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Review Article

CHIVA in the light of long-term studies and awareness of saphenous preservation

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Abstract

Designed as a saphenous preserving, ambulatory, and office-based procedure to treat varicose disease, CHIVA (cure Conservatrice et Hémodynamique de l'Insuffisance Veineuse en Ambulatoire) has been practiced by its proponents for more than three decades. The value of CHIVA has been proven in literature for its therapeutic effects and cost-effectiveness in the treatment of varicose disease including the most advanced cases. Numerous studies suggest that the dilated great saphenous vein (GSV) will return to its normal size and function physiologically following a CHIVA procedure. Moreover, CHIVA preserves saphenous substance for future bypass grafts as needed. Today, the treatment of varicose disease is most often accomplished by stripping or endovascular ablation of GSV. Meantime, reports show that the ablation of GSV is at an alarming level, posing a health threat to the public due to a lack of GSV availability during arterial bypass operations. All these mean that an emphasis on saphenous preserving concepts in varicose disease treatment is validated. Among those concepts, CHIVA is an effective alternative with low recurrence rates to common procedures considering the multiple anatomical variants of varicose disease. As long-term studies demonstrate the safety and advantages of CHIVA, its dissemination should be encouraged in the community of vascular surgeons.

Keywords: Varicose disease, venous insufficiency, chiva, saphenous vein, doppler

INTRODUCTION

CHIVA, a French acronym for cure Conservatrice et Hémodynamique de l'Insuffisance Veineuse en Ambulatoire, was proposed as a strategy to treat varicose disease in 1988 by Claude Franceschi [1]. CHIVA refers to a conservative, hemodynamic, and office-based treatment of venous insufficiency [1-7]. Franceschi's idea for CHIVA operations came from a desperate lack of saphenous grafts for bypass operations [8]. The same concern was also raised by Cooley et al. [9] who were familiar with the inferior results with prosthetic materials [10-12] following arterial bypass operations: "The vascular surgeon, ... is reluctant to remove this source of graft material for cosmetic reasons. .... most intelligent patients, when given reasons for preserving their veins, will not insist on undergoing saphenous vein stripping, for cosmetic purposes alone" [9].

Today, more than three decades later following initial concerns and the conception of CHIVA, there is an industrialized effort at ablating great saphenous vein (GSV) in the treatment of varicose disease. In his presidential address to the Society for Vascular Surgery in 2016, Lawrence emphasized a 4529% increase in saphenous ablations and that some of those procedures were performed by those with only an MD degree and little or no vascular training [13]. Alarmingly, Samson, the editor of Vascular Specialist suggested establishing a society under the name of "SOS, save our saphenous" to prevent the ablation of healthy saphenous veins [14].

An international randomized trial of surgery versus endovascular

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therapy on patients with critical limb ischemia was performed [15]. This study showed that in patients who had an adequate length of GSV for surgical revascularization, the incidence of a major adverse limb event or death was significantly lower in the surgical group than in the endovascular group. The same study also demonstrated that in surgical patients who lacked a saphenous graft, outcomes were similar to the endovascular group.

These experiences among others [16,17] demonstrate that the saphenous vein is indispensable for human health, and underline how dangerous the consequences could be in patients with the arterial disease if there is no saphenous vein available. In accordance with these experiences, current guidelines of European Vascular Surgery, the European Society of Cardiology, and the American College of Cardiology emphasize the quality, availability, and utilization of GSV during peripheral arterial bypass operations [18-20].

Therefore, it seems a prioritization of saphenous preservation teaching in the treatment of varicose vein disease is beneficial for our specialty.

Basic Physiology, Concept of Hemodynamic and Conservative Treatment

Veins under excessive pressure are called varicose when they are dilated and tortuous; either because of a downstream obstacle or more often because of valvular incompetence. Gravitational hydrostatic pressure (GHP) is proportional to the height of the venous blood column from the foot to the heart. It is therefore almost zero in the supine position and maximum in the standing position. In the case of valvular incompetence and reflux, lack of fractionation of GHP in an upright position causes excess pressure in veins. This means that varicose disease (venous insufficiency) due to valvular incompetence cannot occur in the supine position but only in the standing position, in people who cannot reduce their gravitational hydrostatic pressure.

Whatever the cause, whether an obstacle or valve incompetence, excessive venous pressure leads not only to varicose dilatation but also to skin disorders due to a lack of tissue drainage, which manifests clinically from mild to severe symptoms such as edema, skin changes, and ulceration.

