, used for telangiectasias and venulectasias. Polidocanol rarely will cause skin necrosis with intradermal injection. With detergents and hypertonic saline, if there is extravasation or if a skin bleb is created, injection should be halted and the area vigorously massaged to dissipate the solution and help resolve any vasospasm. If full strength hypertonic saline, 23.4% or STS 3% is extravasated, hyaluronidase, 75 units in 3 mL can be injected into the affected area to decrease the likelihood and possible size of ulceration.<sup>13,14</sup> Because STS is the only detergent class FDA-approved sclerosant in the United States, it is unfortunately affected by market forces and is expensive.

Chemical sclerosants have a direct corrosive effect, which disrupts the intercellular cement and poisons cell surface proteins and affects chemical bonds immediately on vein wall exposure. The most common sclerosant used worldwide for telangiectasias is a Chemical class sclerosant called chromated glycerin with trade names Sklermo or Chromex. This agent is not approved by the FDA and

is not commonly used in the United States. Reports, however, have surfaced regarding the efficacy of 72% glycerin which is an off-label FDA-approved drug. This agent is not commercially produced but can be obtained through compounding pharmacies. It is mixed with lidocaine with epinephrine, 1:10 000 in a 2:1 ratio with a resultant concentration of 48% glycerin. The lidocaine minimizes pain with injection and decreases viscosity. The epinephrine helps with vessel constriction producing longer dwell times and helps with its chemical corrosive effect. Typically, tuberculin syringes are used for injection because of its viscosity. Injection should be slow to minimize injection pain and prevention of potential arteriolar crossover from high pressures delivered using tuberculin syringes. Slow injection is the rule for all sclerosants to minimize this side effect and the potential for vein matting. In a small study of 13 patients by Leach and Goldman,<sup>15</sup> the efficacy of 72% glycerin, diluted with lidocaine to 48%, was equal to STS for veins 0.2 to 0.4 mm in diameter with less hyperpigmentation and quicker vessel clearance.

The initial concentration for different vein diameters treated with the common sclerosants is outlined in Table 1. The sclerotherapist should be familiar with more than one agent and the appropriate concentrations for different size veins. A few vials of various solutions should be on hand particularly in cases of suspected allergenicity. The acquisition of different concentrated sclerosants can yield large volumes in the concentrations used for the most common types of veins for injection. Therefore it is not overly expensive to maintain a small supply of multiple types. Dilution tables should be readily available for the staff to avoid the potential for mistakes in formulation. An easy formula to develop a dilution chart for the various concentrations is

$$(X \text{ mL}) (\text{stock solution } \%) = \frac{\text{(desired total volume in mL)} (\text{desired concentration } \%)}{\text{Solve for } X \text{ mL}}$$

This X volume is added to a volume of normal saline or sterile water to reach the desired total volume. This equation can be used to make the solution per syringe (3 mL and 10 mL) or in vials (10 mL and 30 mL) from which the solution can be aspirated.

Patients are provided a rather lengthy and detailed consent form outlining sclerotherapy, the different solutions used and their FDA clearance. Potential complications of sclerotherapy are listed of

which hyperpigmentation is noted as the most common, regardless of solution used. It is important to set realistic expectations for our patients, particularly when you are talking about a cosmetic procedure. Typically 10% to 30% of patients will have some level of staining from sclerotherapy.<sup>16</sup> It is more common in reticular size veins and larger vessels and in patients with dark complexions. Of that population in which it occurs, only 10% will last 6 to 12 months. Approximately 1% of patients will experience permanent hyperpigmentation.<sup>17</sup> In these cases bleaching agents, Retin A, or a combination topical cream, Tri-Luma have been recommended. Intense pulsed light or laser treatment may also be of benefit.<sup>18</sup> Anecdotally, I have found in some patients it is helpful to scratch the underside of the hyperpigmented dermis with a 18G or 22G needle after the area is anesthetized with 1% lidocaine. The resultant trauma theoretically enhances phagocytosis and removal of hemosiderin staining.

