INTRODUCTION

The lower extremity peripheral venous systems comprise three main types of veins, superficial, deep and perforating. the superficial and deep subsystems are defined by major and tributary veins linked by the perforating veins as well as venous networks (plexi), with the goal of directing all venous blood return into deep systems in peripheral, mid or central extremity venous segments. Wide variability is often ncountered in the anatomy, with origins for both systems beginning peripherally at the foot ***(Tisi et al., 2006).***

Varicose veins are dilated, often palpable subcutaneous veins with reversed blood flow, most commonly found in the legs. Estimates of the prevalence of varicose veins vary. Visible varicose veins in the lower limbs are estimated to affect at least a third of the population. There is little reliable information available in the literature on the proportion of people with varicose veins who progress to venous ulceration. One study reported that 28.6% of those who had visible varicose veins without oedema or other complications progressed to more serious venous disease after 6.6 years ***(Rabe et al., 2010)***.

The venous system of the lower extremity is rich in interconnections between the individual vessels. Because of the numerous collateral circulatory routes established, disruption of venous flow as well as compression of the veins by contracting muscles during locomotion or external pressure is prevented during changes in position of the body and extremity itself ***(Eberhardt et al., 2005)***.

Treatment of varicose veins has changed from surgery to include radiofrequency closure of the saphenous vein, endovenous laser obliteration of the saphenous vein, besides the satisfactory esthetic and functional results obtained with this treatment and their low rate of complication, and it's performed in outpatient facilities, under local anesthesia ***(Beebe-Dimmer et al., 2005).***

The most recent development of endovascular treatment options for reflux in superficial veins has established a new standard for patients with varicose veins and incompetent perforators, in whom the invasiveness and risk for wound complications associated with subfascial endoscopic perforating vein surgery (SEPS) exceed those of treatment of saphenous veins. As a result, new modalities, such as ultrasound-guided percutaneous ablation of perforating veins (PAPS) with sclerosing solution or thermal energy, have become increasingly popular, and as usual each of these modalities has its own complications and benefits ***(Nicolaides, 2004).***

AIM OF THE WORK

Aim of work is to discuss the different modalities in management of incompetent perforators after endovenousf LASER ablation or stripping of GSV, as it contributes in the recurrence of varicose veins and venous ulcers.

Chapter 1

LOWER LIMB VEINS ANATOMY

Introduction:

The lower extremity venous system is unique in its constant need to overcome the force of gravity while returning blood toward the heart. An elegant calf pump and vein valve system normally accomplish this task efficiently. The thin bicuspid, semilunar vein valves float open in the venous stream during prograde flow. During calf muscle relaxation, retrograde flow and higher supravalvular pressure cause the margins of the valve cusps to move to the midline and oppose so that caudad reflux is prevented. These valves can be disrupted by a thrombotic event (secondary), can be congenitally absent or atretic, or can become dysfunctional over time as the vein wall or valve loses integrity (primary). CVI has traditionally been classified on the basis of anatomy, function, and clinical severity. The anatomic classification of CVI is important because it links the location of CVI with its subsequent clinical management ***(Labropoulos et al., 2000)*.**

Great Saphenous Vein:

The GSV arises anterior to the medial malleolus and courses obliquely and posteriorly as it crosses the anteromedial surface of the calf. At or below the knee joint, the posterior arch vein joins it. In the calf a solitary vein is found in about two thirds of cases, whereas a duplicated system is present in the remainder. In the vast majority of cases, the GSV at the calf level is anterior dominant. As the main saphenous trunk continues in a slightly more superficial plane around the knee joint, an anterior accessory vein often merges.

