Ultrasound Doppler Evaluation of the Pattern of Involvement of Varicose Veins in Indian Patients

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Abstract Doppler evaluation of lower limb veins was performed to evaluate the pattern of involvement of various sites of incompetence in Indian patients with varicose veins. A prospective Doppler study of 100 consecutive limbs in patients who presented with varicose veins to the vascular surgery department of a tertiary care hospital in India. The Clinico-Etiological Anatomical and Pathological (CEAP) classification was applied for assessment. Doppler evaluation of both superficial and deep venous system of the lower limbs was performed. The data of various sites of reflux was analysed to find the patterns of venous involvement in the affected patients. Superficial venous reflux was seen in all the patients. Deep venous reflux was seen in 50% of the lower limbs examined. Doppler is a simple non-invasive test, and is well tolerated by the patients. Deep venous reflux is common in Indian population, though it rarely occurs in isolation, and is usually associated with superficial reflux.

Keywords Varicose veins · Lower limb · Doppler evaluation · Venous reflux

Introduction

Varicose veins cause a great deal of morbidity in our population today [1]. It is a very common problem affecting

approximately 15% of men and 25% of women of general population in Western studies [2]. However, its prevalence in general Indian population is not known.

Different types of surgical and nonsurgical treatment modalities have been developed for the treatment of varicose veins. Good knowledge of the anatomy and the pathophysiology of the varicose veins in each patient is important in planning the appropriate treatment. The pattern of incompetence at the superficial and deep venous junctions, the distribution of the incompetent perforators and the prevalence of deep venous reflux in Indian patients is described.

Patients and Methods

Hundred consecutive limbs in patients who were referred for routine Doppler evaluation of varicose veins, including for preoperative assessment, were studied on Doppler ultrasound over two years. All cases had varicose veins clinically. Patients with superficial thrombophlebitis, deep venous thrombosis and post operative recurrence of varicose veins were excluded.

All examinations were done on ATL Ultramark 9 Doppler machine with 10 MHz linear probe, using ultrasound, color and spectral Doppler. The patients were examined in the standing position while supporting their weight on the contralateral extremity. Entire surface of lower limb was examined. The diseased leg was clinically examined, patients' symptoms were recorded and patients assigned to different CEAP grades (Fig. 1). There were 6 patients with venous disability score of 0, 75 patients with a score of 1, 18 patients with a score of 2 and 1 patient with score 3.

The diameter and cross sectional areas of femoral vessels (common femoral artery and vein) were measured at the

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Fig. 1 Pie diagram representing the CEAP grades, grade 3, 31 patients with grade 4, 8 patients with grade 5 and 25 patients with grade 6 disease

level of SFJ in the groin. Similar measurements of the popliteal vessels were done in the popliteal fossa. Deep venous reflux was looked for at three sites—in the femoral vein in the groin, popliteal vein in popliteal fossa and gastrocnemius vein–popliteal vein junction (GPJ) in the popliteal fossa. Incompetence was also looked for at junctional sites i.e. sapheno–femoral junction (SFJ), sapheno–popliteal junctions (SPJ) and in perforator veins (Fig. 2). Incompetence at these sites was assessed during Valsalva maneuver and using spectral Doppler analysis. Reflux duration of more than 500 msec was considered as significant incompetence. Great saphenous vein diameter was recorded at seven sites in the limb (three in the thigh, three in the leg and one in the foot) and the total calculated. The number and distribution of the incompetent perforators was also recorded.

Results

The patients had different grades of severity of chronic venous disease. There were 19 limbs with CEAP grade 3, 31 with grade 4, 8 with grade 5 and 25 with grade 6 disease. We did not have any patients with grade 1 or 2 disease.