With detergent solutions it is often thought hyperpigmentation is less common with polidocanol than with STS. This, however, was refuted in a double-blind prospective trial between the 2 agents in 2005. Rao et al<sup>19</sup> reported there was no statistically significant difference in incidence of efficacy, hyperpigmentation, and posttreatment sequelae between these 2 sclerosing agents, liquid or foamed.<sup>19</sup>

Trapped coagula is probably the second most common side effect of sclerotherapy. These areas may be sore because of vessel distention. Initially these are best treated with a heating pad and nonsteroidal anti-inflammatory drugs. The trapped blood is drained using a 22G needle 3 to 4 weeks from the session. Earlier attempts at removing the collection will often have a low yield since the blood is organized thrombus. Other potential complications of sclerotherapy include swelling (particularly with foot and ankle region therapy), telangiectatic matting, nerve damage, painless infarction with arteriolar injection, phlebitis, and rarely deep vein thrombosis/pulmonary embolism.

## Techniques

In my practice a sclerotherapy session is blocked for 20 minutes with 15 minutes spent actively injecting. This allows for maintaining a smooth schedule that is difficult to keep if the sessions are based on volume or area to be treated. After the patient

**Table 1.** Common Initial Concentrations

Vessel Diameter	Sclerosant Concentration
Less than 1 mm	Hypertonic saline 11.7%
	STS 0.1% to 0.3%
	POL 0.3% to 0.5%
	Glycerin 72% / lidocaine-epinephrine Sclerodex
1–3 mm	Hypertonic saline 23.4%
	STS 0.5% to 1.0%
	POL 1% to 2%
4–6 mm	STS 1% to 2%
	POL 2% to 3%
Branch varicosities	STS 2% to 3%
	POL 3% to 5%

Note: POL, polidocanol; STS, sodium tetradecyl sulfate.

reviews areas of concern with me, he or she is placed on the treatment table supine/prone or on the side where the nurse preps the leg with alcohol-soaked nonsterile gauze. The hydraulic table is elevated, and it is placed in slight Trendelenberg position. This allows me to stand during the session without excessive bending or twisting. Using 2.5 magnification surgical telescopes and a Veinlite, the reticular and small varicose veins are readily visualized and addressed first. These veins are tracked with the Veinlite to their most distal leg point where injection is started. The vein is then followed and injected in various distance intervals based on vein size, solution type, and whether liquid or foam is instilled. Following treatment of all larger vessels in that particular leg position, supine, side, etc, injection of the smaller veins in that region is undertaken. In this systematic approach large areas can be treated quickly. The dry skin in the treatment area is wiped with the alcohol-soaked gauze making the skin more transparent and the superficial small veins more noticeable. Indirect lighting also adds to vessel visualization. In patients with skin laxity, the assistant will stretch the skin, which will allow easier vessel cannulation. This is particularly true around the knee.

My preferred solution choices have varied through the years based on availability, FDA approval, and the ability to foam the solution. Within the past year I have switched over to glycerin for all spider veins. The patients and I have noted faster vessel clearing. There still is the potential for hyperpigmentation, although the possibility is lessened. I reserve detergent sclerosants for reticular and varicose veins less

**Table 2.** Maximum Doses per Session

Polidocanol	12 mL of 1%
STS	10 mL of 3%
HS	8 mL of 23.4%
Sclerodex	10 mL
Glycerin 72% with lidocaine (final concentration glycerin 48%)	15 mL plus

Note: STS, sodium tetradecyl sulfate; HS, hypertonic saline.

than 4 mm in diameter. For veins larger than 4 mm, I prefer microphlebectomy. For years I used polidocanol manufactured from various US compounding pharmacies. I recently switched to STS with the lack of polidocanol availability in this country. I have not noticed any significant treatment outcome and side effect differences using approximately half the concentration of STS compared with polidocanol. The maximum volumes for each sclerosant at a certain concentration during one treatment session are listed in Table 2.

To have sclerotherapy treatment success the sources of reflux are treated first. If there is reflux in the greater or small saphenous system, these veins are treated with endovenous ablation prior to undertaking sclerotherapy. This obviously does not preclude proceeding with treatment of the contralateral extremity if there is no major source for reflux present in that leg. Although treatment of axial reflux first may seem obvious, I have seen numerous patients present to our practice with poor treatment outcomes when this basic tenant is not followed. One should not treat visible varicosities without dealing with their etiology for best long-term results. Untreated reflux can be the obvious cause for recurrent varicosities, persistent symptoms, and poor patient satisfaction. Patients with visible varicosities, in our practice, are first evaluated with Duplex imaging in the standing position to assess for deep, superficial, or perforator vein insufficiency.