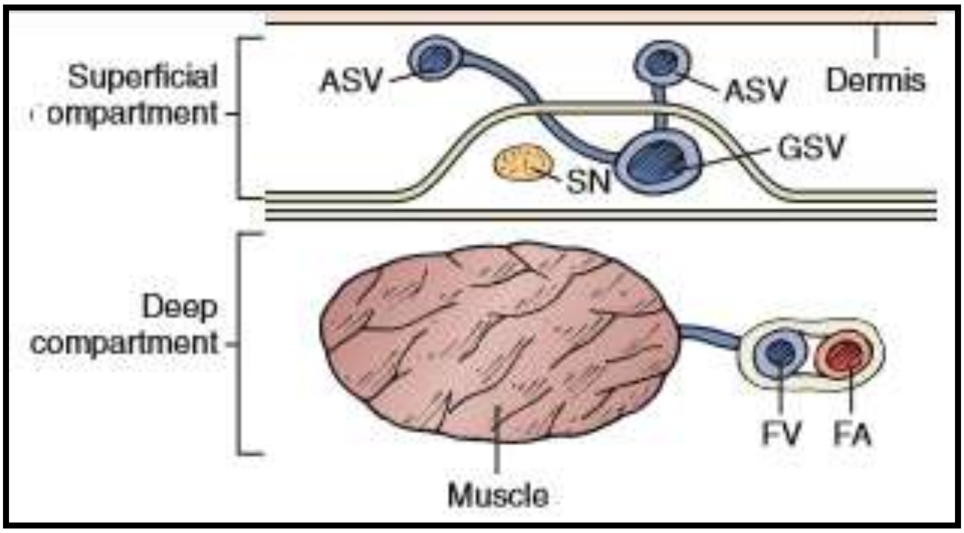

Figure (1): The saphenous compartment is bounded by deep and superficial layers of facia. Tributaries to the saphenous vein pierce the superficial fascia, and it is they that become varicose. ASV, Accessory saphenous vein; FA, femoral artery; FV, femoral vein; GSV, great saphenous vein; SN, saphenous nerve ***(Iafrati et al., 2014)*.**

The GSV then courses cephalad on top of the deep fascia and deep to the superficial fascia (Fig 1). The GSV may run within this envelope for the entire length of the thigh or may enter at some distance above the knee. If the GSV is “duplicated,” both veins will run in this fascial envelope; there may be anterior and posterior accessory veins that enter the fascial envelope to join the GSV, but they exist primarily in the extrafascial plane.

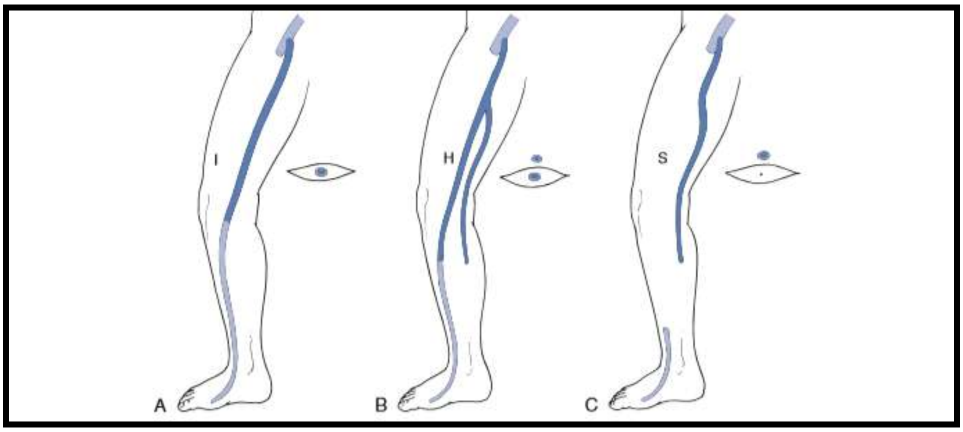

Figure (2): Anatomic types of the great saphenous vein (GSV) with respect to the fascial envelope. A, "I" type. The GSV is present within the trunk (left). C, "S" type. The caudal portion of the GSV in the thigh is atretic, and the extrafascial tributary is dominant ***(Iafratiet al., 2014).***

Three anatomic variants have been characterized and are demonstrated in Figure 2. Kupinski and coauthors reported their experience with duplex ultrasound evaluation of the GSV in nearly 1500 limbs ***(Kupinski et al., 1993)***. This evaluation was divided between approximately 1200 GSV and 470 SSV examinations that were carried out in preparation for infrainguinal bypass.

At the thigh level in 60% of the limbs the GSV had a single medial dominant system, whereas a branching double system was observed in nearly 20%, a complete double system in 10%, and a closedloop system in another 10%. Of interest was a lateral dominant system, present in 8% ***(Kupinski et al.,1993).***

Small Saphenous Vein:

The confluence of the SSV with the popliteal vein has long been recognized as being variable (Fig. 3). Approximately 33% of SSVs terminate at a (high) above-knee popliteal vein site, whereas a low termination site is unusual (<10%).. We have observed that DUS examination of the SSV allows exact perioperative and intraoperative localization of the saphenopopliteal junction for appropriate placement of the skin incision ***(Labropoulos et al., 2000)***.