Deep venous reflux was found in 50/100(50%) lower limbs (Table 1); all of these were associated with some form of superficial venous reflux, either junctional or perforator incompetence. Femoral deep venous reflux was found in 44 limbs (44%). Deep venous reflux in popliteal vein was found in a lesser number of limbs (15%). There were 3 isolated cases of popliteal venous reflux without femoral or GPJ reflux. All other cases of popliteal venous reflux were associated with femoral venous reflux and 2 of these with GPJ reflux also. In these cases, popliteal venous reflux was more than femoral venous reflux in 4 cases, less in 5 cases and equal to femoral venous reflux in 3 cases. Reflux at GPJ was found in 10 cases. Out of these, 3 were

isolated with no associated reflux in popliteal or femoral veins and 7 had associated reflux in the femoral veins. Out of these 7 limbs, popliteal venous reflux was also seen in 2 limbs. Out of the 7 limbs with associated femoral deep venous reflux, the duration of reflux was more in the GPJ than in the femoral vein in 3 cases.

Superficial venous reflux in some form was seen in all 100 limbs [100%] at junctional sites (Table 1) (sapheno–femoral or sapheno popliteal junctions) and in the perforators. Saphenofemoral junction was incompetent in 92 limbs (92%). Out of the 8 limbs that did not have saphenofemoral junction incompetence, 4 limbs had isolated perforator incompetence, 1 limb had SPJ and perforator incompetence, SPJ and deep venous reflux in 1 limb, deep venous and perforator incompetence in 1 limb and SPJ, deep venous and perforator incompetence in 1 limb. Saphenopopliteal junction incompetence was found in 14 limbs (14%). 11 of these limbs also had associated saphenofemoral junction incompetence, with SPJ reflux duration exceeding that of SFJ in 7 limbs, equal in 2 limbs and of a lesser duration in 2 limbs. SPJ reflux without SFJ reflux was seen in 3 limbs. Of these, 1 had associated deep venous reflux, 1 limb had perforator incompetence and 1 limb had both deep venous reflux and perforator incompetence.

The lower limb was divided into different areas and the number of perforators in these areas was recorded (Table 2). The maximum number of perforators was found in the medial aspect of leg. Another common area of significant number of perforators was in the posterior aspect of leg in the upper half where an incompetent perforator was identified connecting gastrocnemius vein to the short saphenous vein. Average number of total perforators was 2.5 and average number of medial perforators were 1.8. Isolated perforator incompetence was present in 4 limbs. In one case, there was no junctional or deep venous incompetence, but there was a single isolated large perforator in the popliteal fossa connecting the gastrocnemius vein to an unnamed superficial vein resulting in varicosity of this vein. Abnormally dilated communications between great and short saphenous veins was seen in 5 cases.

The location of saphenopopliteal junction was variable. In most of the cases (66 limbs) it was situated in the popliteal fossa with the short saphenous vein joining the popliteal vein in its lateral or medial or posterior aspect. SFJ was more consistent and normally sited in most cases. In one case, there were two separate SFJs with the anterolateral and posteromedial tributaries of the GSV draining separately into the femoral vein.

In one case there was an abnormal unnamed dilated superficial vein in the popliteal fossa which was due to an abnormal dilated incompetent perforator from the gastrocnemius vein to the dilated superficial vein. This patient did not have junctional or deep venous reflux.

Fig. 2 Doppler image demonstrating significant reflux at sapheno-femoral junction (1313 milliseconds)

In 50 limbs with deep venous reflux in femoral vein, dilated intramuscular (IM) veins were seen in 25 limbs. Out of 50 limbs with no deep venous reflux, 15 had dilated IM veins. We classified the venous reflux into different grades according to the duration of reflux. The relationship between the relative diameters and cross sectional areas of the veins and their corresponding arteries with the duration of reflux in deep veins and that at the saphenofemoral and saphenopopliteal junctions was assessed using Pearson's correlation coefficient. There was statistically significant correlation between the diameter of the superficial veins and the duration of the reflux at the respective junctional sites (Table 3). However, no such correlation was found in the deep venous system (-0.139). The relationship between the clinical severity of the disease (CEAP grade, VCSS, VDS) and the duration of reflux in deep veins, reflux at the saphenofemoral junction and number of perforators was assessed using Pearson's correlation coefficient (for deep venous and junctional reflux) and Spearman's correlation coefficient (for number of perforators) (Tables 4, 5 and 6).

Though deep venous reflux is a very frequent observation in chronic venous disease, there was no statistically significant positive correlation between the duration of deep venous reflux and the clinical severity except for those associated with popliteal venous reflux. Although the clinical severity of chronic venous disease increases with increasing duration of reflux in the junctional sites, it was not statistically significant.

