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Review Article

# History of Saphenous Vein Bypass. An Update Based on Actual Medical Evidence

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## Abstract

The aim of this document is raise awareness to the angyiologist and cardiologist world, about the indiscriminate destruction of the great saphenous vein GSV, that today, has recovered its value as a conduit for arterial bypass [1,2].

Nowadays the destruction of this anatomic capital element is performed by phlebologists and dermatologists, many of them without vascular surgery skills.

A great number of patients suffered the GSV ablation only for aesthetical reasons, without hemodynamics considerations.

The ablation of the saphenous vein is effective when it reaches diameters that makes it useless to preserve and its ablation is necessary to decrease symptoms and complications. This point should be noted, this occurs in patients with a long history of venous disease.

***Keywords:*** *Saphenous Vein; Ablation; Venous Disease*

## Ultraounds considerations for vein sparing and ablation

| | First stage | Second stage | Third stage |
|---|---|---|---|
| Great saphenous vein diameter | < 5 mm | > 5 - < 8mm | > 8 mm |
| Peak Reflux Speed | < 30 cc/sec | < /= 30 cc/sec | > 30 cc/sec |
| Total Reflux volume | < 10 cc/sec | 10/100 cc/sec | > 100 cc/sec |
| EVLAR plus tributary avulsion | + | + | |
| Internal Laser Valvuloplasty | | + | |
| Ablation | | | + |

*E Ferracani MD. CICE 2016. Sao Paulo. Ultrasound considerations in venous surgery based in ultrasound. Personal presentation.*

The majority of specialists do that just by economical interest or just by unawareness of the actual tendency of early treatment of vein disease.

Less aggressive methods as sparing strategies (CHIVA ; ASVAL , EVLAR) based on current hemodynamic principles are available today, proved by scientific medical research evidence [3-8].

The renewal evidence of the GSV patency permeability, similar to the radial artery, is now under discussion and must be clarified seriously by angyiologist.

This document has been written also with the purpose of updating hemodynamic concepts, which underpin the new strategies of preservation of the great saphenous vein, exclusively.

## History of the coronary bypass with saphena magna

Before Sones and Shirey performed the first cinecoronariography during the beginning of the 1960, little was known about physiopathology and anatomy of cardiac ischemia [9].

Sones, on his own body performed the first study; an incredible act of research and courage.

This opened a new era; the knowledge of coronary anatomy, the cause of flow obstruction and the treatment of ischemic heart disease; the atheroma plaque.

Dr Kolesov in 1964 was the first who performed a coronary surgery. He did an open surgical procedure in which, the internal mammary artery was anastomosed to the left anterior descending artery, but he abandoned the procedure [10].

At the same time; 1967; Favaloro and Effler at the Cleveland clinic, understanding that an occlusion could be raffled using the reversed saphena magna [11].

By a bride building over an obstacle, they overcome the "arterial occlusion".

They developed the all system and transformed an idea into a reality; the coronary bypass era was born.

The success of these pioneers was due to the implementation of the logistics and systematization of the procedure, being globally recognized as the creators of direct myocardial coronary revascularization.

I mention this, because Vineberg had previously performed a direct cardiac surgery, immersing the mammary artery into the myocardial muscle, for further development of circulation [12].

The success of this approach was limited and the method remains only for remembrance.

## Aspects of vein graft preparation

The saphenous vein was used for revascularization at the Cleveland Clinic by the first time in cardiac surgery history.

Undoubtedly, for its use, it must be preserved and an era of preservation of the venous conduit began.

A segment of the GSV of 60 cm was removed from the leg, beginning its dissection always from the distal premaleolar sector for its lesser diameter.

The diameter of the vein could be greater than 5 mm and is not a relevant fact, as the vein reduce their diameter by themselves over time, adapting to the new function into arterial position [13].

A question about patency rates arised, permeability.

The plaque of the saphenous vein into arterial position is anatomopathologically different from the atheromatous plaque.

The atheromatous plaque has a fibrotic cover, with foam cells inside laden with lipids (LDL and HLDL), necrotic areas and it is soft because it has low fibrotic content [14].

