

# Assessment of Relationship between Saphenofemoral Junction Reflux and Great Saphenous Vein Diameter using Doppler Ultrasonography in Patients with Chronic Venous Disease: A Cross-sectional Study

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## ABSTRACT

**Introduction:** Chronic venous disease is a commonly occurring disease that includes a variety of pathological conditions like varicose veins, oedema, skin abnormalities, and ulceration, among which the most prevalent are the varicose veins. Doppler imaging is presently the first investigation for evaluating chronic venous disease.

**Aim:** To investigate the relationship between Saphenofemoral Junction (SFJ) reflux and Great Saphenous Vein (GSV) diameter in patients with chronic venous disease and to determine the best cut-off value of GSV diameter in predicting reflux.

**Materials and Methods:** The present cross-sectional study was conducted in the Department of Radiology, SRM Medical College and Hospital, Tamil Nadu, India, from December 2019 to June 2021 on 76 patients with chronic venous disease. The study was conducted on a GE Logic P9 ultrasound machine, the diameter of GSV was measured close to the SFJ, at the Proximal Thigh (PT); 15 cm distal to the SFJ, and at the calf. The diameter of the GSV was compared with the presence of SFJ reflux. Similarly, Short Saphenous Vein (SSV) diameter was also measured posterior to the knee and was correlated with Saphenopopliteal

Junction (SPJ) reflux. Chi-square and student t-tests were used for analysis with a cut-off value determined through Receiver Operating Characteristic (ROC) curve analysis.

**Results:** The mean age of study participants was 51±15.85 years with age range of 19-78 years. Of total, 42 (55.26%) had chronic venous insufficiency on the left side and 34 (44.74%) had on the right side. The mean GSV diameter at SFJ and at PT was higher in patients with SFJ incompetence and was statistically significant with a p-value of 0.001 and 0.002, respectively by t-test. Although the mean GSV diameter at calf was higher in patients with SFJ incompetence, it was statistically insignificant. The GSV diameter at the SFJ had the best cut-off value for predicting incompetence, with a mean diameter of 5.95 mm with 76.3% sensitivity and 76.3% specificity. The cut-off of SSV at the posterior knee for predicting SPJ incompetence was 4.6 mm which had a sensitivity of 72.7% and specificity of 88.7% and diagnostic accuracy of 86.84%.

**Conclusion:** The GSV diameter at SFJ and PT help in predicting SFJ incompetence. The SSV diameter at SPJ aids in predicting SPJ incompetence.

**Keywords:** Diagnostic imaging, Oedema, Phlebitis, Varicose veins

## INTRODUCTION

Chronic venous disease includes a spectrum of pathological conditions like varicose veins, skin changes, oedema, and ulceration among which, the most prevalent is the varicose veins. They are nothing but dilated, convoluted and twisted veins [1]. Varicose veins tend to affect between 5% and 30% percent of the adult population, but reports have ranged from less than 1% to more than 70% [1]. Framingham's study estimated the incidence of the development of varicose veins and recorded an annual incidence of 1.9% in men and 2.6% in women [2]. The varicose disease is the most frequently encountered lower limb vein disease and affects 33% of the general population [3]. Age, female sex, obesity, positional factors and familial history are identified as major risk factors [3]. Duplex imaging has been the priority for evaluating varicosities to establish the diagnosis as well as predict the aetiology and anatomy [1-3]. Duplex scanning uses 'B mode and colour flow imaging' to determine whether there is a thrombus and for measuring the venous diameter and pulsed doppler is used to assess the reflux time [4-7]. The increase in the

diameter of the Great Saphenous Vein (GSV) is a classical finding in patients with Saphenofemoral Junction (SFJ) incompetence [7].

The majority of the patients are subjected to duplex scans, to examine the superficial, deep as well as perforating veins and to categorise them for the treatment of varicosities [4]. Chronic venous disease patients with SFJ or Saphenopopliteal Junction (SPJ) incompetence may be considered for surgery, duplex-guided sclerotherapy, or an endovenous treatment. Patients with only saphenous vein tributary incompetence can be treated by phlebectomy or sclerotherapy. Varices will return sooner if all venous filling sources are not identified correctly and treated adequately [8-11]. Due to SFJ incompetence, reflux can occur in the GSV and there is an increased diameter of GSV that is affected by reflux [12-15]. The GSV diameter in the presence of reflux has been the subject of numerous studies. Currently, there are very few studies with proper diagnostic validity of GSV diameter in predicting SFJ reflux [8-10]. However, most of these studies were outside India, hence this study was done to assess and validate the GSV diameter for predicting SFJ reflux for the Indian population.

## MATERIALS AND METHODS

A cross-sectional study was conducted in the Department of Radiology, SRM Medical College Hospital and Research Centre, Kattankulathur, Chengalpattu, Tamil Nadu, India, from December 2019 to June 2021. Institutional Ethical Committee approval was obtained (1801/IEC/2019) before the start of the study. Informed written consent was obtained from each participant.

