

The sapheno femoral junction involvement in the treatment of varicose veins disease

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Abstract

Sapheno femoral junction (SFJ) incompetence has been considered the most important cause of chronic venous insufficiency in a high percent of cases since the beginning of history varicose veins treatment. As a consequence SFJ dissection, ligation and section has been practiced all along the last century, generally associated to great saphenous vein stripping, with the porpoise of stopping the effect of hydrostatic pressure considered the origin of varicose veins. Recurrence prevalence at the site of SFJ, even in correctly performed dissection suggests that this attitude may not be the ideal one. Moreover, with the introduction of catheter-based systems of endovenous heating of the great saphenous vein with radiofrequency or endovenous laser ablation, it was shown that venous ablation could be achieved without high ligation of the SFJ. Also foam sclerotherapy demonstrated good results, even if less effective, always leaving the SFJ untouched. Following this trend several methods have been suggested that spare the SFJ, so that this site have lost its strategical importance. In this review history of the SFJ involvement in the varicose vein strategy is analyzed with particular attention to the new generation methods, technology assisted, launched on the market.

Introduction

Sapheno femoral junction (SFJ) as origin of the varicose veins disease has been the center of the attention from the beginning of the history of varicose veins treatment, however its responsibility has been weighted differently in the course of the last 100 years in parallel to technological innovations (US, endovascular methods), clinical evolution (conservative surgery, follow up experience), new materials (nitinol, cyanoacrylate) and physical preparations (Foam).

At the beginning of 1900, very rapidly SFJ surgical ablation become a truism for any ideal treatment and on this basis the

phlebologists proceeded without any doubts for a century; but how history teaches, cyclic changes of ideas are the rule and not the exception, so that now the SFJ, still important, is a *supporting actor* of the screenplay, needing a lesser if no attention at all. It would not be strange if in the following cycle things would turn back again, however, this review is centered mandatorily on the first present revolution and its reasons and causes.

Trendelemburg era

In 1890 Friedrich Trendelemburg¹ published a fundamental paper entitled: *Ligation of the greater saphenous vein in varicose veins of the leg*. The author describes the phenomenon of downward filling of the varicose bed through the incompetent saphenous trunk:

A very simple experiment will prove the correctness of this view. One lays the patient flat again, raises the leg to perpendicular, lets all the blood flow out of the saphenous field and compresses the trunk of the saphenous with a finger at a spot where it is definitely recognizable. Now one lets the patient come down from the cot cautiously, without removing the compressing finger from the saphenous. We see that the whole saphenous vein now remains empty at first on standing. Not until the lapse of a quarter to a half minute does one see the varicosities in the leg gradually begin to fill with blood again. The fullness, however, is not nearly so tense as it previous was, as long as pressure on the trunk persists. Only when removes the compressing finger, does a larger amount of blood rush down from above into the saphenous and the old picture of the tensely distended varicosities returns.

This is the birth of what will be called the *Trendelemburg test*.

As a consequence, quoting Trendelemburg:

In thus the simple fact that the varicose branches of the saphenous are separated from the vena cava by no valve closure as the result of the simultaneous dilatation of the trunk causes a large part of difficulties and dangers to which the sufferers from varicosities of the legs are subject, then the next thought is to prevent the back flow of blood from the vena cava through the saphenous into the varices operatively, by a permanent closure of the saphenous at one place, and to the same time to relieve the veins at the lower leg and foot from the abdominal pressure which burdens them. Such a permanent closure can be produced easily and without danger by double ligation and section of the vein between the ligatures, and as I have used the operation since the year 1880 in a large series of cases with the best results, I can recommend it for all cases of lower leg varicosities with simultaneous dilatation of the saphenous.

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This publication starts the modern treatment of varices: no more direct actions on varices (only), but attempt to eliminate the cause (saphenous reflux). Although the *Discovery of saphenous vein incontinence* has many previous fathers (Home, Rima, Brodie)² Trendelemburg had the merit of a large scientific diffusion ligated to his reputation, but also times were ready to a better solution of varicose disease thanks to surgical art evolution in the second half of the century (antiseptis and anaesthesia overall).

