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A FIVE PART SERIES: Lower extremity venous insufficiency MUST be evaluated and treated as part of “infra-diaphragmatic venous disease”

Part 2: Physiology of the venous system and the concept of ambulatory Venous hypertension

By Sanjiv Lakhanpal, MD, FACS

Summary: To be able to propel blood against gravity, nature has provided us with an elegantly designed system of veins further enhanced physiologically with some ingenious mechanisms. The primary purpose of these mechanisms is to prevent ambulatory venous hypertension (AVH). It is this AVH that leads to changes at the capillary level that are responsible for the various presentations of venous insufficiency in the legs.

In this five-part review I will lay out the compelling case for such clinical evaluation and for appropriate treatment tailored to the needs of the individual patient, if the need is substantiated by a more detailed diagnostic workup. All articles will be archived and can be found at: http://www.centerforvein.com/physicians-corner/newsletter/

This review will be broken down into the following parts:

Part I: The anatomic logic for evaluation of the entire infra-diaphragmatic venous system in patients with advanced lower extremity venous disease.

Part III: Pathologic conditions leading to post-ambulatory venous hypertension in the lower extremities.

Part IV: Diagnosis of Infra-diaphragmatic venous insufficiency, venous diseases of the lower extremity and Pelvic Congestion syndrome.

Part V: Treatment of Infra-diaphragmatic venous insufficiency, venous diseases of the lower extremity and Pelvic Congestion syndrome.

In this issue we’ll present

Part II: The physiologic logic for evaluation of the entire infra-diaphragmatic venous system in patients with advanced lower extremity venous disease.
Physiology of the venous system and the concept of ambulatory venous hypertension

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It’s not until the emergence of Homo erectus 1.89 million years ago that hominids grew tall, evolved long legs and became completely terrestrial creatures. The column of blood in our veins at the level of our ankles has to make an arduous journey back to the heart against a pressure gradient (gravitational) of over 100 mm Hg.\(^3\)

WHAT IS VENOUS INSUFFICIENCY?

Veins carry blood from your body tissues back to the heart and lungs to be replenished with oxygen and to be recirculated. To be able to propel blood against gravity nature has provided us with an elegantly-designed system of veins further enhanced physiologically with some ingenious mechanisms.

One such mechanism is the strategically-placed anatomical enhancements that prevent blood from falling down a certain column (Figure 1). These are called venous valves. The closer we are to the ground in our supine state the higher the number of valves.

The second, probably even more important, mechanism is the blood-pumping action of the calf muscle when we walk (Figure 2). To facilitate this arduous journey, the foot and calf muscle pumps are recruited to work when we walk.

See the schematic illustration of the venous pump systems of the foot and calf in the relaxed and active states (Figure 3). The muscle pump unit consists of muscles (M) ensheathed by a common fascia (F) and veins within the same compartment. Contraction of the calf muscles (muscle systole), as in plantar flexion of the ankle joint during walking (below), expels blood into the proximal collecting vein.

During relaxation (muscle diastole, above) the blood is drained from the superficial veins (SV) into the deep veins (DV) in addition to the arterial inflow, making the pump ready for the subsequent ejection. V: venous valve. The distal calf (“piston”) pump is indicated in the middle. On dorsiflexion of the ankle (passive or active), the bulk of the calf muscle (M) descends within the fascial sheath (F), and expels blood in the distal veins like a piston.

The foot vein pump is illustrated on the right. The plantar veins are connected like a bow-string from the base of fourth metatarsal in front to the medial malleolus. On weightbearing the tarso-metatarsal joints are extended and the tarsal arch is flattened. Thus the veins are stretched, causing them to eject their blood content.
Physiology of the venous system and the concept of ambulatory venous hypertension

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See the schematic illustration of the superficial venous pressure at rest, and during ambulation (Figure 4). The AVP represents the lowest mean pressure during walking at the site of measurement, and the recovery time (RT) is the time interval between the termination of walking until the vein pressure reaches the pressure level at passive dependency. In healthy subjects, AVP at the distal calf is about 30 mm Hg and RT is 20-30 s.

AVH in the lower extremity occurs in patients with valvular reflux or venous obstruction (Figure 5 and 6).

This reflux or obstruction can occur either in the legs or the pelvis, in which case it is transmitted to the legs through the ‘escape veins’.

Lower Extremity:
1) Venous thrombosis
2) Valvular unsufficiency

Pelvis:
1) Venous hypertension in the pelvis
   Via escape veins

Ambulatory venous hypertension (AVH) in the lower extremities
Physiology of the venous system and the concept of ambulatory venous hypertension  

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This AVH is what changes the hemodynamic balance at the capillary level, causing tissue changes that lead to the signs and symptoms of venous insufficiency in the legs (Figure 7). These signs and symptoms are classified by the CEAP classifications C1 to C6. (See page 5)

Venous hypertension (characterized by abnormally leaky venous valve) leads to erythrocytes with iron seeping into tissue (Figure 8). This causes a cascade of deleterious reactions and increase oxidative stress. There is further inflammatory response through tumor necrosis factor alpha (TNF-α) and interleukin-6 (IL-6) which is constantly secreted venous leg ulceration (VLU). Dermal fibrosis is the result of matrix metalloproteinase (MMP) activation and fibroblast aging.