**Inclusion criteria:** All chronic venous disease patients presenting with varicose veins, leg oedema, leg ulcers, leg pain and phlebitis were included in the study.

**Exclusion criteria:** Patients presenting with deep vein thrombosis, lymphoedema, partially recanalised veins following deep vein thrombosis treatment, and patients with a history of varicose vein surgery were excluded from the study.

**Sample size calculation:** Consecutive sampling of patients with chronic venous disease presenting to Radiology Department for doppler ultrasound during the study period till the sample size was reached was practiced. The sample size was calculated using the formula,  $N = Z_{1-\alpha/2}^2 \cdot \sigma^2/d^2$ .  $N = 1.96^2 \cdot 6.9^2/0.0155^2 = 76$ . 'σ' is the standard deviation of SFJ incompetence which is 6.9 mm, 'd' is precision which is 1.55 mm, at 95% confidence interval ( $Z_{1-\alpha/2}/2 = 1.96$ ) [16]. Thus, the total sample size required for the study was 76.

### Study Procedure

Doppler ultrasound was done using GE LOGIQ P9 machine with a linear transducer probe of frequency 3-10 MHz. Clinical proforma with details of the patients regarding their demography, clinical signs, and symptoms were documented. The anteroposterior dimension of GSV diameter was measured at the SFJ, 15 cm distal to SFJ in the PT, and at the calf. SSV was measured posterior to the knee, at the level of SPJ. The largest diameter of the great and Short Saphenous Vein (SSV) in the supine and standing positions was considered. Venous reflux was assessed at SFJ and SPJ. Reflux was assessed in both supine and standing position. Reflux was considered to be present if the valve closure time was more than 0.5 seconds [8]. Perforators if present were recorded and their incompetence was assessed. If more than 3 mm with the presence of reflux for more than 0.5 seconds on doppler was present, perforators were termed incompetent. Similarly, deep venous reflux also was assessed by checking reflux in deep veins. If the reflux lasts for more than 0.5 seconds on the doppler, then reflux was deemed to be present.

## STATISTICAL ANALYSIS

Data were entered in Microsoft (MS) excel sheet, analysed using Statistical Package for the Social Sciences (SPSS) software version 21.0. When a 'continuous variable' is associated with "categorical variable", the variables were represented by mean ( $\pm$ standard deviation) in tables and the significance of the difference between the means was tested by Student's t-test. If the distribution of the variable is not normal, then non parametric tests were used for testing the significance. The cut-off value of the screening test for predicting the outcome variable was determined using the Receiver Operating Characteristic (ROC) curve. The p-value less than 0.05 was considered statistically significant.

## RESULTS

Total 76 participants were included in the study with a mean age of  $51 \pm 15.85$  years ranging from 19-78 years. Among the study group, 42 (55.26%) had chronic venous insufficiency on the left side and 34 (44.74%) had on the right side [Table/Fig-1]. They had a mean incompetent perforator of  $1.49 (\pm 0.5)$  ranging from 1 to 2 in number. Among the study population, 45 (59.21%) were males and 31 (40.79%) were females [Table/Fig-1].

The study population had a mean GSV diameter at SFJ of  $6.7$  mm ( $\pm 3.07$ ), at the PT of  $5.42$  mm ( $\pm 2.66$ ), and at the calf of  $3.29$  mm ( $\pm 1.48$ ). The mean GSV diameter at SFJ among those with SFJ

Variables	Frequency (n)	Percentage (%)
<b>Age group (years)</b>		
≤40	19	25
41-50	16	21.05
51-60	20	26.32
>60	21	27.63
<b>Symptoms</b>		
Oedema	22	28.95
Pain	23	30.26
Pigmentation	3	3.95
Spider veins (Dilated superficial veins)	5	6.58
Ulcer	10	13.16
Varicosities	13	17.11
<b>Leg side</b>		
Right	34	44.74
Left	42	55.26
<b>Deep venous reflux</b>		
Yes	3	3.95
No	73	96.05
<b>Perforators</b>		
Yes	50	65.79
No	26	34.21
<b>Sex</b>		
Males	45	59.21
Females	31	40.79

**[Table/Fig-1]:** Age, symptoms, side distribution along with the presence of deep venous reflux and presence of perforators.