Trendelemburg operation spread and had great success; results were reported as very satisfying³ but recurrences were already registered (22%, considered optimistic Rose⁴) as frequent for collateral veins canalization and Perthes, Trendelemburg's pupil, already suggested to ligate GSV the higher possible for eliminating bypass possibilities:

*When the ligation is made high up on the trunk there will be fewer side branches above the point of ligation and it will be less likely that one of them will reopen the area of varicose veins to the pathological blood pressure.*³ He had a recurrence rate of 18%.⁴

Junction conquest

The sapheno femoral junction, initially

not considered, was involved - or at least nearly attained - already in Thelwell Thomas paper of 1896:⁵ to avoid *new varicose vein formed along the branches which entered the saphena above the site selected by Trendelenburg... Since 1893 I resolved to tie and cut the internal saphena immediately below the saphenous opening, and have operated upon fifteen cases in this manner with perfect results.*

Moore,⁶ in 1896, has the same suggestion: *An incision one and a half to two inches long is then made parallel to the fold of the groin, and about two inches below Poupart's ligament.*

In 1916 John Homans⁷ admirably describes the state of the art of varicose veins disease of its age, and in particular:

The radical removal of the surface veins is perhaps most satisfactorily performed upon the following plan: A transverse incision several inches long is made in the groin about one inch below Poupart's ligament: Through this incision the great saphenous vein is divided at the saphenous opening. At the same time any other veins which parallel it or enter from above are found and divided in order to do away with any vessel capable of reestablishing a large, single, collateral trunk. The internal saphenous is then dissected out with the Mayo stripper or other appropriate means to the region just below the knee.

Parallel to the groin dissection of the GSV, at the beginning of the century it appears evident that GSV interruption alone is not sufficient to control the disease, but also that the dilated GSV system should be eliminated for reducing recurrences. For this porpoise between 1905 and 1907, in the turning of only 3 years, 3 American surgeons (Keller,⁸ Mayo,⁹ Babcock¹⁰) conceived the 3 basic stripping methods today still in use (respectively invagination, external, internal stripping), in the attempt of finding less aggressive methods than those in use at that time (Madelung: long incisions over the varices, Schede: circular incisions, Rindfleisch: spiral incisions).¹¹

Interestingly, none of the 3 surgeons suggested junction ligation at their time. Babcock¹⁰ describes the inguinal time of his operation as: *about 2, inches below Poupart's ligament a transverse incision, one inch in length, is made through the skin and subcutaneous fat down to the muscular sheath. The index finger is then inserted to the bottom of the wound, slid backwards for a short distance close to the muscular sheath and then hooked inward and forward away from the muscle, when it at once catches the thick resistant cord of the saphenous vein., which is lifted into the wound and at once clamped above by a hemostat.*

Still it is not matter of *high ligation*, Homans' rules came later.

In Northern America Stripping becomes a new tool in surgeons' hands obtaining progressive (but not so fast) agreement, till the general consensus at the half of the century,^{11,12} finally popularized by Myers'¹¹ experience (1954) with the use of flexible strippers, also in Europe.

Sclerotherapy (r)evolution

Frightened by the *cruelty* of surgical procedures, physicians develop in parallel injection method starting from the archaic roots of the Pravaz syringe invention and of the first *coagulating substances* (ferric perchlorure and iodotannin solution). Originally considered a too dangerous method (Congress of Surgery Lion 1894), injection treatment progressively evolved through the search of new less toxic substances like phenic acid (Tavel 1904), potassium iodio-iodure (Schiassi 1906), sublimate 0.5% (Linser 1916), sodium carbonate and finally salicylate (Sicard 1920).¹³ Salicylate revolution, finally a non-toxic agent, fixed the beginning of sclerotherapy renaissance at least in Europe. Sclerotherapy begun a very busy affair in Europe, enhanced by the creation of the first society of phlebology (*Société Française de Phlébologie*) in 1947. A deep dualism between sclerotherapy and surgery took place that partly is present still nowadays.