Recent studies by Sindrilaru et al. (2011) and Sindrilaru (2013) have identified a subset of iron-overloaded inflammatory M1-like macrophages, which are implicated in the pathogenesis of CVD. 9-11 Continuous uptake of Hb is thought to be the cause of high intracellular concentrations of heme-iron which induce an unrestrained pro-inflammatory macrophage activation. Macrophage iron can be further increased during inflammation by virtue of increased systemic or local hepcidin expression, which leads to reduction in ferroportin, an iron efflux protein, resulting in intracellular iron accumulation. Individuals may also be predisposed to CVD disease through a genetic inability to counteract the skin iron overload. 9,12 Studies have shown that common hemochromatosis gene mutations significantly increase the risk of ulcer in CVD by almost seven times. 9,13
Classification of Chronic Venous Disease and Course-of-Action: use of this classification system improves the accuracy of the diagnosis as well as communication between specialists and their patients.

CONCLUSION:
To be able to propel blood against gravity, nature has provided us with an elegantly designed system of veins further enhanced physiologically with some ingenious mechanisms.

The primary purpose of these mechanisms is to prevent AVH. It is this AVH that leads to changes at the capillary level that are responsible for the various presentations of venous insufficiency in the legs. Venous insufficiency is readily treatable through simple in-office, minimally-invasive and relatively pain-free procedures.

REFERENCES FOR THE DIAGRAMS, ILLUSTRATIONS AND CHARTS USED IN THIS ARTICLE:


Warning Signs: Skin Changes and Varicose Veins—What Is The Connection?

Most adults these days are very familiar with varicose veins—it’s a common condition, especially in the 45+ age group, and plagues more than 30 million Americans. What is most talked about, though, are the obvious veins themselves:

Spider veins are tangled groups of tiny blood vessels, just under the skin. These are mostly a cosmetic concern.

Varicose veins are dark purple or blue veins that may appear twisted and bulging – like cords.

One of the most common misconceptions about varicose veins is that people only seek treatment because they’re embarrassed by the unsightly appearance of these veins. A quick search will turn up articles about how Hollywood celebrities “battle varicose veins,” with the emphasis mostly on the aesthetic and less on the health issues (“How these stars get, and keep, their glamorous legs!”). However, there are other warning signs of venous disease to be aware of—changes that can occur to the skin of the legs that are a precursor to a more serious condition.

SKIN CHANGES AS A RESULT OF VENOUS INSUFFICIENCY

Varicose veins slowly and gradually get worse as time goes by. Skin changes are a very good reason for seeing a primary care physician; allowed to progress, the skin can become damaged, and even develop into an ulcer. An examination of the legs for tender areas, swelling, skin color changes, sores, and other signs of skin breakdown, followed by further tests by a specialist, can verify a deep vein problem.

Malfunction of the vein’s valves leads to blood pooling in the lower extremities and the swelling of the veins as pressure inside increases. When pressure increases, blood flow to surrounding skin and tissue decreases. This is when inflammation can occur, causing skin redness that can gradually evolve into brown discoloration. In the advanced stages, other changes can occur:

- A buildup of fluid and swelling in the leg
- Skin becomes red and irritated—often inflamed
- Significant swelling and calf pain after sitting or standing for a long time
- Skin color changes (stasis pigmentation) around the ankles and lower legs
- Dry, stretched, swollen, itching, or scaling skin
- Superficial thrombophlebitis (when a blood clot and inflammation develop in a small vein near the surface of the skin)
- Open sores (ulcerations) that can be difficult to treat
- Bacterial infection (cellulitis)
- Bleeding and/or bruising after a minor injury
Warning Signs: Skin Changes and Varicose Veins—What Is The Connection?  Continued from Page 6

DERMATITIS

Some people with venous insufficiency develop stasis dermatitis—the earliest skin-change sign of the disease. Blood pools in the veins of the lower leg. Fluid and blood cells leak out of the veins into the skin and other tissues. In the early stages of dermatitis the skin of the ankles and lower legs may look thin or tissue-like. The skin can also become dry, irritated or scaly. Scratching may cause the skin to crack, and fluid may seep out.

ATROPHIE BLANCHE

Atrophie blanche is the name given to a particular type of scar arising on the lower leg, often due to vein disease. Scars form as tissue replaces areas of dead skin. These depressed, millimeter-sized patches of skin are usually gray-white in color. Prominent red dots within the patches are due to enlarged capillary blood vessels.