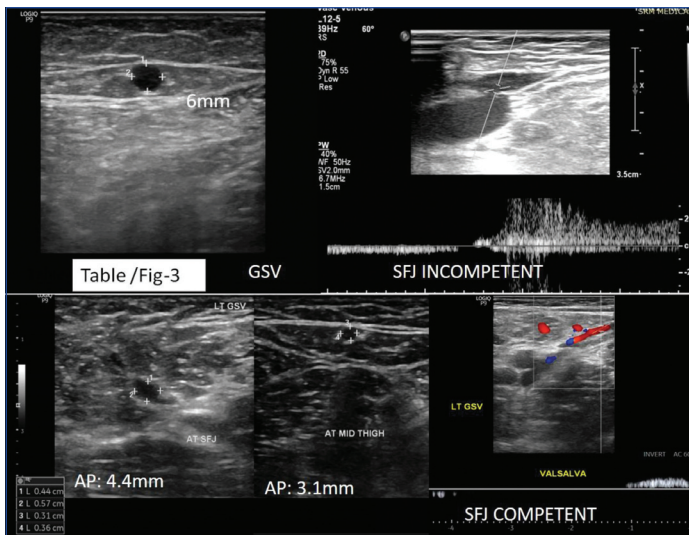
incompetence was  $8.09$  mm ( $\pm 3.25$ ) which was higher than mean GSV diameter at SFJ among those without SFJ incompetence which was  $5.31$  mm ( $\pm 2.12$ ) and the difference was statistically significant with a p-value of  $0.001$  [Table/Fig-2,3]. The mean GSV diameter at calf among those with SFJ Incompetence was  $3.56$  mm ( $\pm 1.32$ ) and among those without SFJ Incompetence was  $3.21$  mm ( $\pm 1.53$ ) and the difference was not statistically significant [Table/Fig-2]. Since, it was statistically insignificant, the area under the curve was not calculated.

Parameters	SFJ incompetence	n	Mean $\pm$ SD	p-value (t-test)
GSV diameter at SFJ	Yes	38	8.09 $\pm$ 3.25	<b>0.001</b>
	No	38	5.31 $\pm$ 2.12	
GSV diameter at PT	Yes	38	6.34 $\pm$ 2.84	<b>0.002</b>
	No	38	4.50 $\pm$ 2.13	
GSV diameter at calf	Yes	38	3.56 $\pm$ 1.32	0.285

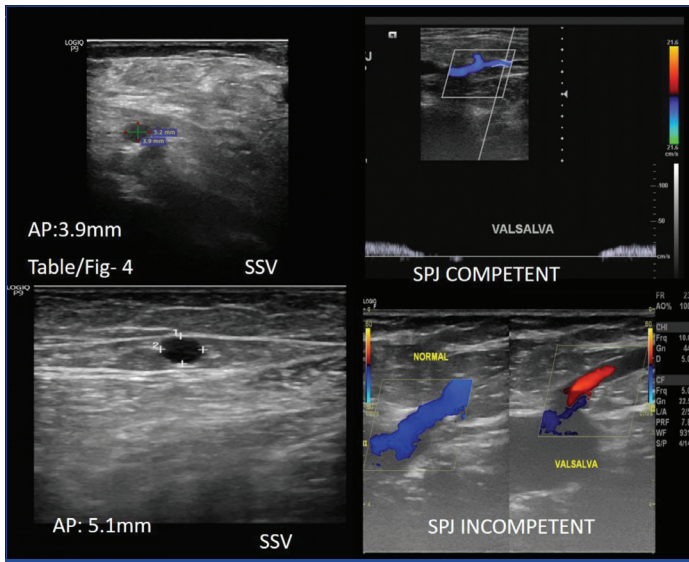
**[Table/Fig-2]:** Relationship between GSV diameter at various levels with SFJ incompetence. p-value in bold font represents statistically significant value

The mean SSV diameter at posterior to knee among those with SPJ incompetence was  $5.51$  mm ( $\pm 2.40$ ) which was higher than the mean SSV diameter at posterior to knee among those without SPJ incompetence which was  $5.51$  mm ( $\pm 2.40$ ) and the difference was statistically significant with p-value of  $0.001$  [Table/Fig-4,5].

The cut-off value of GSV at SFJ for predicting SFJ incompetence was  $5.95$  mm which had a sensitivity of  $76.3\%$  and specificity of  $76.3\%$  and diagnostic accuracy of  $76.32\%$  with area under curve of  $0.812$ . The cut-off of GSV at PT for predicting SFJ incompetence was  $4.75$  mm which had a sensitivity of  $68.4\%$  and specificity of  $63.2\%$  and diagnostic accuracy of  $67.9\%$  with area under curve of  $0.735$ . The cut-off of SSV at posterior knee for predicting SPJ incompetence was  $4.6$  mm which had a sensitivity of  $72.7\%$  and specificity of  $88.7\%$  and diagnostic accuracy of  $86.84\%$  with area under curve of  $0.866$  [Table/Fig-6].



**[Table/Fig-3]:** Ultrasound doppler image showing increased diameter of great saphenous vein at saphenofemoral junction measuring 6 mm in a patient with saphenofemoral junction reflux and reduced diameter of great saphenous vein at saphenofemoral junction measuring 4.4 mm at SFJ and 3.1 mm in the Proximal Thigh (PT) in a patient without saphenofemoral junction reflux.