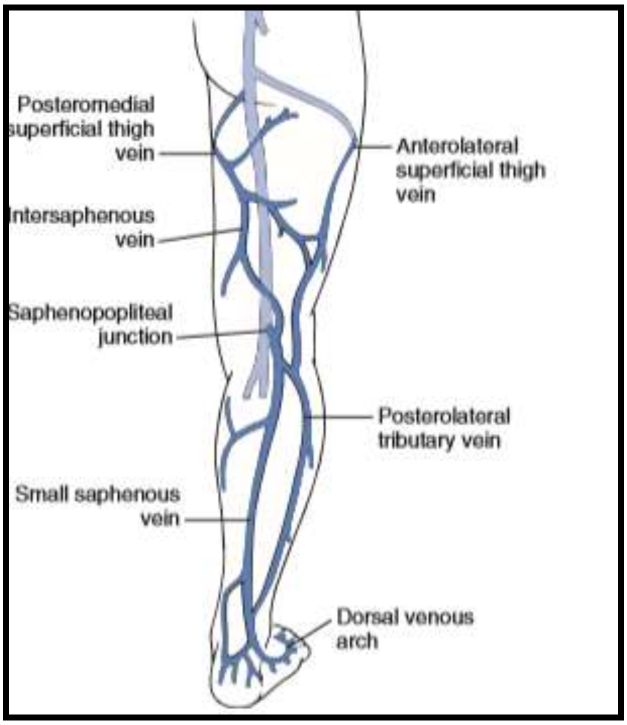

Figure (3): The small saphenous vein dominates the posterolateral superficial venous drainage and originates in the dorsal venous arch. At the posterolateral aspect of the ankle, it is intimately associated with the sural nerve. Note the important posterolateral tributary vein and the posterior thigh vein, which ascend and connect the small saphenous venous system with the GSV. The anterolateral superficial thigh vein and the posterolateral tributary vein can be very important in congenital venous anomalies, such as klippel-Trenaunay syndrome ***(Iafrati et al., 2014).***

Gastrocnemius Veins:

The gastrocnemius veins arise from both the medial and lateral heads of the gastrocnemius muscle and may join the popliteal vein directly or merge with the SSV to form a common trunk and then enter the popliteal vein ***(Hobbs et al., 2004)*.**

Conversely, the SSV may join with the gastrocnemius vein to enter the popliteal vein. Hobbs and Vandendriessche reported a 20% incidence of incompetence of the gastrocnemius veins ***(Hobbs et al., 2004)***-a proportion similar to that described by Gillet and colleagues in 180 operations for SSV reflux ***(Gillet et al., 1997)*** if the SSV is ligated distal to its junction with a common trunk and an incompetent gastrocnemius vein, persistent reflux is ensured.

Intersaphenous Vein:

The second important non-SSV vein of the popliteal fossa, the intersaphenous (Giacomini) vein, has been classically described as coursing up the posterior medial aspect of the thigh ***(Delis et al., 2004)***. The intersaphenous vein usually arises off the SSV either as a branch or as a truncal continuation of the SSV, and it courses along a subfascial plane to join the GSV more frequently (64%) than the deep venous system (45%) ***(Delis et al., 2004)*.** Reflux is less frequent in the intersaphenous vein than in either saphenous vein.

The proportion of limbs with intersaphenous vein incompetence, however, is greatly increased when incompetence of the SSV is found alone (odds ratio of 11.94) or combined with GSV incompetence (odds ratio of 11.7), ***(Delis et al., 2004)*** and this vein may facilitate reflux between the GSV and SSV ***(Zierauet al., 1996)*** In our series a dominant and incompetent intersaphenous vein that formed a common trunk with the SSV was observed in 8.5% of limbs undergoing surgery for SSV reflux.

Delis and colleagues' DUS study of 818 limbs also showed a low 3% incidence of popliteal area veins, ***(Delis et al., 2004)*** the third non-SSV vein of the popliteal fossa. By contrast, Dodd's classic study of 444 operations in the popliteal fossa showed popliteal area veins in 177 cases (40%), and in 60% they were branches of the SSV (50%) or gastrocnemius veins ***(Dodd et al., 1996)*** They directly entered the popliteal vein in 37% of cases.

Perforating Veins:

As their name suggests, PVs perforate the deep fascia of the leg that separates the superficial and deep compartments; they can be classified as direct or indirect. Direct perforators connect the superficial to the deep venous systems, whereas indirect perforators join the venous sinuses of the calf muscles. Furthermore, PVs connect to each other via communicating veins above and underneath the deep muscle fascia. The majority of PVs are accompanied by perforating arteries (Fig .4) and nerves that provide blood supply and innervation to the skin.3,35 Within the fascial orifice the artery is usually located proximal to the vein, but the topography of the subfascial and suprafascial segments of perforator arteries varies significantly ***(Caggiati et al., 2002).***