LIPODERMATOSCLEROSIS

This type of inflammation results in a thickening of tissues under the skin. It can affect the lower inner leg of one or both legs. The skin becomes thick and hard, dark red-brown and may look lumpy, and resemble cellulitis. In addition to pain and tenderness, there is a constant sensation of heat. The skin changes eventually become permanent—in the final stages, the skin breaks down, and an ulcer forms.

ULCERATION

All the previously described skin changes are pre-ulcerous conditions. People with long-term, untreated venous insufficiency can develop ulcers. Current estimates show that approximately 70% of leg ulcers in the United States are due to venous insufficiency. Wound healing cannot take place until the underlying cause is treated. Ulcers that are not aggressively treated can become infected or even gangrenous.

If you, as a physician, see changes to a patient's skin and suspect he or she could be suffering from a result of varicose veins, recommend the patient seek testing; an ultrasound scan with a registered vascular technologist (RVT) that will take approximately 30 minutes per leg to determine the cause. The good news is that there are minimally invasive treatment options available for varicose veins and chronic venous disease that are covered by many insurance plans. These treatments address the condition before it progresses further, allowing for a short, comfortable recovery and a quick return to everyday activities.
In each issue of Venous Review, our medical team answers questions we’ve received from referring physicians.

Q. Is there a cure for venous disease?

A: While the varicose veins in a patient’s leg can be cured, there is nothing modern medicine can do to prevent future varicose veins from developing. Venous disease can be managed and minimized, allowing patients to enjoy a better quality of life, free from the disease’s discomfort and pain.

Treatments eliminate varicose veins with a series of relatively painless, minimally invasive procedures that are done in an office setting. Appointments are brief and patients can immediately resume normal activities with few restrictions.

Generally, patients who are predisposed to forming varicose veins continue to do so throughout their lifetime. Factors that predispose a patient, like family history, aging, gender (females are more prone to the disease), and jobs requiring prolonged standing are not easily controlled and lend to the formation of future varicose veins.

Fortunately, those veins can typically be managed by follow-up appointments once or twice a year.

Q. Can I refer a patient for your treatment that is currently taking blood thinners?

A: This is a common concern of referring physicians. By nature, venous insufficiency becomes progressively symptomatic as patients age. Therefore, the patients referred to us for treatment are often elderly and on multiple medications including anti-coagulants. Prior treatment modalities such as vein ligation and stripping required the transient discontinuation of anti-coagulation and the risk benefit ratio of treatment had to be assessed.

This has been corroborated in studies and in our extensive experience. Microstab phlebectomy, when needed as an adjunct treatment, does require transient withholding of anti-coagulation medications.

Fortunately, significant advances in duplex ultrasound and interventional techniques have resulted in minimally invasive treatment for venous insufficiency that are highly effective with very few contraindications. Our cutting-edge endovenous thermal and chemical ablation treatments do not require the discontinuation of anti-coagulation without increasing any significant bleeding risk.

If this is not safe for the patient, the other treatment modalities are always available.

Reference:
Questions & Answers

Elderly patients can benefit from treatment.

Q. I have a male patient, age 80, with visible symptoms (severe skin discoloration, swollen ankles, pain). Is he too old to undergo treatment for venous insufficiency? Will he benefit?

A: While there is no set age cut-off for patients at CVR (we’ve taken care of patients older than 90 years with great outcomes), always first determine if treatment would be in the patient’s best medical interest.

Perhaps more important than a patient’s actual age is their other medical history and other possible co-morbidities (severe heart or lung disease, poorly-controlled diabetes, chronic sedentary lifestyle, dementia, etc.). We weigh in all factors (medical and social) to determine if the patient will derive true clinical benefit from the procedure.

Although we admit to taking extra care and diligence in regards to the treatment of our elderly patients, we pride ourselves on recommending treatment only if it’s medically necessary, if the patient will benefit from the treatment, and above all else—if the procedure is safe and feasible for the patient.

Q. If a patient has very visible varicose veins (thick, ropey, purplish) is it automatically assumed they are a higher risk for DVT?

A: In a word, yes. On the Thrombosis Risk Factor Assessment\(^2\) by Joseph A. Caprini, MD, MS, FACS, RVT, the presence of varicose veins is listed as a condition on the assessment form that increases the risk for post-operative DVT formation. The Caprini model has been validated in a variety of surgical patient types (plastics, general, vascular, and urological).

Dr. Caprini’s model forms the basis of many of the current hospital-based venous thromboembolism prophylaxis protocols for both surgical and non-surgical patients. Superficial venous thrombosis or SVT (“phlebitis”) is often seen in patients with varicose veins.