According to Marmasse¹⁴ *starting with 30 years of advantage over sclerotherapy - 1890-1920 - varices surgery fell to sleep during the following 30 years - 1920-1950.*

At present very effective and safe agents are in use (polidocanol, tetradeilsulfate) and, finally, a new way of administration (foam) that appears more efficient, however direct SFJ treatment is not really expected with this method as shown by, Butie,¹⁵ Biegelsen.¹⁶ Some attempts have been made in the past to treat directly the Junction.¹⁷⁻¹⁹ preferably by injections few centimeters below the groin to avoid Pudendal artery injection and Femoral vein thrombosis, but the wash out of the tributaries seems to avoid closure of the terminal part of the GSV, how demonstrated in Duplex era assessment.^{20,21}

Surgery/sclerotherapy (liquid) combination

Tavel (1904),²² from Berne, published the first an experience in injection treatment

after *subcutaneous* GSV ligation, if spontaneous post ligation saphenous thrombosis was lacking. However, Schiassi (1907)²³ suggested what is considered a milestone in treatment of varices: simultaneous ligation (by local anesthesia) and injection (iodide solution) of varices. According to Foote,¹¹ he was much in advance of his time, as the combination of the two methods became firmly established in 1925 and for quarter of century high resection of the GSV in combination with retrograde injection of sclerosant has been employed all over the world.^{4,24-27}

Interestingly, Nobili (1921), Schiassi pupil, had the merit of suggesting the injection higher in the groin, allowing the sclerosant to be eliminated through a second distal incision; Unger (1927) suggested to use a catheter for injecting the distal GSV through the groin dissection; Moszkowics (1927) employed dextrose injections; Mairano (1949) made thigh stripping and salicylate injection in the crural GSV.²⁸

Rose⁴ tells us, in one historical talk, that:

The operation I performed in 1941 was high ligation of SFJ, tributaries ligation and retrograde passage of a ureteric catheter down the cut end of the vein until it would go no further (Unger technique - Editor's note.). About 6 to 8 ml of 5% to 10% of sodium morrhuate was injected down the catheter as it was slowly withdrawn. The entire procedure was carried out with the patient under local anesthesia and done in an outpatient basis. The result was an immediate massive reaction along the line of the saphenous vein from ankle to groin. A chemical thrombophlebitis was produced that required heavy bandaging and caused considerable disability. The patients were painfully incapacitated during the 2 to 4 weeks it took for the condition to solve. The ultimate fate of the thrombosed vein was recanalization, which took place sooner than expected.... Use of ureteric catheter was discontinued in 1945, and the practice of simultaneous sclerotherapy was ended in 1946. In the French survey (1962),^{29,30} over 147 participants, 24 still practiced the method, 20 of them reporting thromboembolic accidents or even death.

More recently Lofgren,³¹ Jakobsen,³² Sladen,³³ Neglen,³⁴ Racek³⁵ still practiced this method with good but not stable results, in any case inferior to stripping methods.

Whatever method was used to treat the distal varices, high ligation become highly recommended for avoiding groin recanalization while sclerosing injection were preferably practiced in limited extension and successively.

Stripping prevalence

After the II world war the *american way* took place.^{4,11,12,28,36,37} High ligation and GSV stripping became the gold standard although with plenty of variations and “inventions” as: long or short stripping, below-upward or above downwards stripping, pleating or inversion by string or mesh, redon drainage, association to perforator ligation or varicectomy or sclerotherapy, by general, spinal, local anesthesia, with a choice of plenty of strippers in commerce.