It is the transmural pressure (TMP) that regulates the degree of drainage of tissues [21]. The TMP is the difference between intravenous pressure (GHP and/or motive) and external pressure (tissue and atmospheric pressures combined). Therefore, excessive TMP can be ameliorated either by reducing intra-venous pressure or by increasing extra-venous pressure. Reasonably, any treatment modality that ensures a decrease in the TMP, either by increasing the external pressure or by reducing the intravenous GHP can be considered a hemodynamic treatment. The former can be obtained by compression, while the latter can be obtained lying down with the legs elevated or by the CHIVA [1]. Conservative refers to the preservation of GSV anatomy and function.

Evolution of Varicose Vein Treatment

Naturally, varicose disease has been in the interest of medical practitioners since ancient times. Historically, treatments included recumbent positions for several weeks, cauterization, ligation, and compression bandages without scientific basis. Essentially, the bandage maintains an increased external venous pressure, counteracting the increases in GHP and TMP. Over time, bandaging proved itself as a hemodynamic measure of pathophysiologic restoration in the treatment of varicose disease [22]. German Dermatologist Dr. Unna, further improved this concept by applying an inelastic bandage with zinc oxide dressing to ulcerated leg [23]. Physiologically, Unna's Boot creates a high external venous pressure during muscular contraction, thus improving tissue drainage and healing.

While ligation of GSV in the thigh was described earlier [24] and modified later as flush ligation (high ligation) [25,26], Trendelenburg's name is associated with the hypothesis that GSV reflux is eliminated following ligation of incompetent GSV [27]. After the introduction of the reflux concept into the medical field, Trendelenburg introduced the disconnection of the GSV from the femoral vein. Trendelenburg divided the venous column with increased hydrostatic pressure and greatly facilitated venous ulcer healing [26,28]. Perthes, an assistant to Trendelenburg, is well known for his hemodynamic test. Using a tourniquet, he obliterated the superficial venous system of the leg with varicosities, thus fragmenting the venous column and eliminating reflux. While on a tourniquet, disappearing varicosities during walking (Perthes Test) confirm that the underlying deep venous system is physiologically normal [29].

The above-mentioned modalities are based on a hemodynamic concept, since eliminating reflux and fractioning high gravitational hydrostatic pressure on the venous column, as well as reducing tissue edema by compression, result in improved tissue perfusion and venous drainage. All are hemodynamic measures to cure the disease.

Phlebectomy procedures, including stripping of the GSV for reflux elimination, have been the preeminent treatment for varicosities since the beginning of the 20th century. Later, endovenous procedures [30-32] became the dominant technique, albeit with a fierce rivalry among them.

Sapheno-femoral junction (SFJ) high ligation (high tie or crossectomy) without stripping has never been completely abandoned [33,34] as a GSV preserving modality. Nonetheless, today it is the standard understanding around the world that GSV obliteration should be the main goal in varicose disease treatment, using one of the ablative methods.

CHIVA: Anatomical and Physiological Background

According to the UIP consensus document, the lower limb has three different venous compartments, including superficial, saphenous, and deep venous systems, respectively [35,36]. The saphenous compartment is a subgroup of the superficial compartment which is surrounded by a hyperechoic superficial fascia and deep muscular fascia [36]. The physiological hierarchical order of venous blood flow [6,7], is from the most superficial to deep venous system due to pressure gradient [37]. This pressure gradient is maintained through a series of complex interactions among cardiac performance, muscular contraction, postcapillary residual pressure, hydrostatic pressure, and rheologic factors.

The varicose disease is characterized by a diversion of blood from veins against the physiological hierarchical order that is called a shunt. The shunted blood deviates from the physiological order through an escape point. According to CHIVA theory, it is logical to interrupt the shunt and treat the disease with a ligation of escape point. Once the ligation is performed, such as high ligation in the presence of saphenofemoral incompetence, GSV receives a venous return from its tributaries and continues to transit blood to the deep system, though in a retrograde fashion. In the CHIVA mindset, in contrast to the traditional view [38,39] a retrograde flow in the GSV following a high ligation is not considered a pathological reflux. It is rather considered physiological because GSV functions as before; draining tributary venous flow to the deep venous system through perforators. The anatomical hierarchical order of venous drainage is maintained and there is no pressure or volume overload in a post-CHIVA circulation [40]. Moreover, it is reported that GSV in a post-CHIVA setting retains its normal parietal structural properties and is therefore eligible for arterial bypass surgery [41].