When starting treatment a basic rule for injection sclerotherapy is treat larger veins first before cutaneous veins. Injection with liquid sclerosant should proceed from proximal leg veins and progress distally. The reverse pattern, distal to proximal, is recommended with foam therapy. This change in sclerotherapy technique is because of vasospasm created with foam. The more distal veins subsequently will not be visualized if one starts proximally and hence require treatment at a later date when visible. With liquid sclerosant it is recommended not

to exceed 0.5 to 1.0 mL at any one injection point and to advance 3 to 4 cm. Foamed sclerotherapy allows for instillation of larger volumes at one site and a longer injection interval, which can be 8 cm or longer. The increased foam volume injected at one site can be tracked with the Veinlite or ultrasound. The foam or liquid sclerosant can be massaged in various directions to get a more widespread effect.

When using foam sclerotherapy there is a longer dwell time resulting in extended contact period with the vessel wall. The foam displaces blood from the vein creating an air block. This prevents rapid dilution and mixing with blood. Lower concentrations of sclerosants can be used to achieve the same results in light of these attributes. It is reported by the American Society of Dermatologic Surgery in their technology report "The advantage of a foam is that the sclerosing power of the solution is increased 2-fold to 3-fold, while decreasing the toxicity four fold." In addition, the use of lower detergent concentrations minimizes the complication risks with extravasation.<sup>20</sup>

Foam is created with a 2-way or 3-way stopcock, 2 syringes, one loaded with a volume of room air and the other with a volume of detergent sclerosant, polidocanol or STS. The air solution mix is passed quickly 10 to 20 times between the two syringes, which allows for rapid agitation and foam creation.<sup>21</sup> During this process the aperture of the 3-way stopcock can be made smaller if rotated off center creating a thicker, longer lasting foamed state. Typically foam lasts 60 to 120 seconds before it breaks down. As the foam dissipates in the injecting syringe it can be recreated in the same fashion as outlined above. Typical ratios described of air to sclerosant are 3:1 to 5:1.<sup>22</sup> Foam can be used for spider veins, but there can be excessive inflammation with treatment of vessels of this size. Foam is more commonly used for reticular size and larger veins. Ultrasound-guided foam sclerotherapy is an effective treatment adjunct for nonvisible subcutaneous varicosities and perforator veins. The acoustic shadowing of the foam injected will be readily appreciated on ultrasound imaging. The foam air/sclerosant mix can be tracked to determine which veins have not had exposure and require additional foam to be injected.

A rare complication of foam sclerotherapy is the appearance of neurologic symptoms. A large registry report of 6395 sessions of foam sclerotherapy from Europe revealed an extremely low risk of complication, 0.4%. There was a rare transient neurologic

sequelae using foam because of crossover through a patent foramen ovale (PFO). The most common neurologic side effect was temporary visual disturbance and headache.<sup>23</sup> There has been one report in the literature of a permanent neurologic deficit with foam injection. This was reported from Ireland where the greater saphenous vein under ultrasound guidance was directly injected with 20 mL of foam. The patient subsequently was confirmed to have a PFO.<sup>24</sup> With the option of endovenous ablation for greater saphenous reflux, this treatment complication would have been avoided.

There still remains a lack of data supporting optimum air/sclerosant ratios and the safe volume of air that can be injected during one treatment session. The European Consensus Meeting in 2003 provides some guidelines for foam sclerotherapy.<sup>25</sup> Still there remain many areas without specific guidance and hence the "art" of sclerotherapy.

My preference is not to exceed a total volume of 8 mL of air. This is used to create 4:1 foam during a session. I try to avoid injecting foam directly into the greater or small saphenous vein via injection of varicosities that are adjacent to them. These truncal varicose veins are usually larger than 4 mm, which I prefer to remove with microphlebectomy. Using this approach will help avoid the potential for a bolus volume of air injected into the central venous system, which could result in crossover through a PFO.