High pick pressure increases disrupt the plaque and a coronary ischemic event is the consequence [15].

The venous plaque of the vein, in arterial position, is a reactive answer to ischemia induced by the suppression of oxygen supply, with myointimal cell proliferation and fibrosis.

Later in advanced stages, we can find calcium and lipids and it is similar to the post stenting coronary wall reaction pathway.

During vein extraction, the damage should be minimal and is mandatory extremely care over the endothelium, do not leave venous sacs and avoid the use of dilated sectors, usually close to the venous valves.

The vein was during decades "skeletonized without it's fat and fascia protection, and this was the biggest mistake of vein extraction technique.

The vein nutrition is not done by blood lumen nutrition, its oxygen supply is done by the vasa vasorum, destroyed during extraction.

Other mistake was destroying its lymphatic drainage which is carried out by the perivenous tissue.

Conventional harvesting of saphenous vein used for coronary artery bypass surgery induces a vasospasm.

Saphenous vein harvested with perivascular tissues by a "no touch" technique does not suffered vasospasm, leading to an improved graft patency.

Endothelial nitric oxide synthesis production were significantly reduced by high-pressure distension and removal or damage to the perivascular tissues [16].

The preservation of perivascular tissue on saphenous vein with the "no touch" technique protects against distension-induced damage, preserves vessel morphology, and maintains endothelial nitric oxide synthesis and enzyme synthetase activity.

This was the basis of the failure of late permeability; a vital non-ischemic duct was transformed into an ischemic one, when we destroy the vasa vasorum and diminishes the amount of nitric oxide production.

Today the vein has to be removed as the ITA, with the pedicle in place and surrounding tissues.

This method changed rates of permeability, similar to the radial artery and ITA internal mammary artery.

## Vein bypass evolution

Over the first 2 months, up to 10 - 15% of venous grafts present early thrombotic occlusion. This process is related to the lesion of the endothelium by the surgical technique. The non-touch technique was focused on this point.

After the first year, another 5 - 10% of venous grafts occlusion occurs due to the intimal hyperplasia process by migration of smooth muscle cells to the middle layer of the vein, deposit of fibrin, erythrocytes and neutrophils. All these events results in a permeability to more than 7 years threw low permeability indexes.

In 1980 began to use arterial conduits for coronary revascularization whereas the vein responded to systemic pressure with a myointimal proliferation process and development of a histopathology occlusive plaque different from arteriosclerotic one.

Is a false concept or almost incomplete understanding that the histopathological alteration is mainly due to the exposure of the venous graft to the pressure of the arterial circuit.

The most important fact of vein aggression was the skeletonizing procedure during surgical extraction.

The skeletonizing of the vein destroys its nutritional support done by the vasa vasorum. As a consequence transformed a vital conduit into an ischemic one

In conclusion, over this particular topic, the most important issue is the iatrogenic ischemia of the GSV done during surgical extraction.

This transformation never happens when the saphenous vein is used for infrapopliteal *in situ* bypass.

It does not suffer these changes, protected by the surrounding tissues and is today the graft of choice in infra-popliteal critical limb ischemia.

## Which consequences brought the low saphenous vein patency rates?

The first consequence was the beginning of use arterial conduits instead of vein conduits; internal thoracic mammary artery (ITA) and radial arteries [17].

The second was a diminished respect of venous conduit preservation and started an increased the number of GSV ablation, many of them just for aesthetical reasons in young women.

An era of industrial medical devices for phlebology started after 1998 with the development of endovascular methods as LASER ablation presented in Germany by Dr Bone Salat in 1998, the first who used the LASER into endovenous ablation strategy.

## The past of vein ablation

The surgery of the GSV was born in the late nineteenth century and was then developed at the Mayo Clinic, being the first surgery performed by newly initiated surgeons.

Consisted of a bloody extraction surgery using a metal or plastic instrument inside the vein and complete with later avulsion, with a painful postoperative recovery and not exempt of complications; the so-called "stripping".