Discussion

Epidemiological studies show that there is a zone of great varicose occurrence (Western Europe, North America); a zone of mild occurrence (Black Africa, the Far East, the Third World in general); and zones showing discrepancies, (South America, the Mediterranean Basin, India)[3]. Although there are many studies on this topic, there are no major studies done in Indian population. The exact prevalence of the disease in general Indian population is

Table 1 Distribution and duration of reflux

	Number of limbs				
	Femoral vein	Popliteal vein	Gastronemius popliteal junction	SFJ	SPJ
Total	44	15	10	92	14
Continuous	5	4	1	39	10
> 3001 msec	5	3	2	13	1
2001–3000 msec	7	4	3	10	2
1001–2000 msec	12	1	1	20	1
< 1000 msec	15	3	3	10	0

Table 2 Distribution of incompetent perforators

Location	Number
Above knee (Dodd's and Hunter's)	9
Below knee medial upper third (Boyd's perforators)	44
Below knee medial mid third (Cocket's)	77
below knee medial lower third (Cocket's)	58
posterior leg upper half	38
posterior leg lower half	3
Lateral leg	19
Anterior leg	0

unknown. However, it is a significant problem affecting a large number of patients and causing long-standing morbidity. A survey to determine the prevalence of varicose veins among railway sweepers in the North and South of India showed that the overall prevalence was 25.08% in South Indian sweepers and 6.8% among North Indian sweepers. The survey included 323 men from Madras in the South and 354 men from Ajmer in the North of India [4].

Although most acute venous problems are concerned with obstruction by thrombosis, most chronic venous problems are caused by reflux. Reflux is defined as retrograde flow of blood in the veins caused by absent or incompetent valves. The failure of check valves in the perforating veins, in particular, allows high pressures (upto 250 mmHg) generated in the deep veins by muscular contraction to be transmitted directly to the unsupported superficial veins.

Table 3 Correlation between relative venous size and duration of venous reflux

Variables	Pearsons correlation coefficient	Significance
Femoral venous reflux and ratio of femoral vein and artery diameter	-0.119	0.239
Femoral venous reflux and ratio of femoral vein and artery cross sectional area	-0.139	0.169
Popliteal venous reflux and ratio of popliteal vein and artery diameter	0.066	0.517
Popliteal venous reflux and ratio of popliteal vein and artery cross sectional area	0.037	0.715
Saphenofemoral junction reflux and diameter	0.104	0.302
SFJ reflux and diameter of GSV in thigh	0.445	0.000*
SFJ reflux and sum of diameter of GSV at 7 sites in limb	0.447	0.000*
SPJ reflux and diameter	0.759	0.000*
SPJ reflux and diameter of SSV	0.706	0.000*

Table 4 Correlation between venous reflux and size with CEAP grading

Correlation of CEAP grading with	Correlation coefficient	Significance
Femoral vein reflux	0.192	0.056
Popliteal vein reflux	0.368	0.000*
SFJ reflux	0.054	0.595
GSV diameter in thigh	0.131	0.193
Sum of GSV diameter at 7 sites in limb	0.125	0.215
Total number of incompetent perforators	0.010	0.923
Number of incompetent medial calf perforators	0.122	0.229

The resultant venous hypertension is associated with skin pigmentation, lipodermatosclerosis and ulceration.

Of the various diagnostic tests for detection and assessment of venous reflux, recently, color flow Doppler scanning is considered the gold standard for non-invasive anatomical and functional assessment of venous reflux [5]. We have studied all our patients with 2D ultrasound, color and spectral Doppler. Although, there are different methods described to elicit and measure the venous reflux, we used the Valsalva maneuver because of ease of performance [6, 7].

Varicose veins are classically described to be commoner in females [2] and this has been attributed to hormonal factors [8]. We had a larger number of male patients (55 males and 22 females). This could be due to lesser number of affected Indian women seeking medical help. The Edinburgh vein study also quotes a higher prevalence of varicose veins in women [9].