In 1962 the French *Enquete sur la crossectomie et le stripping*²⁹ based on a questionnaire to whom participated more than 147 phlebologists (69)/surgeons (77) experts of France (93) and Europe (53) reveals that high ligation/stripping is largely prevalent over sclerotherapy alone, but evidence appeared that neither surgery alone, or sclerotherapy alone (apart Carl Sigg opinion), could satisfy the request of the ideal treatment of varices, a wise combination being the best solution: (E. Maes-Belgique): *That phlebologist that operates on varices excluding sclerosant injections is like a piano player playing only on white keys leaving out the black ones.*²⁹

The Myth

While things constantly change in varicose treatment history, one single concept becomes a myth: Spheno-femoral junction should be full dissected and all junction collaterals should be ligated/divided possibly till their secondary division. This act would stop the pressure from above, primary cause of varicose disease. Every single junction collateral vein left could be the origin of recurrence. Dissection should be even extended to the Common Femoral Vein, to possibly exclude branches joining separately to the deep system.³⁰

According to Foote,¹¹ *The only way to ensure a satisfactory clearance is to divide everything entering the sapheno-femoral trunk, however small it may be. It is essential to seek out the circumflex iliac branch for a little distance laterally to ensure that it has no descending branch... The rule is, therefore, any adjacent descending branch must be ligated however small it may be.*

According to Geier:³⁸ *Although never proven by a randomized study, long-lasting experience with varicose vein surgery has led to the postulate that resection of the SFJ should be done as close to the femoral vein as possible, without leaving a long residual stump. The rationale behind this technique is the assumption that such a long residual*

stump will be affected by refluxing blood from the femoral vein, which with time will cause further dilatation and incompetence of the stump and its branches, resulting in recurrent varicose veins.

Recurrences

No other disease, maybe except dental pathology, has so great tendency to recurrence than varicose veins. As soon as a scientific method of treatment has been undertaken (Trendelenburg, Perthes), the first cases of recurrence were recorded (22, 18% respectively). Already in 1940 Stalker²⁶ writes: *With all types of treatment there have been a large percentage of recurrences in spite of the fact that immediate results have been encouraging. No type of therapy for the relief of varicose veins of the lower extremities is new. All have been tried, have been discarded, and have reappeared at one time or another.*

Due to the *benign* nature of varices, that are not life threatening and respond positively to any treatment in the immediate, usually phlebologists consider their results very positively unless their patients are assessed after at least 5 years (but often even 2 years are critical). Furthermore recurrence are generally due to others' management. A more scientific approach (Hobbs³⁹) and US facilities (Fisher⁴⁰) showed a different and more realistic situation in outcomes that is going to originate a new research movement, still going on today. Hobbs,³⁹ in 1974 by clinical analysis comparing “enthusiastic sclerotherapy with enthusiastic surgery” observed, after one year 82% of unselected patients were cured (no symptoms or signs and no varicose veins) by injection, but after six years the cure rate was only 7%. At the opposite after surgery, at one year 40% were cured *versus* 20% at six years. According to Fisher,⁴⁰ in 2001, 125 limbs (77 patients) that underwent operation between 1960 and 1967, were evaluated clinically and with duplex sonography for possible superficial-to-deep vein reconnections and clinical recurrence of high varicosities at a mean follow-up of 34 years. Clinical examination suggested sapheno femoral recurrence in 59 limbs (47%) while duplex ultrasonography demonstrated sapheno femoral reflux in 75 limbs (60%). Interestingly, all the patients were considered receiving a correct terminal high ligation.

More than 50% of recurrences are localized at the SFJ: a phenomenon that is linked to GSV trunk recanalization, a pelvic leaking point involvement and/or a neovascular-

ization.⁴¹⁻⁴⁴

The *recurrent varicose veins after surgery study* (REVAS)⁴¹ reported the outcomes from a large cohort of patients treated with ligation and stripping at a number of international centers and demonstrated that 20% of these recurrences originated from sapheno femoral neovascularization, 19% from incorrect junctional ligation, and 55% from perforator reflux.

Evidence based results and ultrasound assessment of outcome outlined that the phlebologists' optimism had to be reviewed.