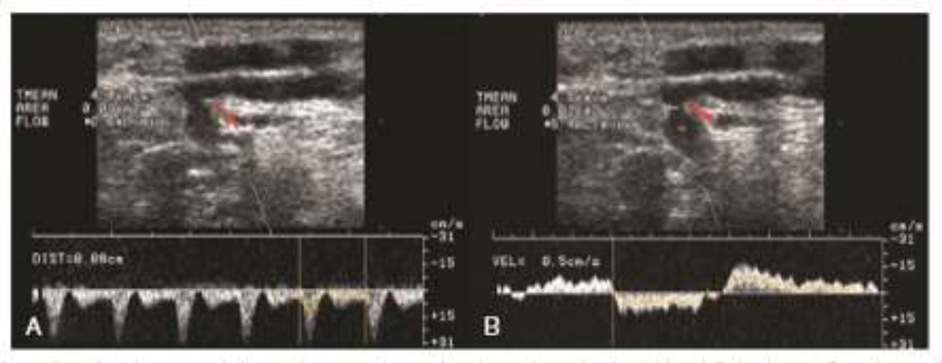

Figure (4): A, A small perforating artery is located next to the perforating vein at the fascial level. Pulsed wave Doppler confirms arterial. B, Doppler signal form the incompetent perforating vein indicates bidirectional flow ***(Lurie, 2014).***

These arteries can be clearly identified by duplex ultrasound, and their position should be taken into account, especially if sclerotherapy is being considered as a treatment option ***(Lurie et al., 2014)***. The International Interdisciplinary Consensus Committee on Venous Anatomical Terminology recommends classifying PVs into six groups according to the segment of the lower extremity in which they are found ***(Caggiati et al., 2002).***

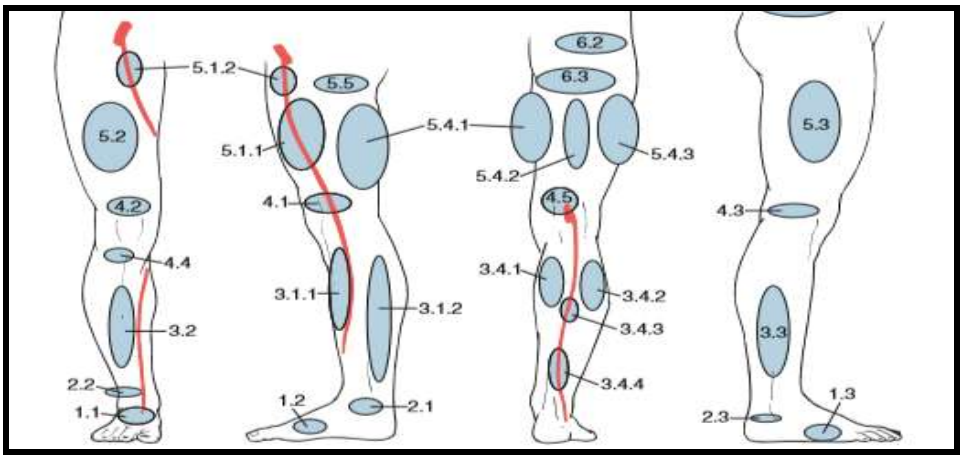

Figure (5): Schematic representation of the topography of the main groups of perforating veins (PVS). Foot PVs: 1.1, dorsal foot PV; 1.2. medial foot PV; 1.3, lateral foot PV. Ankle PVs: 2.1, medial ankle PV; 2.2. anterior ankle PV; 2.3, lateral ankle PV. Leg PVs: 3.1.1, partatibial PV; 3.1.2. posterior tibial PV; 3.2, anterior leg PV; 3.3; lateral leg PV; 3.4.1, medial gastrocnemius PV; 3.4.2 lateral gastrocnemius PV; 3.4.3. intergemellar PV; 3.4.4. para-achillean PV. Knee PVs: 4.1, medial knee PV; 4.2. suprapatellar PV; 4.3, lateral knee PV; 4.4. infrapatellar PV; 4.5, popliteal fossa PV. Thigh PVs: 5.1.1, PV of the femoral canal; 5.1.2, inguinal PV; 5.2. anterior thigh PV; 5.3, lateral thigh PV; 5.4.1, posteromedial thigh PV; 5.4.2, sciatic PV; 5.4.3, posterolateral thigh PV; 5.5, pudendal PV. Gluteal PVs: 6.1, superior gluteal PV; 6.2. midgluteal PV; 6.3, lower limbs: an international interdisciplinary consensus statement. J Vasc Surg 36: 416-422, 2002) ***(Caggiati et al., 2002)*.**