Therefore, CHIVA is a concept that aims to correct GHP and volume overload on the venous system while preserving GSV as well as the physiological hierarchy of venous drainage. Without performing a phlebectomy, CHIVA reorganizes the venous anatomy in a way that eliminates reflux sources, and therefore blood is transferred in the hierarchical drainage order [5-7]. Objective tests such as ambulatory venous pressure [3], air plethysmography [42], and duplex scanning following CHIVA operations reported irrefutable evidence of hemodynamic improvement [43,44].

Another GSV preserving methodology, ambulatory selective varicose vein ablation under local anesthesia (ASVAL), is based on the phlebectomy of varicose tributaries [45]. In this technique, there is no hemodynamic relief for SFJ incompetence which is often associated with varicose disease. Intuitively, this drawback associated with ASVAL explains the high recurrence rate [46]. ASVAL, from a hemodynamic point of view, is limited to cases where phlebectomy of varicose tributaries eliminates pathologic GSV reflux, whereas CHIVA provides a surgical solution for all anatomical varieties of varicose disease [5-7].

Technical Aspect of CHIVA

CHIVA procedures are performed under local anesthesia and in office-based settings (Figures 1 and 2) [47]. Small incisions are performed to flush ligate escape points. In case of SFJ incompetence, the preferred technique is a crossotomy where all descending tributaries are left intact, draining to GSV in a physiological way [48]. Additionally, refluxing tributaries are flush ligated as necessary (CHIVA 1 Procedure, Figures 3a and 3b). If SFJ is competent, only refluxing tributary(s) is (are) flush ligated (CHIVA 2 Procedure, Figures 4a and 4b). Therefore, CHIVA is performed utilizing either one or two-stage operations depending on the anatomy and physiology of the given patient [16,19]. It is easy to get confused and misinterpret ASVAL and CHIVA 2 as the same procedure [17]. These two operations are completely different in terms of planning as well as technical execution. The first step of CHIVA 2 -a preliminary operation before the second step of CHIVA 2- is a flush ligation of the refluxing tributary, whereas ASVAL is a modified phlebectomy of varicose tributary described by Muller [49]. Regarding CHIVA and its practice, a recent study showed that 45% of patients undergoing the first step of CHIVA 2 may not need the second step [50]. Technical modifications are welcome in the CHIVA strategy [51], including those using an endovenous device [52-55]. In a CHIVA procedure, operative strategy is largely dependent on preoperative Doppler ultrasonography findings. Competency of the SFJ, presence or absence of a re-entry perforator along the saphenous trunk, and incompetent tributaries connecting to the deep venous system should be identified preoperatively. Experience and Doppler skills are utilized preoperatively to evaluate the post-CHIVA GSV drainage to the deep venous system through a re-entry perforator. Thus, CHIVA is a revolutionary saphenous preservation methodology that is far ahead of all other saphenous preservation modalities. This is because CHIVA utilizes experience, doppler skills, and reflux eliciting dynamic maneuvers as well as time through a series of staged operations as needed, to ensure that GSV will continue to function following the operation.

Figure 1. A. A patient with SFJ insufficiency and refluxing tributaries; **B.** Same patient following a CHIVA 1 procedure including FV-GSV and tributary disconnections; No phlebectomy or sclerotherapy were performed; FV: femoral vein SFJ: Sapheno-Femoral Junction

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Figure 2. A. A patient with SFJ insufficiency, reflux along the GSV and several refluxing tributaries; SFJ: Sapheno-Femoral Junction; **B.** Photograph was taken 6 weeks after a CHIVA 1 procedure; No phlebectomy or sclerotherapy were performed