While groin recurrence has been universally related to insufficient quality of surgical procedure (technical failure), evidence exists that junction recanalization occurs in proper groin dissection too.⁴⁵ This phenomenon of formation of new venous channels between the saphenous stump on the common femoral vein (CFV) and the residual GSV or its tributaries is called *neovascularization*.⁴⁶ The potential pathophysiological mechanisms of reference are many: angiogenic stimulation in the free endothelium of the ligated stump, trans-nodal lymphovenous connection, dilation of small adventitial vessels in the vasa vasorum of the femoral vein, disturbed venous drainage of the ligated tributaries of the SFJ.

A significantly higher risk of SFJ recurrence was reported⁴⁴ in cases of Iliac Femoral Valve incompetence (IFV) with an odd ratio of 4.8. In the 45 cases of recurrence over 381 cases analyzed at 5 years follow up, 27% of recurrences were associated to IFV incompetence, *versus* 7% in non-recurrence patients.

Paradoxically, when the SFJ has been missed and a portion of the GSV has been left attached to the CFV, the postoperative hemodynamic situation (reflux) remains unchanged, with minimal or missing impetus for postoperative neovascularization. On the contrary, after correct ligation, the hemodynamic situation at the SFJ changes completely, activating possible pathophysiological mechanisms.⁴⁷

Complete resection of the GSV stump⁴⁸ and inversion suturing of the common femoral vein did not seem to decrease neovascularization.⁴⁹

Results on the use of barrier materials are conflicting and these techniques have also not yet been introduced into common clinical practice.^{50,51}

Re-do surgery

In symptomatic patients with varices recurrence and hemodynamic anomalies treatment is indicated. There is no consen-

sus on preferring sclerotherapy *versus* surgery as evidence is very poor.⁵² Surgery is considered the best option when a major reflux may be identified due to a large stump. A lateral approach first visualizing the Femoral artery has been the most employed technique,⁵³ while a medial indirect approach may be used in alternative.⁵⁴ However this type of surgery, easy in skilled hands, but rarely analyzed in the literature is anecdotally considered technically challenging, time consuming, at risk of complication, reported to fail in 30 to 80% of cases,⁴⁴ inducing to refrain from aggressive surgery.^{55,56} As an alternative, sclerotherapy alone^{57,58} or associated to surgery⁵⁹ may give good results.

The Duplex advent

The development of duplex ultrasound has been like the invention of the microscope or telescope in biology or physics, allowing us to see better in real time the venous network, to monitor venous disease noninvasively in clinical and research uses. Ultrasound is now used preoperatively, intraoperatively, and postoperatively.⁶⁰

Duplex evaluation of varicose veins was first reported in 1986,⁶¹⁻⁶³ however routine use of duplex scanning prior to varicose vein surgery has not become an established practice till the end of the century. In the mid-1990s, it was found that in the United States, 18% of noninvasive vascular laboratories did not use duplex ultrasound for vein mapping and another 37% did so only occasionally.⁶⁴ Some investigators advocated using color coded duplex sonography only for investigation of the popliteal fossa^{65,66} or recurrences.

Phlebology practice of 2000 is strongly ligated to Duplex /Color assessment due to the large diffusion of modern, simple and relatively cheap equipment allowing the single phlebologist to display its own assessment. This induced a progressive enormous advancement in anatomic and functional knowledge of venous pathology⁶⁷⁻⁶⁸ and, as a consequence, an evolution of treatment methods. Already in 1989 Sclerotherapy through Ultrasonic guidance of injection into the superficial venous system was first published.⁶⁹ The initial aim of this technique was more to reduce the risks inherent in injection of *hidden* (non visible and palpable) veins than to improve results.⁷⁰ In 1990s foam appeared and rapidly became popular and diffused for its efficacy and US visibility.⁷¹⁻⁷³

Furthermore, also postoperative analysis changed its perspective as clinical

aspects could be verified by Duplex revealing a much higher recurrence rate.⁷⁴

In particular, it became clear that GSV reflux is not always associated to SFJ incompetence;⁷⁵ in fact terminal valve may be competent in a very high number of cases (33% Abu-Own;⁷⁶ 40% Pieri;⁷⁷ 55% Cappelli;⁷⁸ 56% Somjen⁷⁹). In this instance junction dissection and high ligation is useless⁸⁰ and even harmful, the source of reflux coming from a perforator or tributaries.