- Perforators of the foot (venae perforantes pedis)
- Perforators of the ankle (venae perforantes tarsalis)
- Perforators of the leg (venae perforantes cruris)
- Perforators of the knee (venae perforantes genus)
- Perforators of the thigh (venae perforantes femoris)
- Perforators of the gluteal muscles (venae perforantes glutealis)

Each group includes several subgroups (Fig. 5). One of the aims of this classification is to allow topographic description of PVs to avoid the use of personal names, which are often historically inaccurate. Many PVs are small vessels and have little clinical significance. The most important perforators from a clinical standpoint are the direct medial calf perforators, which cross the superficial posterior compartment ***(Caggiati et al., 2002).***

The posterior tibial PVs originate from the posterior accessory saphenous vein of the calf (posterior arch vein in the old terminology). The most distal posterior tibial perforators are located behind the medial malleolus, whereas the middle and upper posterior tibial perforators are located more proximally in the calf (at 7 to 9 cm and 10 to 12 cm from the medial malleolus, respectively) and about 1 inch medial to the tibia; these PVs connect the posterior arch vein to the posterior tibial veins (Cockett perforators) ***(Caggiati et al., 2002).***

More proximal direct PVs are the paratibial direct perforators or “24-cm perforators,” which are located closer to the tibia and 18 to 22 cm from the medial malleolus, as evident in anatomic cadaveric studies ***(Caggiati et al., 2002).***

Another group of medial calf perforators, found just below the knee, is known as Boyd’s perforators. They connect the GSV and its tributaries to the tibial or popliteal veins ***(Caggiati et al., 2002).***

Also of probable clinical importance are the posterolateral or peroneal perforators, which connect tributaries of the short saphenous vein to the peroneal veins. Among these, the most important are Bassi’s perforator, located at 5 to 7 cm, and the “12-cm perforator,” located at 12 to 14 cm from the lateral aspect of the ankle ***(Caggiati et al., 2002).***

Thigh perforators are less developed than calf PVs. The main ones are Dodd’s perforators and the hunterian perforators, which are located in the medial aspect of the thigh and connect the GSV to the popliteal or femoral veins. Other PVs connect the superficial system to the profunda femoris vein.and femoral canal perforating veins communicate between the femoral vein or popliteal vein and the GSV either directly or indirectly ***(Caggiati et al., 2002).***

Chapter 2

PATHOPHYSIOLOGY OF VARICOSE VEINS

Varicose veins (VVs) have been described since before the Common Era and are obvious on the lower limbs of many people. The fact that varicose veins primarily affect the lower limb directly implicates the upright nature of humans-specifically, the effect of hydrostatic pressure on the pathophysiology of such veins ***(Labropoulos et al., 1997)*.**

The relationship between body weight and extent of varicose veins and symptoms is variable. Limb symptoms are generally local and consist of pruritus and swelling. Occasionally, varicose veins can erode and bleed. Conversely, most such veins do not thrombose, despite relatively slow blood flow through these torturous structures, and this fact underlies the natural anticoagulant nature of venous endothelium, even in structurally abnormal vessels ***(Sadick, 1992).***

The initial anatomic location of varicose veins is typically in the great and small saphenous distributions and their tributaries in the superficial system ***(Labropoulos et al., 1997)***.

Related risk factors are multiple, including primary etiologies associated with pregnancy, prolonged standing, female gender, and, rarely, congenital absence of valves

(Sadick, 1992). In addition, varicosities may develop as a result of prior DVT or trauma.

Studies support a genetic predisposition of the varicose vein ***(Gundersen et al., 1969).*** In a prospective study of 402 subjects, the risk of development of varicose veins was 90% if both parents were affected, 25% for males and 62% for females if one parent was affected, and 20% if neither parent was affected ***(Cornu-Thenard et al., 1994)*** These data suggest an autosomal dominant with variable penetrance mode of genetic transmission.

Studies are generally lacking in relation to early vein wall changes associated with varicose veins, because most histologic studies are limited to end-stage surgical specimens. In varicose veins, the orderly appearance of the medial layer is replaced by an intense and disorganized deposition of collagen that separates the closely apposed muscle cells. Smooth muscle cells appear elliptical and are likely a secretory phenotype, and both TGF-β and basic fibroblast growth factor (bFGF) have been documented to be significantly increased in hypertrophic segments of varicose veins ***(Badier-Commander et al., 2001)***. The underlying mechanism for these histologic changes is unknown, but the inciting event of increased hydrostatic pressure or an intrinsic genetic defect is probably primary.

Active vein wall remodeling is consistently observed in specimens of varicose veins with abnormal matrix collagen