In performing sclerotherapy there are two basic methods of holding the syringe while injecting. The plunger can be operated by the index finger or thumb, which I prefer. Injections around the ankle, foot, and the popliteal fossa are facilitated with slight bending of the needle to achieve vessel entry. With reticular and larger veins you should aspirate to confirm access. The caveat is to minimize motion of the syringe needle once you have entered the vein to avoid extravasation. This may require a two-hand technique of steadying the syringe with one hand while aspirating and injecting with the other. If using a Veinlite, an assistant will often be necessary. Another technique is to use your fingers to pull and push the plunger in a one-hand technique. You can also obtain a thumb finger hole adapter that can attach to the syringe allowing aspiration and injection with one hand smoothly.

Liquid and foam sclerosants are delivered using a 3-mL syringe. Tuberculin syringes are used for glycerin as noted previously because of its viscosity. When injecting venulectasias, telangiectasias, or

areas of matting, aspiration is not necessary. Gentle pressure is applied on the plunger while advancing the needle. The volume of extravasated sclerosant is minimal prior to vessel entry. Using dilute detergents and glycerin, extravasation necrosis and ulceration are extremely rare. On entering these small vessels there will be blanching from the liquid or foam at which point slightly more pressure is applied to deliver the volume of sclerosant to fill the visualized vein. Do not be tempted to inject large volumes at one site unless using foam that can be tracked. Do not inject under pressure. This can rupture the vein. It is also postulated matting may be secondary to high pressure injections as well.

After injecting I no longer apply pressure to the sites for spider or reticular veins. Cotton balls, dental roll, or foam sponges frequently get in the way of injecting multiple other veins at the same location. Vasospasm is created by the foam used in the reticulars and therefore not needed during the treatment session. Direct compression after injection is reserved for larger varicose veins.

Once the session is completed for the patient where telangiectasias to reticular veins are treated, the leg is compressed with a short stretch wrap of Medirip or Coban, ankle to thigh, worn until the following morning. This is followed by thigh-high class I compression stockings worn during the day for a minimum of 3 days and preferably up to 3 weeks during the day. The biggest impact stocking use has is on decreasing hyperpigmentation and vessel clearing.<sup>26,27</sup> In a controlled comparative study of duration of compression postsclerotherapy by Robert Weiss, MD, "three weeks of continuous compression leads to the best results, although even 3 days of compression results in greater improvement than no compression" at all.<sup>28</sup> When larger vessels are treated, direct compression with foam, cotton balls, or dental roll is applied with a short stretch compression wrap overnight. Following this, continuous use of class II compression stockings is advised for a minimum of 1 week, and preferably 3 weeks, for achieving good results. Patients are advised to walk daily to help decrease superficial vein hypertension. Treadmill or elliptical use is allowed. Patients are instructed to avoid all high-impact activities and weight lifting for 1 week. Warm showers are allowed, whereas hot baths avoided.

Patients are instructed to expect slow gradual changes over a period of weeks to months. Prior to treatment, a set of pictures are reviewed with the

patient showing a treated leg over a year timeline. The picture shows areas of hyperpigmentation and “trapped blood” vein segments to set realistic expectations. This education has resulted in a marked decrease in patient concerns following treatment. Patients are informed that retreatment of the same area will not be entertained for a minimum of 3 to 4 weeks. This does not preclude treatment of other ipsilateral leg areas or the contralateral extremity. Patients are advised not to expect complete resolution with only one treatment of a particular vein area. Like a facial skin blemish, elimination often requires repeated application of medicine. This concept applies to vein therapy and is easily understood by all patients. This foundation of realistic expectations and outcomes for this chronic condition avoids numerous phone calls and the potential for dissatisfied patients with unrealistic goals.

## Summary

Sclerotherapy remains the gold standard for leg vein treatment. There is a relatively short treatment technique learning curve, and skill improves rapidly with repetition. Using a Veinlite and outlined treatment protocols increases treatment accuracy and outcomes. Although there are numerous sclerotherapy agents in use worldwide, there are only a few available in the United States. Familiarity with these sclerosants and the appropriate concentrations recommended for different size veins is essential. Additionally, the use of compression gradient stockings will yield successful results with low incidence of adverse effects.

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