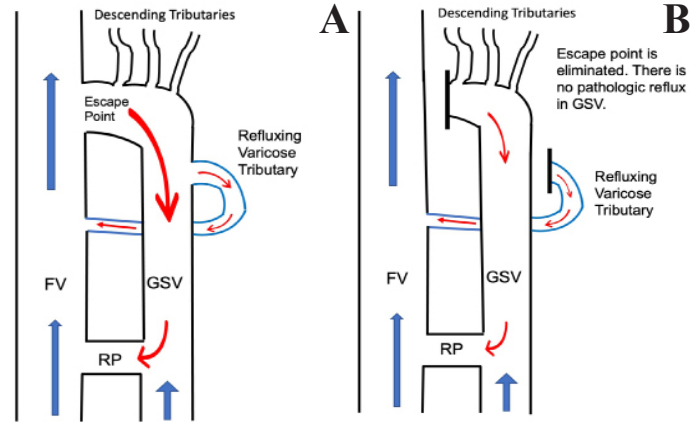

Figure 3. A. Presence of SFJ incompetence and a refluxing tributary; **B.** CHIVA 1 Procedure is performed including SFJ disconnection and flush ligation of the tributary; SFJ: Sapheno-Femoral Junction, FV: femoral vein, GSV: great saphenous vein, RP: re-entry perforator

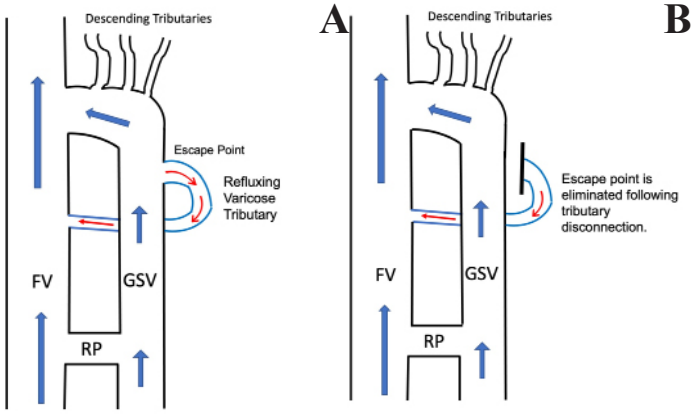

Figure 4. A. A case with a competent SFJ and refluxing tributary; **B.** Flush ligation of the refluxing tributary (CHIVA 2 Procedure); SFJ is left intact; FV: femoral vein GSV: great saphenous vein RP: re-entry perforator

A CHIVA practitioner should be able to discriminate a pathological reflux flow from a retrograde flow in GSV following CHIVA (Figures 5a and 5b). In the former, the systolic and diastolic directions of flow are different, whereas in the latter, there is a constant systolic and diastolic flow direction. It is widely accepted that there is a steep learning curve for CHIVA, emphasizing that adequate training and experience are necessary to obtain satisfactory results following the operations [56,57].

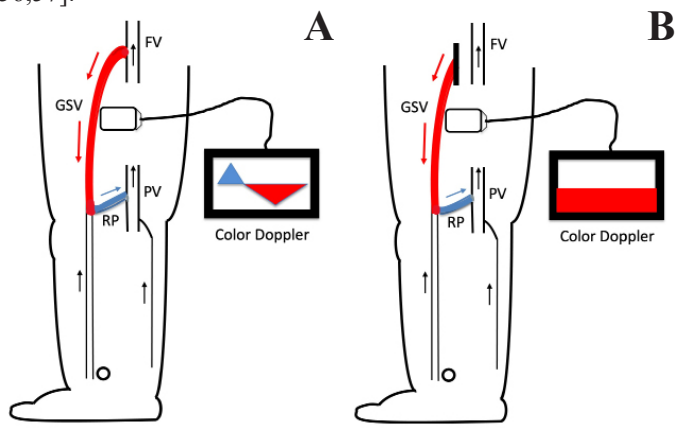

Figure 5. A. Preoperative cartography of a patient with SFJ insufficiency, GSV reflux and a reentry perforator along the GSV during muscle relaxation; Color echo-Doppler shows flows during muscle contraction and relaxation; There is significant reflux for an extended period; **B.** Cartography following the Chiva 1 procedure (SFJ disconnection) during muscle relaxation; Echo-Doppler shows constant direction of flow during muscle activity (contraction and relaxation)

Major benefits of CHIVA include:

1. Restoration of dynamic fragmentation of GHP. CHIVA fragments the venous column which is normally a function of valvular closure and muscular contraction. Ligation of escape points and segmentation of GSV lessens venous column length. Therefore, GHP is reduced, which helps to maintain TMP close to the physiologic range.
2. Interruption of shunts and elimination of turbulent flow relieves the venous structures from pressure and volume overload, it also relieves a reactive inflammatory process that is related to turbulent pathological shunt flow [58].
3. Sparing the tissue drainage: Once the escape points are disconnected, GSV continues to serve as a conduit draining venous return from the superficial compartment to the deep venous system. On the contrary, ablative procedures leave normal functioning, non-refluxing tributaries undrained. The superior tissue drainage explains the appearance of a less benign form of varicose disease following CHIVA operations compared to other ablative procedures [59,60].
4. Preservation of the GSV as a conduit for future bypass operations.
5. In the case of a deep venous obstruction, GSV continues to serve as a vicarious (bypassing) shunt.