These thrombosed varicosities are quite painful and can lead a patient to an office or even an Emergency Department visit. Not all SVT’s will progress to a DVT, however in a recent prospective study of 844 patients with SVT > 5cm, 4% had symptomatic PE and ultrasound found proximal DVT in 10%. A distal DVT exam was recommended in these patients with SVT above the knee. Anticoagulation is now recommended in those patients found to have a superficial thrombosis 5cm or more in length and/or a proximity to a deep vein of less than 5cm due to the increased risk for development of a DVT.

Reference:
\(^2\)Thrombosis Risk Assessment as a Guide to Quality Patient Care Joseph A. Caprini, MD.
In September of this year, Center for Vein Restoration was proud to announce its expansion in Virginia with the addition of talented specialist, Dr. Keith Nichols and his team in Virginia Beach and Suffolk, Virginia to the CVR family. This expansion marks another exciting milestone for CVR, which can now bring much-needed services to patients in Virginia with 12 clinics. As the leader of these two new CVR locations, Dr. Nichols’ career commitment is in the treatment of venous insufficiency.

“Venous insufficiency is a condition that affects more than 30 million Americans and we believe that treating this potentially serious problem is a right, not a privilege. That’s why we’re proud to expand our practice to serve more patients than ever and bring them genuine relief”, said CVR President and CEO Sanjiv Lakhanpal, MD.

“CVR is able to bring world-class support services to this new partnership, managing billing, staffing and all the tasks that often take a physician’s focus away from treating patients. Local patients will have access to an expanded suite of advanced treatments for venous insufficiency, and access to a large Patient Services call center offering person-to-person assistance to discuss treatment options, answer insurance questions, and make appointments,” Dr. Lakhanpal said. “This is a perfect example how our practices can be stronger together.”

Keith C. Nichols, MD is quick to tell you that he’s gratified helping to relieve pain and suffering of patients and helping them get back to their normal lives. He’s also thankful to have enjoyed successful careers in two specialties: emergency medicine and venous/lymphatic medicine. As a former emergency physician, he has a knowledge base of many different medical problems and the technical skills necessary to treat venous diseases. As a venous and lymphatic specialist, he also has 13 years’ experience in the diagnosis and treatment of venous diseases.

Dr. Nichols earned his AB Chemistry degree and his Medical degree from the University of North Carolina-Chapel Hill. He served his internship and residency in Emergency Medicine at the University Of Louisville, Kentucky. He later founded and managed the Family Life Services Free Medical Clinic in Martinsville, Virginia, for several years. He also has served as operational medical director for several organizations, including Piedmont Area EMS, Stone Ambulance Service and Martinsville Speedway.

Dr. Nichols served as Staff Physician, Department of Emergency Medicine at the Memorial Hospital of Martinsville and Henry County Virginia, and as Medical Director of the Virginia offices of Circulatory Centers of America (a practice he founded as Genesis Vein Specialists).

He is a member of AOA, American College of Phlebology, American Society for Laser Medicine and Surgery, and the Portsmouth Academy of Medicine. He is also a diplomate of the American Board of Emergency Medicine and of the American Board of Venous and Lymphatic Medicine.

After these rewarding professional milestones, Dr. Nichols is proud to now serve on the team at Center for Vein Restoration, where the physicians have rededicated their careers to bringing relief to patients coping with venous disease. “I like the combination of new minimally invasive technology we use, and the smiles on my patients’ faces when their legs and their lives are changed.”

“I was introduced to venous disease 14 years ago, and I was intrigued by the tremendous scope of the problem and the technical advances that made minimally invasive treatment available. I was also impressed by the millions of people who suffer needlessly with venous disease because they are not aware of the latest treatment options. I saw the problem and knew that I wanted to be a part of the answer.”
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It's been a whirlwind year here at Center for Vein Restoration. We're thrilled to report that our rapid growth has continued, allowing us to serve more patients than ever. In fact, we've recently passed a new milestone, now at 42 clinics strong with the addition of our newest locations in Virginia Beach & Suffolk, Virginia, and Hamilton, New Jersey. We couldn't do it without the support of you, our referring physicians, or without the hard work of our tremendously dedicated staff.

In this edition of Venous Review, we bring you the second part in a series exploring the physiology of venous insufficiency: “Physiology of the venous system and the concept of ambulatory venous hypertension.” We also examine the skin changes associated with vein disease, from spider veins and varicose veins to dermatitis, lipodermatosclerosis, atrophie blanche and ulceration.

Finally, we'd like you to join us at the American College of Phlebology 2015 Annual Congress in Orlando, Florida; you can find us there at Booth 313. In addition to hearing the latest research and practice updates in our rapidly evolving specialty, we'll be using the occasion to network with colleagues from around the country – including highlighting opportunities for physicians, vascular techs and other clinical professionals to join our expanding network of clinics.

Thank you as always for reading Venous Review. We hope you find this information of use to you and your practice.

Yours in good health,