Venous Structural Angulations and their Relationship with Insufficiency

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Abstract: *Objective*: The venous insufficiency of lower limb is a common complaint in the population. The natural history of CVD is not clear enough to satisfy. We have investigated the venous anatomy and reflux existence of the lower limb by using the structural angulations of the venous outlets and related this to the occurrence of venous reflux in the superficial, deep and perforator venous system, demonstrated on CDS.

Methods: We investigate 44 limbs of 22 healthy subjects and 46 limbs of 23 patients with chronic venous disease (CVD). The participants were evaluated with duplex scanning for venous reflux. The CDS examination performed in the upright and supine position. Compression on gray-scale and color Doppler were employed to assess the absence of venous thrombosis.

Result: 45 patients (31 female, 14 male) were examined on doppler ultrasonography. The mean age was 54.5 years (41 to 79 years). All subjects were in normal range of body-mass-index and had no significant disease. We measured the vascular angulations on gray-scale ultrasonography. The measured the angulations of common femoral vein-saphenofemoral junction, saphenofemoral junction-vena saphena magna, common femoral vein-superficial femoral vein, common femoral vein-deep femoral vein and bifurcation of superficial femoral vein-deep femoral vein, respectively. Anatomical structural angulations were measured at 5 levels on sonography.

Conclusion: The CDS is a definitive, economical and noninvasive safe diagnostic method in the diagnosis of CVD. This method appears to suggest a new imaginative approach with the measure of the angulations between venous vessel connections, consequently may predictive further CVD in early periods.

Keywords: Chronic venous disease, doppler ultrasonography, venous angulation.

INTRODUCTION

Venous hypertension and stasis due to valvular incompetence with/without venous outflow obstruction are usually leading chronic venous insufficiency (CVI); the superficial and the deep venous system may both affect. Insufficiency of the saphenous system is the most common cause of CVI. Color Doppler sonography (CDS) is the primary, practical and noninvasive imaging tool in the diagnosis. The user dependent technique requires the knowledge of venous network of normal anatomy and varieties. Blood circulation attends into superficial, deep and perforating veins in the lower extremity venous system [1].

The peak incidence of CVI identify in women aged 40 to 49 years and in men aged 70 to 79 years [2]. The progress on the disease leads poor cosmetic results, pain and heaviness especially after prolonged standing. Lipodermatosclerosis and stasis ulcer usually located in the medial aspect of the legs are the typical skin alterations in the advanced period. CDS is valuable in not only the evaluation of venous valvular incompetence and chronic obstruction, but also selection for intervention and follow-up after treatment; it is also useful during minimally invasive procedures [2,3].

The main superficial veins are the greater and lesser saphenous veins and their tributaries; their traces are at the subcutaneous fatty tissue and plunge into the deep muscular fascia. The communicating veins incorporate the both saphenous veins. The deep veins consort to the arterial system and direct to the muscular fascia. Perforating veins connect superficial and deep venous system. The flow direction is forward from superficial to deep in normal conditions. The main perforating veins are the Hunter in the mid thigh, the Dodd in the lower thigh, the Boyd in the upper calf [1,3].

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Table 1: Anatomical Structural Angulations were Measured at 5 Levels on Sonography

Angulations of vascular junction	Degree	min-max.
Common femoral vein-saphenofemoral	39.3	12.9-68.7
Saphenofemoral junction-vena saphena magna	27.2	2.3-57.4
Common femoral vein-superficial femoral vein	13	4.3-37.1
Common femoral vein-deep femoral vein	13.5	3.4-46.5
Bifurcation of superficial and deep femoral veins	23.6	2.1-41.7

MATERIALS AND METHODS

This study has been carried out on 31 women and 14 men at Giresun University Hospital between January 2013 and November 2013. After having local ethics committee approval with subjects informed consent, we investigate 44 limbs of 22 healthy subjects and 46 limbs of 23 patients with chronic venous disease (CVD). The participants were evaluated with duplex scanning for venous reflux. We exclude subjects with signs or symptoms of CVD and previous thrombosis episodes. All subjects were in normal range of body-mass-index and had no significant disease.

CDS was used for the evaluation of venous valvular incompetence. Single radiologist performed the duplex scanning with variable multi-frequency 4 to 7 MHz bandwidth linear probe (Esaote, MyLab60, Geneva, Italy) and evaluated the scans. The CDS examination performed in the upright and supine position. Compression on gray-scale and color Doppler were employed to assess the absence of venous thrombosis. We measured the vascular angulations on gray-scale ultrasonography. The measured the angulations of common femoral vein-saphenofemoral junction, saphenofemoral junction-vena saphena magna, common femoral vein-superficial femoral vein, common femoral vein-deep femoral vein and bifurcation of superficial femoral vein-deep femoral vein, respectively. The anatomical localization conformation of the saphenopopliteal junction and the perforating veins were extremely variable to measure vascular angulation. The femoropopliteal veins were evaluated for valvular insuffivciency with reflux after Valsalva maneuver and calf compression. The saphenofemoral and saphenopopliteal junctions were examined to identify type of junction, continence, accessory vein and incompetent collaterals. Perforating veins were established at thigh and leg. After Valsalva maneuver, we consider outward reflux flow lasted more than 0.5 ms. Finally, we researched the relationship between vascular angulations and venous insufficiency.