## Ultrasound open a new phlebology dimension

The initial theory; the descending theory, was that GSV become dilated exclusively by gravitational hydrostatic factors.

Thanks to the advent of ultrasound the strict anatomical concept, pave the way to a more complete understanding of venous disease.

Since the development of ultrasound (US) today is unthinkable, practice venous surgery without its diagnostic use and are the eyes of the surgeon, transforming blind surgery in a controlled ultrasound one.

The work of Dr Shadeck considered pathological venous reflux the cause of vein dilation only based on time; it is only a "qualitative" index, not a quantitative index of total reflux volume.

He created a scale based in time (seconds of reflux time); when the reflux lasted more than 0.5 seconds, the disease is present.

It developed different severity indexes based on reflux time. It is real that in advanced stages of venous disease; the largest refluxing time is particularly equal to worst disease [18].

But this qualitative assessment does not analyses the primordial factor in the development of venous insufficiency and its consequences; the Total Reflux Volume.

The pioneering work of Dr Yamaki developed a formula to evaluate the Total Reflux Volume (TRV). His US-based formula results from the product of the average peak reflux multiplied by the time of reflux (seconds) and area ($cm^2$). She yields results based on maximum peak (cc/seconds); prognosis index of venous insufficiency evolution [19,20].

With this conception based on time and the descending theory as the principal cause, gave rise the development of multiple techniques and endovascular systems, with the sole purpose of closing the conduit; the great saphenous vein.

Unfortunately, the lack of judgment or the ethical behavior of many experts supported by the industry, produced veins ablations of 5 mm with minimal refluxes in young patients, giving rise to the euphemism "aesthetic phlebology".

The alleged futility by part of the phlebology world without a post grade in vascular surgery and the power of marketing industry initiates a new era that Dr Samson, cardiac surgeon of Florida, call the flourishment of Starbucks ambulatories vein centers [21].

Thanks to the work of Dr Lee; the UIP Hemodynamic Consensus; light was introduced into the darkness [22].

A new vision appeared; now is the venous area the key point of reflux, not time exclusively.

Under the scope of physiopathology Total Reflux–volume is the main responsible for venous disease edema and venous ulcer.

Another magnificent contribution was made by Dr Raju [23].

He demonstrated that the affection of the soleus muscle pump has vital importance in venous disease progression.

Reflux peaks greater than 30 cc/sec are responsible for the deterioration and loss of ejection fraction of the muscular pump, which leads to venous stasis.

Today the great saphenous vein should not be ablate with a peak reflux less than 30 cc/sec as it does not reaches a reflux volume capable of altering the systolic ejection of the muscular pump.

### Ablation and not ablation criteria

We consider as a rational medical behavior GSV ablation under the following conditions:

- Diameter greater than 10 mm.
- Maximum reflux peak greater than 30 cc/second.
- Reflux time greater than 4 seconds (it implies elevated reflux volumes)

Not ablation must be taken into account in: young patients at risk of Arteriosclerotic disease, patients with proven ischemic disease (arterial or coronary), severe hypertension, hypercholesterolemia or dyslipidemia, insulin dependent juvenile diabetes or diabetics with bad arterial beds.

### Actual evidence

Other capital defender of this phlebologic point of view is Professor Franceschi, one of the pioneers of patient anatomic capital preservation.

In his own words, "the patient never knows the truths because they are concealed to patients"; as himself named "Verites Cachees Aux Patients". Chiva Fans Blog 2016.

Phlebologist and dermatologist, transformed in venous vascular experts surgeons never told this issue, the relevance importance of the anatomical capital when propose the surgical destruction or venous pathway of the saphenous vein in the varicose disease. Even more, they never takes a decision supported by the new concepts (UIP Hemodynamic Consensus).

It is mandatory that patients should receive a complete information about Evidence-Based medicine, although not provided by the majority of phlebologist [24].

Today the most ethical attitude should be explain to the patient all these facts and after that performed a signed consent explaining all these issues, recidivism rates after the endo-venous procedures are equivalent to that of stripping, thus superior to the CHIVA cure and other sparing methods.