Terminal and pre-terminal valves function,⁷⁷ prevalence of AASV incompetence,⁸¹ possible influence of common femoral valve on SV hemodynamics,⁴⁴⁻⁷⁸ peri junctional veno-lymphatic network,⁸² GSV hypoplasia⁸³ are all aspects revealed by US observation, influencing treatment strategy and tactic, and often rising recurrences.

A new perspective given by US studies was started already in 1988 (maybe too much early over an unprepared audience) by Franceschi⁸⁴ who conceived a method (CHIVA) that allowed conservation of the GSV stem and venous network - even incompetent - for possible bypass use, with simple limited surgical actions (ligatures), but after a deep analysis of the single patient's venous hemodynamic.

Again SFJ is the *chief character* but in a new conservative perspective, to be adapted to single patients hemodynamic.

Chiva Crossotomy

In ideal CHIVA treatment cases, the junction is high ligated without interruption of the junction tributaries which are drained through the incompetent saphenous stem in counter current through the distal perforator(s) centered on the same saphenous stem; the incompetent tributaries are de-connected from the saphenous stem but are not removed. The final result is a normalization of the venous hypertension without removal of any venous tract.

The junction phase is called Crossotomy (section of the *croisse*, the French name for Junction), in opposition to what is conventionally called Crossectomy (removal of the *croisse*). Unfortunately, scientific evidence of crossotomy results is lacking and single CHIVA authors mostly report anecdotic experience.

Junction dissection without tributaries interruption may be a challenging operation due to the great anatomical variations of tributary arrangement when they merge proximal to the Femoral vein. Once the junction dissected, interruption may be obtained by placing a clip flush to the femoral vein plus a second clip in proximity

placed in opposite direction. Traditional ligation by non-resorbable threads seems at risk of *ice effect* recanalization. Section of ligated saphenous stump is the best option for a de-connection but may be difficult if a limited space remain between the femoral wall and the tributaries. In some instances the more proximal tributary(s) can be sacrificed.⁸⁵ Del Frate⁸⁶ compared surgical division crossotomy to two different triple superimposed flush ligations (N. 2 non-absorbable braided coated suture *versus* N. 0 polypropylene ligation) without division. The incidence rates of neovascularization was 4.9%, 6.1% and 37.5% respectively. According to Zamboni,⁸⁷ recurrence rate at 3-10 years is 2.9% for crossotomy *versus* 5.5% for crossectomy (stripping).

Valvuloplasty

Another way of sparing incompetent GSV opposite to ablation is the reconstitution of competence of the junction when valvular incompetence is due to diameter dilatation while the valves are still efficient. The basic idea has inspired different methods of obtaining the goal: banding of the junction area with fascia lata,⁸⁸ with prosthetic material (Dacron or Politetrafluoretilene - PTFE),⁸⁹ fenestrated for tributary sparing,⁸⁵ with the VENOCUFF stapler (Dacron/silicon banding with automatic caliber fixation),⁹⁰ with the EVS (Gore External Valve Support), a Dacron device Nitinol reinforced,⁹¹ with OSESTTM (Oval Shaped External Support): acting traction onto the inter-commissural diameter of an incompetent valve (Assut Europe SpA, Italy)⁹² Perivenous injection of viscose fluids like jalaronic acid has also been attempted for the same porpoise.⁹³

Generally good results are reported even at long term considering symptoms and function, however usually studied population is limited in numbers and specifically selected. Belcaro⁹⁴ reported his 15 years clinical experience of external valvuloplasty with EVS in 101 patients. This author completed a four-year follow-up of a total of 47 patients without infections, thrombosis, foreign body reactions or other prosthesis-related complications, with 4% of SFJ reflux recurrence. Jin-Hyun Joh⁹⁵ re-examined thirty-one limbs from 27 patients at mean of 92.6 months registering persistent reflux in 19 (61%).