RESULTS

Fourty five patients (31 female, 14 male) were examinated on doppler ultrasonography. The mean age was 54.5 years (41to 79 years). Anatomical structural angulations were measured at 5 levels (Table **1**) on sonography.

The vascular structural angulations (Figure **1**) were compared after the diagnosis of venous insufficiency on patients with Doppler sonography (Table **2**) and there were no statistically significant existence ($p>0.05$). In patients with varying degrees of structural angulations had failure to demonstrate clinically relationship with venous insufficiency.

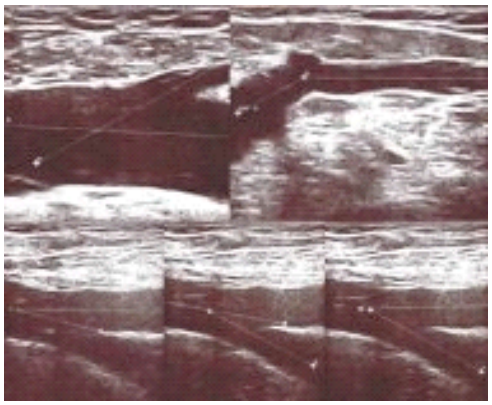

Figure 1: The sonographic angulations of the lower limb venous vessels.

Table 2: Number and Percentage of Patients with Venous Insufficiency

CFVn (%)	SFVn (%)	DFVn (%)	SFJn (%)	VSMn (%)
20 (50%)	13 (32.5%)	1 (2.5%)	22 (55%)	13 (32.5%)

n: patients with insufficiency, CFV: common femoral vein, DFV: deep femoral vein, SFV: superficial femoral vein, SFJ: saphenofemoral junction, VSM: vena saphena magna.

DISCUSSION

The venous insufficiency of lower limb is a common complaint in the population. The natural history of CVD is not clear enough to satisfy. We have investigated the venous anatomy and reflux existence of the lower limb by using the structural angulations of the venous outlets and related this to the occurrence of venous reflux in the superficial, deep and perforator venous system, demonstrated on CDS. The spills of liquids and total volume per time are depending on their duct angulations. We have suggested that increased venous angulations of the venous structural outlets significantly with affected valvular incompetence.

Retrograde flow less than 500 ms is shining lights on CVD in the superficial veins and deep femoral and deep calf veins. Duration of reflux in the various normal veins varies. These alterations may be related to the size, valve location and number, collector veins uniting these vessels and wall compliance. The femoropopliteal veins have the largest diameters in the lower extremity; due to large diameter the closure of the valves may prolonged. The number of the valves and the length of the vessel are the other factors for prolonged reflux [4, 5].

CVD may give rise to edema, pigmentation, pain and ulceration in lower extremity due to reflux [6]. This valvular incompetence exists to venous ulcerations may occur in the superficial, deep and perforating systems [7]. The great saphenous vein and tributaries are the most common affected anatomic sites [8]. The diameter of the greater saphenous vein wider than 7.3 mm (femoral junction), 6mm (midthigh) and 4mm (midcalf) is highly predictive of venous incompetence. The diameter smaller than 5.5, 3 and 2 mm at the same respective levels are shining lights on lack of reflux [1]. The measure of the short saphenous vein diameter less than 5 mm has a potential to predict deep or superficial venous incompetence of the same limb [6]. The diameter of the incompetent perforating veins are larger than competent ones; although preoperative CDS is unable to distinguish incompetent and competent perforating veins less than 3 mm diameter when compared with intraoperative CDS [9]. The elimination of the primary source of reflux, the perforating vein diameter may diminish and the valves may regain competency [10].

Reflux confined to the tributaries alone is frequently observed in the greater saphenous vein distribution; reflux in non-saphenous tributaries is uncommon. Identification of the reflux pattern leads to manage the treatment as such restricted tributaries alone, sparing the main trunk of the saphenous veins [11]. Early prediction may direct the appropriate management on the treatment.

CVD is a complex, important and progressive disease, and as such it requires definitive diagnosis based on objective criteria. The importance of a complete diagnosis that meets the criteria of clinical, etiologic, anatomic, pathophysiologic conditions predict information for understanding of the disease process and selection of specific treatment for individual problems. The CDS is a definitive, economical and noninvasive safe diagnostic method in the diagnosis of CVD [12]. Now that we have this method; we appear to suggest a new imaginative approach with the measure of the angulations between venous vessel connections may predictive further CVD in early periods.

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