Out of the field of cardiovascular coronary and arterial bypass nowadays a trend to new sparing techniques in venous surgery are arising. The concept of descending theory is changing by the ascending origin of venous disease origin supported in studies done by Labropoulus, Perrin and others [25-30].

Metalloproteases and leucocytes activation plus shear stress, are considered today, the beginning of the disease. The key issue is the treatment, as soon as possible, the origin of venous disease.

The pioneer of this wave was prof Franceschi the creator of CHIVA Cure, which preserve venous capital and give 2 times less recidivism than stripping and less side effects showed by the Revue CHOCRANE system database done by Bellmunt-Montoya for the treatment of chronic venous insufficiency.

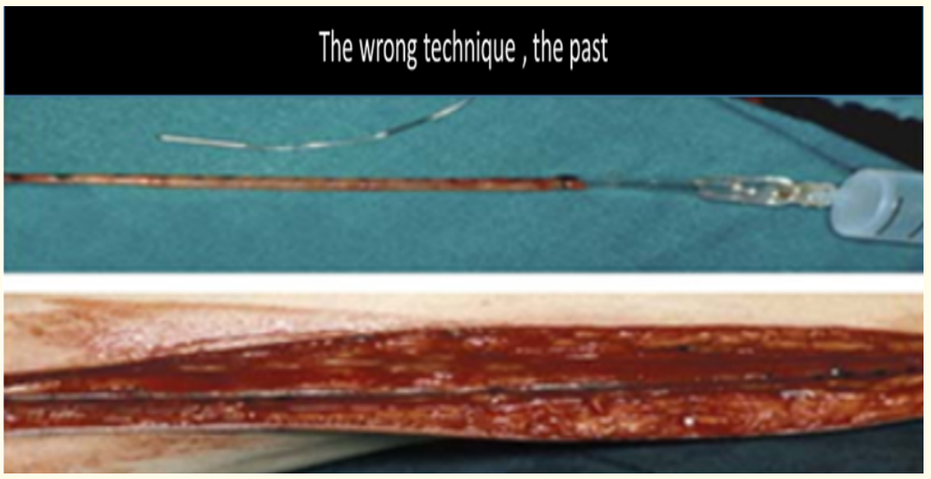
Others strategies like ASVAL done by Dr Pittaluga and Chastanet, EVLAR and short LASER heat occlusion, fractioning the hydrostatic pressure, are now availables at initial stages of vein disease avoiding vein destruction as the first treatment approach.

The saphenous vein or long saphenous vein is the best bridging material of the arterial peripheral especially below the knee. This work was done under a meta-analysis in critical limb ischemia [31,32].

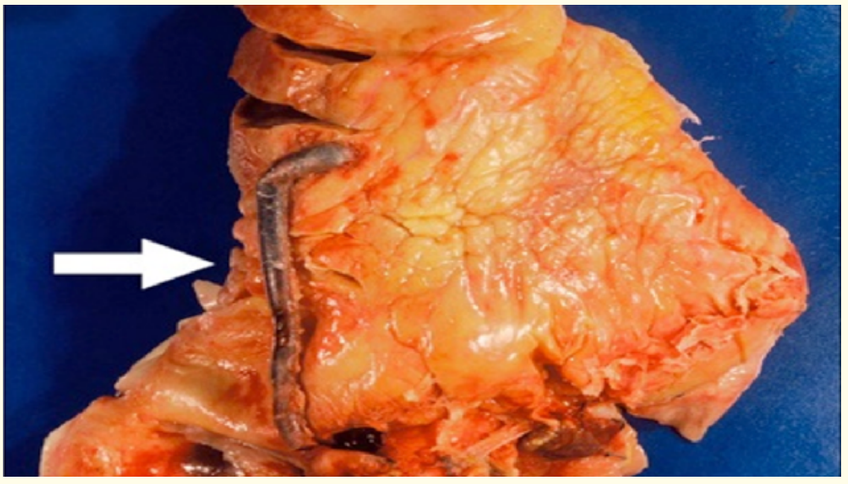
The method described by Souza and Dreifalt; the non-touch technique of saphenous vein harvesting; changes the patency rates of the GSV in coronary position; this statement today is a reality without any question about it 's efficacy.