The true advantage is the conservation of GSV integrity opposite to ablation, and particularly the maintenance of centripetal flow in the same GSV. The present loss of compulsory need of absolute suppression of

Junction reflux can explain the loss of interest in these techniques.

Surgery with Junction respect

In 1993 Dortu⁹⁶ suggested the possible *over the fascia* junction interruption: this Author currently practiced Muller Phlebectomy on varicosities and, in selected cases, pushed the vein avulsion to the saphenous stem arriving till the groin; through a micro incision of 2-3 mm, 2 to 3 cm below the skin projection of the junction he hooked the saphenous stem out, ligated the tributaries and finally double ligated the Saphenous stump, that remained 6-10 mm long. Over 276 limbs controlled after at least 3 years (mean 5.6 years) 271 had good outcome, two cases having recurrence on posterior accessory and 2 on anterior accessory and one as typical neogenesis. Rapidly other authors followed this *revolutionary* trend.^{97,98}

This atypical and heretical surgical application, corresponding to a stripping with an uncomplete high ligation (and to EVA techniques result) has been successively re-evaluated by several authors for its very satisfying outcomes: Pittaluga⁹⁹ with only 2.7% recurrence at 27.3 months; Casoni¹⁰⁰ with 8% recurrence at two years; this same author, in a randomized trial (stripping alone *versus* stripping - high ligation) found at 8 years 9.8% *versus* 29% of clinical recurrences and 11.4 *versus* 32.2 of US reflux recurrence respectively.¹⁰¹

Mariani in 2015¹⁰² reported an experience of *selective high ligation* (sparing veins coming from the abdominal wall, as the superior epigastric vein or the superior iliac circumflex vein), on 360 limbs with follow up from 5 to 12 years, recording only 1.9% (7 cases) of groin recurrences.

Recently Ricci¹⁰³ described GSV pre terminal ligation/transection by a simplified surgical approach made easy by US assistance: GSV is hooked 3 cm from the junction through a micro incision under direct visualization of the vein. The distal saphenous stem then can be treated in the preferred way or left for conservation.

Tributary avulsion without GSV reflux treatment

The evidence of varicose veins development not associated to SFJ and GSV incompetence (Labropulos, Coleridge) suggested a possible ascending mechanism of progression of varicose disease, for which the ter-

minal/junctional valve represents the last stage of a venous reflux that advances from lower levels, challenging the traditionally accepted retrograde theory descending directly from Trendelenburg's observations.

Venous wall weakening is the initiating factor of primary reflux that, therefore, might not develop in a retrograde manner beginning from the terminal valve but, more likely, following a reverse, upward directed, pattern.¹⁰⁴ According to this hypothesis, Pittaluga in 2005 suggested the ablation selective of varices in anesthesia in local (ASVAL). Following the Author's words:¹⁰⁵ *Progression of the disease starts in the supra fascial tributaries, which are the most superficial, the most exposed veins outside the saphenous compartment and whose walls are the thinnest. Venous dilatation begins on the supra fascial tributaries distally, where the hydrostatic pressure is higher, creating a dilated and refluxing venous network called varicose reservoir (VR) within the supra fascial space.*¹⁰⁶ When this refluxing network becomes large enough, it can create a *filling* effect in the saphenous vein, leading to decompensation of the saphenous vein wall, reaching progressively the SFJ or SPJ. The goal of the ASVAL method is to decrease or eliminate the saphenous vein reflux by minimizing VR using ambulatory phlebectomy described by Robert Muller¹⁰⁷ or sclerotherapy. Pre-operative ultrasound assessment has enhanced the precision for phlebectomy.

Although isolated treatment of varices leaving an incompetent GSV was not new,¹⁰⁷⁻¹⁰⁹ ASVAL had the merit of giving a scientific dignity to an empiric method.

Endovascular generation

Endovenous laser treatment of saphenous veins developed during the 1990s, only from 2000 were published the first relevant papers about endovenous treatments of the Great Saphenous vein.