**[Table/Fig-4]:** Ultrasound doppler image showing reduced diameter of great saphenous vein at posterior knee measuring 3.9 mm in a patient without Saphenopopliteal Junction (SPJ) reflux and increased diameter of Short Saphenous Vein (SSV) measuring 5.1 mm at posterior knee in a patient with saphenopopliteal junction reflux.

Parameter	SPJ Incompetence	n	Mean±SD	p-value (t-test)
SSV diameter at posterior to knee	Yes	11	5.51±2.40	0.001
	No	65	3.10±1.31	

**[Table/Fig-5]:** Relationship between SSV diameter at posterior knee with SPJ incompetence.

Variables	Cut-off value	Sensitivity	Area under the curve	95% Confidence interval		p-value (t-test)
				Lower bound	Upper bound	
GSV diameter at SFJ	5.95 mm	76.3%	0.812	0.715	0.908	0.001
GSV diameter at PT	4.75 mm	68.4%	0.735	0.624	0.847	0.001
SSV diameter posterior to knee	4.6 mm	72.7%	0.866	0.764	0.968	0.001

**[Table/Fig-6]:** Area under the curve to estimate cut-off value.

**DISCUSSION**

Varicose veins occur in superficial veins of lower limbs, most commonly in GSV, and sometimes in the SSV. Of the varicose

veins involving GSV, SFJ incompetence was the usual main anatomical and pathological factor. This will cause reflux in the column of blood into GSV, and the size of GSV gradually increases. Similarly, SPJ incompetence results in an increased size of SSV [8-10]. The study group had a mean age of 51 (±15.85) years ranging from 19-78 years with a higher proportion of more than 60 years age group. Joh JH and Park HC also showed a similar mean age of 54.5 (±14.5) years ranging from 17-93 years and Karmacharya R et al., had 49.19 (±15.58) years ranging from 22-80 years [15,16]. Among the population, 60% were males and 40% were females. The study by Karmacharya RM et al., also showed similarly 57% males and 43% females [16]. But studies by Joh JH and Park HC and Kim MJ et al., showed higher proportion of female patients which may be due to their selection bias [15,17].

Among the study population with symptoms distribution, 30.26% had pain followed by 27.63% had oedema and 1.32% had swelling. Kim MJ et al., also reported pain and oedema as the most common symptoms along with heaviness and tiredness [17].

The cut-off of GSV at SFJ for predicting SFJ incompetence was 5.95 mm which had 76.3% sensitivity and 76.3% specificity. Joh JH and Park HC showed that a cut-off of 5.05 mm of GSV diameter at 5 cm close to SFJ predicts venous reflux with a sensitivity of 75% and specificity of 40% [15]. Engelhorn C et al., showed a slightly higher cut-off of 7 mm of GSV diameter at SFJ in predicting venous reflux with a positive predictive value of 73% [18]. This may be because of the different study populations and the study was old.

The cut-off value of GSV at PT for predicting SFJ incompetence was 4.75 mm which had 68.4% sensitivity and 63.2% specificity. Karmacharya RM et al., showed that a cut-off of 4.95 mm of GSV diameter at the level of the thigh predicts venous reflux with a sensitivity of 82% and specificity of 83%. The Area Under Curve (AUC) for GSV diameter in ROC was 0.898 [16]. Kim MJ et al., showed that AUC for GSV diameter at the thigh in predicting venous reflux is 0.642 with 5 mm as a best cut-off [17]. Navarro TP et al., showed that cut-off of 5.5 mm GSV diameter at PT predicts venous reflux with sensitivity of 78% and specificity of 87% with a diagnostic accuracy of 82% [13]. All these three studies were similar to the present study with less than 0.8 mm difference.

The cut-off of SSV at posterior knee for predicting SPJ Incompetence was 4.6 mm which had a 72.7% sensitivity and 88.7% specificity. Joh JH and Park HC showed that a cut-off of 3.55 mm of SSV diameter at 5 cm distal to SPJ predicts venous reflux in SSV with sensitivity of 87% and specificity of 30% [15].

Even though there are slight variations in the cut-off value between various studies, they may be attributed to the statistical variation depending upon the sample population.

**Limitation(s)**

The sample size may be small so that there can be slight variation in the cut-off values of GSV determined. The sample population was selected from hospital cases which could have led to some selection bias.

**CONCLUSION(S)**

Many patients with chronic venous insufficiency present with venous reflux. GSV and SSV diameter has a significant association with the development of venous reflux. The GSV diameter at SFJ and PT helps in predicting the SFJ incompetence. The SSV diameter at SPJ aids in predicting the SPJ incompetence.

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