The randomized trial done by Papakonstantinou showed comparable patency between the Non-touch saphenous vein and to the left internal thoracic artery [33].

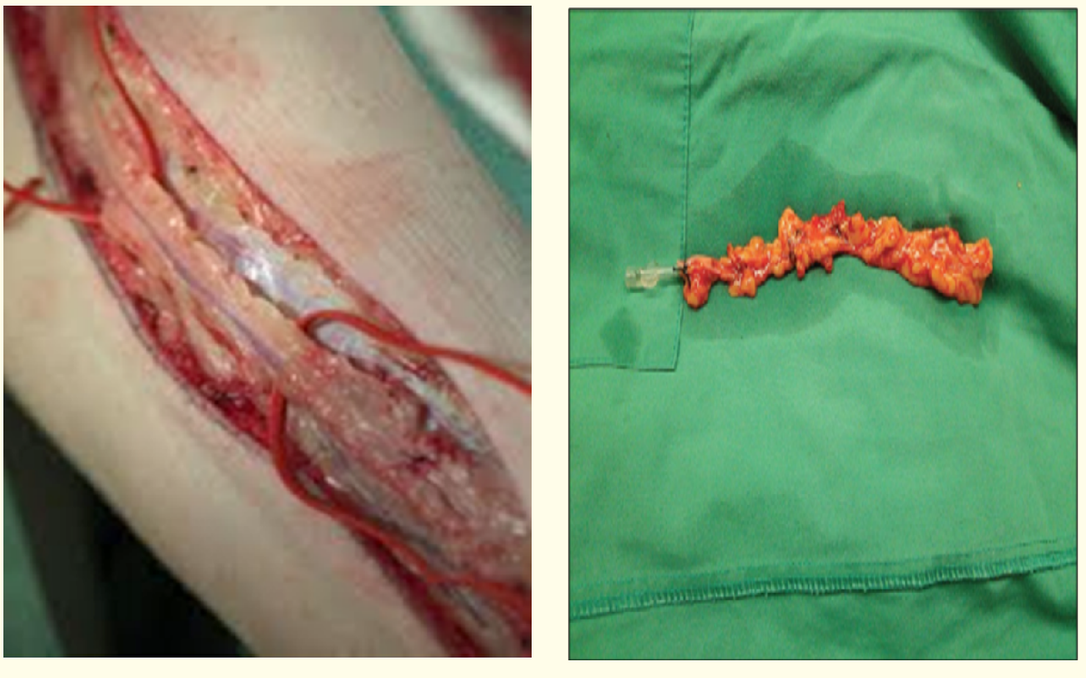
The GSV used as an allografts taken during stripping and then frozen give less good results than autologous grafts. Mostly in critical limb, ischemia and they are meta-analysis done supporting that evidence [34].




*Complete denudation, of perivenous supplies, vasa vasorum, lymphatic drainages, lack of surrounding support.*



*Venous bypass occluded. Complete denudation of perivenous tissues.*



*Perivenous tissues ,vasa vasorum and fat respected.*

## Conclusions

The patient receiving the phlebologist indication of ablation of the GSV should receive all this information.

It should be an obligation on the informed consent to be entered into and signed by the patient.

Today the Societies of Angiology and Vascular Surgery are promoting a more ethical and truthful attitude towards the patients.

Unfortunately in all International Meetings of Phlebology this important topic is not developed like a "taboo", maybe by the pressure of the industry and the undeclared interest of the academic exhibitors, all of them world famous members of International Societies.

I wrote this paper as a duty with the patient because into my conscience I have the following principle; "Never use the flesh of a patient as the clay of your masterpiece".

I humbly invite to the Cardiology and Angiology world; in particular; to become aware and deeply think about these concepts, that were dumped in the interests of the patient's health.

All of us, someday, we will be one of them.

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