There were also a higher number of left sided limbs (59 limbs) affected than the right (41 limbs). We speculate

Table 5 Correlation between venous reflux and size with Venous clinical severity scoring

Correlation of VCSS with	Correlation coefficient	Significance
Femoral vein reflux	0.171	0.088
Popliteal vein reflux	0.359	0.000*
SFJ reflux	0.077	0.447
GSV diameter in thigh	0.126	0.210
Sum of GSV diameter at 7 sites in limb	0.095	0.346
Total number of incompetent perforators	0.190	0.059*
Number of incompetent medial calf perforators	0.266	0.008*

Table 6 Correlation between venous reflux and size with Venous disability scoring

Correlation of VDS with	Correlation coefficient	Significance
Femoral vein reflux	0.155	0.124
Popliteal vein reflux	0.253	0.011*
SFJ reflux	0.118	0.244
GSV diameter in thigh	0.074	0.466
Sum of GSV diameter at 7 sites in limb	0.083	0.414
Total number of incompetent perforators	0.266	0.007*
Number of incompetent medial calf perforators	0.235	0.019*

whether this could be related to the left iliac artery crossing the left iliac vein. However, other studies in literature show equal involvement of right and left lower limbs [10].

We found deep venous reflux in 50% of cases. All these cases had associated superficial venous reflux at the junctional sites or in the perforators. In literature, a variable percentage of deep venous reflux has been quoted ranging from 35.3% in limbs with primary chronic venous insufficiency and in 92.3% of the limbs with post-thrombotic chronic venous insufficiency of limbs with venous ulcer, and 55% in another series of patients with venous ulcer [11–13].

Incompetent perforator veins were seen in the majority of cases (96%). Isolated incompetent perforator veins were present in 4 limbs (4%). Most of the perforators were found in the medial aspect of the leg as described in literature. However, we found another common site in the upper half of posterior leg between the gastrocnemius vein and the short saphenous vein. Average number of incompetent perforators was 2 to 3.

Sapheno-popliteal junction incompetence was seen in 14% of cases. The classical clinical teaching is that, in saphenopopliteal junction incompetence, dilated superficial veins are seen in lateral aspect of leg. But, we found that in 5 of the 14 limbs that had SPJ incompetence, the short saphenous vein decompressed into the great saphenous vein via dilated communicating veins and short saphenous vein beyond these communicating veins was not dilated. In these cases, SPJ incompetence could be clinically missed and could be a cause for post operative recurrence.

There was no statistically significant correlation between the relative size of the deep veins compared to the corresponding arteries and the amount of reflux or dilated intramuscular calf veins and the deep venous reflux. This indicates that the dilatation of the deep venous system

could be associated with certain other factors, not necessarily due to the reflux. The reflux circuit theory of venous overload suggests that deep veins can be dilated due to increased re-entering blood flow into the deep venous system due to superficial venous incompetence [14].

Statistically significant correlation was found between the diameter of great saphenous and short saphenous veins and duration of reflux at SFJ and SPJ respectively. Though junctional reflux was found in most of the cases of varicose veins, there was no statistically significant correlation between the duration of junctional venous reflux and clinical severity of chronic venous disease. However, significant correlation was observed between the clinical severity of disease and number of incompetent perforators. Similar results were seen in other studies [15, 16].

Most of the anatomical variations were seen in the popliteal fossa region at the drainage site of SSV. Anatomical variations were seen in 36% of cases including variable drainage of SSV in 34%, two sapheno-femoral junctions (also had 2 GSV) 1% and an unnamed perforator with dilated unnamed superficial vein the popliteal fossa 1%.

Dilated deep veins in the calf muscles was a common finding in general, it was 1 ½ times more frequently seen in association with deep venous reflux. This may be due to more stasis of the blood in calf veins in affected limbs with reflux. However, this particular finding has not been mentioned in the literature, though it is a frequently observed finding.

In conclusion, patients with varicose veins and chronic venous disease, have varying degrees of deep, superficial, and perforator valvular incompetence; combined multiple site incompetence being the commonest pattern. Color Doppler is very useful in identifying the distribution and extent of reflux in these patients for complete diagnosis as well as preoperative mapping of incompetent sites so that the surgery is targeted at the sites of incompetence. There is high prevalence of deep venous reflux and surgeries targeted to this site also need to be developed.

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