GSVs can be utilized as an arterial bypass graft even in the presence of incompetence [61], including stripped and cold-preserved GSVs [62]. It is well documented that following a high tie to treat SFJ reflux, GSV diameter markedly reduces, almost to its normal size [63,64]. One study demonstrated that EP disconnection as a single procedure in patients with a GSV diameter ≥9 mm caused a significant reduction in diameter and clinical improvement in 80% of patients [64]. A study found only local dilatations in GSV and confirmed that it is not the vessel wall disease that makes the GSV dilated, but pressure and volume overload by the reflux [65]; these findings are supported by another study [66]. The unique anatomical feature that saphenous vessels are wrapped and protected by the fascia is most likely the underlying mechanism explaining this phenomenon. It is shown that even in the presence of short-segment varicose dilatations, a prosthetically reinforced GSV can be utilized as a bypass graft [67,68].

Randomized controlled trials (RCTs) proved that CHIVA results in superior outcomes and ulcer healing compared to stripping [69]. Also, a review of RCTs concluded that compared to stripping, CHIVA was associated with fewer recurrences and side effects [70].

Faccini et al. emphasized that CHIVA results in less bruising, nerve damage, recurrence, and associated costs compared to ablative procedures. Yet, authors admit that it is difficult to fund CHIVA studies and, therefore, publicity remains limited [56]. In an RCT study, compared to CHIVA, little or no difference in recurrence was found following stripping, compression, endovenous laser, and RFA treatments, still keeping the CHIVA superior with its GSV preserving and lower-cost qualities [71]. A large review reported: "CHIVA seemed to have superior clinical benefits on long-term efficacy for treating varicose veins. However, the conclusion still needs additional trials for supporting evidence" [72]. A recent meta-analysis elaborated significant variations in the technical success rates, recurrence rates, and post-intervention pain levels among different interventions. In the same study, CHIVA exhibited superior performance in terms of lower recurrence rates [73]. In a randomized controlled trial by Pares et al., CHIVA was more effective compared to stripping at 10 years, in terms of varicose vein recurrence, both with or without duplex markings. CHIVA continues to be superior to stripping only without duplex markings at 20 years. Authors conclude that this is related to a low retention rate [74].

American Vein and Lymphatic Society clinical practice guidelines for the management of varicose veins of the lower extremities recommend: "For patients with symptomatic varicose veins, we suggest preserving the GSV using the ambulatory conservative hemodynamic correction of venous insufficiency (CHIVA) technique if performed by a physician who is familiar with the strategy" [57].

According to our experience, as well as that of others, CHIVA is able to effectively treat varicose veins, even in the most severe cases [7,69,70,75]. CHIVA retains the functions and valuable substance of GSV. Therefore, it can be used during future bypass procedures. There has been enthusiasm for mini-invasive CHIVA using new technological tools [52-55]. Time will clarify if these methods translate into sustained and reproducible outcomes.

There are signs that Increased awareness of having a healthy saphenous vein is likely to induce changes in the guidelines in our specialty [76]. It may be ethical to inform patients about alternative conservative therapies, even if it is not legally required. This may include the loss of the chance to perform an arterial bypass with GSV before performing an ablative treatment of the saphenous vein. Sharing available scientific data in informed consent before the treatment of varicose disease will be a cautious disciplinary action. Likewise, it is legitimate to incorporate the concept of saphenous preservation in the training of vascular surgeons.

CONCLUSION

Human beings have a long venous column that is exposed to the stress of the GHP. When intrinsic mechanisms to counterbalance this stress fail, varicose disease occurs. CHIVA has numerous advantages in varicose disease treatment compared to other modalities. In addition, CHIVA conserves GSV which is a precious structure for human health. Our societies have aging populations, and they will likely have an increasing need for saphenous grafts for increasing arterial diseases in the future. Our discipline is likely to recognize CHIVA as a useful tool for saphenous preservation. Advanced sonography skills and a steep learning curve in complex hemodynamics are major factors preventing CHIVA from spreading worldwide.

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