At the beginning of the new century, minimally invasive endovenous laser ablation (EVLA)¹⁰⁵ and radiofrequency (RF) ablation¹⁰⁶ have emerged as effective outpatient treatment approaches both delivering electromagnetic energy to destroy by heating the vein wall.¹⁰⁷

Initially, reports of successful ablation of the GSV using either radiofrequency or laser energy without ligation or stripping were treated with great skepticism. In fact all the endovascular approach methods are applied for closing the GSV stem, leaving untouched the last 2-3 cm of GSV, *i.e.* the

SFJ. This technical aspect assures the junction tributaries drainage and avoids the nearer Common Femoral Vein involvement (EHIT: endovenous heat-induced thrombus)¹⁰⁸ similarly to what occurs to sclerotherapy, where the washout of the same tributaries maintain the junction patent.

However, the absence of neovascularization appeared so striking that many skeptics have begun to believe that former emphasis on a clean groin dissection may have been in error.³⁰

In fact, the majority of cases of recurrence occurred due to recanalization of a segment of a previously treated vein with recurrent reflux or new reflux in an accessory or alternate truncal pathway as shown by some 5 years outcome randomized studies.¹⁰⁹⁻¹¹³

Gradman, in a survey of members of the American Venous Forum and American College of Phlebology, concluded that regardless of the method of saphenous vein ablation (RF, laser, or foam sclerotherapy), concomitant ligation of the sapheno femoral junction offered no advantage in outcome no matter the size of the proximal great saphenous vein.¹¹⁴

In the same time sclerotherapy begun its *renaissance* through foam formula of the two detergent agents (polydocanol, tetradecilsulfate). Foam ultrasound guided sclerotherapy rapidly showing a better efficacy compared to liquid sclerotherapy became a valid alternative to EVA as endovenous chemical ablation. Although offering a lower occlusion rate as primary treatment, but with a good secondary success, it has the advantage of a low cost and a simple administration so that it can be easily repeated.¹¹⁵

Based on the *new* concept that SFJ dissection is not necessary while GSV stem still needs to be eliminated, several methods are constantly and progressively conceived to satisfy the following requests, the order of importance of the factors being variable: i) outpatient setting; ii) ease to perform; iii) efficacy; iv) industrial business.

In 2007 Milleret¹¹⁶ started to study an endovascular heat ablation employing steam. At the tip of the catheter, steam is emitted at 120°C achieving results similar to the other heating methods.

In 2011 A new mechano chemical device (ClariVeinw, Madison, CT, USA), was developed to minimize the negative aspects of both endothermal ablation and ultrasound-guided sclerotherapy (UGS), while incorporating the benefits of each.¹¹⁷ The method has the advantage of not needing tumescent anesthesia that thermal ablations do.

In 2013 Almeida¹¹⁸ begun to study fea-

sibility of GSV occlusion by a special glue, having the advantage of not requiring perivenous tumescence and post treatment compression. Post ablation thrombus extension (PASTE) through the SFJ, seen infrequently following thermal or foam saphenous ablation, was seen in 8/38 (21%) patients in the first human study; this problem appears to have been resolved by moving the 1st injection to 5 cms below the SFJ.^{119,120}

In 2013 Frullini¹²¹ published preliminary results of a technique combining a particular attenuated laser action, that shrinks the vein wall, to foam sclerotherapy.

In 2013 thermal segmentary ablation has been suggested by Giancesini¹²² and contemporarily by Passariello¹²³ with the purpose of using endovascular techniques for high GSV occlusion (below the junction, for a length of few centimeters only) sparing the more distal part of the saphenous stem. Recently Mendoza¹²⁴ employed this technique on 104 patients with results comparable to surgical crosssectomy.

Followed: i) a *vessel occluder* that can be placed percutaneously, in initial study phase;¹²⁵ ii) a mechanical closure using a spiral shaped device;¹²⁶ iii) a Coil closure combined to foam injection US assisted¹²⁷ or by image intensifier (and conscious sedation).¹²⁸

To be continued...

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