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## **Diameter reflux relationship in perforating veins of patients with varicose veins and its correlation with clinical severity of disease**

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**Abstract**--Treatment of chronic venous insufficiency requires understanding of the hemodynamics of perforating veins. Color Doppler analysis is the best modality to understand the hemodynamics of perforators. Perforating veins were categorized as competent or incompetent depending on the duration of reflux. Perforating veins in which duration of reflux was more than 0.5 seconds were categorized as incompetent perforating veins and perforating veins with reflux less than 0.5 seconds were categorized as competent perforating veins. The average diameter of incompetent perforators was increasing with increasing severity of disease. The number of incompetent perforator per limb also increased with

worsening of disease severity and it was significantly higher in CEAP classes 4–6 compared to CEAP classes from 1 to 3 ( $p < 0.05$ ). The average diameter of incompetent perforator in the present study was 3.8mm.

**Keywords**---Varicose Veins, Perforators, Color Doppler, Incompetent Perforators.

## Introduction

Varicose veins are defined as dilated, tortuous, subcutaneous veins  $\geq 3$ mm in diameter measured in the upright position with demonstrable reflux.<sup>1</sup> Varicose veins do not threaten life and are seldom disabling, but it causes a considerable demand on medical care.<sup>2</sup> Pathogenesis of varicose veins may lie in superficial vein, perforators or deep veins. The main principles of surgical treatment are to ligate the source of the venous reflux (usually the SFJ, SPJ or perforators) and to remove the incompetent saphenous trunks and the associated varices. Perforating veins take blood from superficial venous system, pass through muscle and fascia, and deliver to deep venous system of lower extremity.<sup>3</sup> Pathologic perforator veins are described as having reversed flow from deep system to superficial veins for more than 500 milliseconds.<sup>4</sup> Risk factors for incompetent perforator veins are same as for all chronic superficial venous disease including history of DVT, multiple pregnancies, advanced age and genetic factors. Incompetent perforator veins have been linked to chronic venous insufficiency including recurrence of superficial venous reflux after treatment, varicose veins and ulcer development. Ligation of perforating veins has been questioned.<sup>5, 6</sup> In the treatment of varicose veins, aesthetic and functional considerations may be conflicting. Risk of an unacceptable aesthetic result is diminished when perforating vein ligation or stripping is avoided or limited. In contrast, presence of insufficient perforating veins increases the risk of varicose vein recurrence. Treatment for incompetent perforator includes compression therapy, *Ultrasound guided sclerotherapy*, *subfascial* ligation of perforating veins, subfascial endoscopic perforator surgery, thermal ablation, radiofrequency ablation and endovenous laser ablation.<sup>7</sup> This study underlines the importance of perforating veins and correlates its size with clinical severity of disease.

## Material and Methods

This study was conducted in Department of general surgery, Pt. B.D Sharma Post Graduate Institute of Medical Science, Rohtak. A total of 50 patients with varicose veins were enrolled between June 2018 and September 2020. The clinical severity of the disease was recorded as per clinical grading of CEAP classification as recommended by society for vascular surgery. Diagnosis of varicose veins was established by clinical examination and further confirmed by Color Doppler analysis. All the patients underwent color Doppler examination. Patency of deep veins were checked, competency of SFJ, SPJ and perforator veins were also checked. All the perforating veins were evaluated with their location and size. Perforating veins were categorized as competent or incompetent depending on the duration of reflux. Perforating veins in which duration of reflux was more than 0.5

seconds were categorized as incompetent perforating veins and perforating veins with reflux less than 0.5 seconds were categorized as competent perforating veins. The number and size of perforating veins was correlated with clinical severity of disease (CEAP classes) and statistical analysis was done.

## Results

A total of 50 patients were included in the study. Male-female ratio was 2.3:1. The mean age of the patients was 44.46 years. Right lower limb was involved in 13 (26%) patients and left lower limb was involved in 37 (74%) patients. Dilated vein was the commonest presenting symptom in all 50 patients (100%). Pain and discomfort were present in twenty-one patients (42%), twelve patients had swelling over limbs (24%), twenty-five patients had skin changes over the ankle region (50%), while nine patients (18%) presented with venous ulcer over the leg. We measured the clinical severity of disease according to CEAP classification. Disease severity ranged from C1 to C6 in our study group. Four patients (8%) presented with C1 severity, Seventeen patients (34%) presented with C2 severity, four patients (8%) presented with C3 severity, sixteen patients (32%) had C4 severity, six patients (12%) presented with C5 severity while three patients (6%) presented with C6 severity of disease. Color Doppler was done in all the patients. Saphenofemoral junction (SFJ) was found to be incompetent in 47 patients (94%), Saphenopopliteal junction (SPJ) was found to be incompetent in 5 patients (10%) and Perforator incompetence was seen in 48 patients (96%). Deep veins were found to be normal in all 50 patients. In our study we found that majority of perforators were incompetent in C4(41.6%) , C5(56.8%) and C6 (72.2%) disease as compared to C1(12.5%), C2 (26.4%) and C3 disease (23%)[Table no.01].

Table No-01: Number Of Competent And Incompetent Perforators With Ceap Classes

CEAP classes	Number of limbs	Total no of perforators	Total number of competent perforators(refl ux<0.5seconds)	Total number of incompetent perforators(refl ux>0.5sec)	Percentages of incompetent perforators
1	4	16	14	2	12.5%
2	17	106	78	28	26.4%
3	4	30	23	7	23%
4	16	125	73	52	41.6%
5	6	51	22	29	56.8%
6	3	36	10	26	72.2%
Total	50	364	220	144	

In our study we found that majority of incompetent perforators were present on medial side of calf [(67/144); 46.8%]. In lateral and posterior aspect of calf, 60(40.4%) incompetent perforators were found, in ankle 12 (9%) incompetent perforators were found and in thigh 5 incompetent perforators were present. In our study we found that as disease progresses (CEAP classes) number of perforators per limb detected by color doppler was more proving a significant positive correlation (correlation coefficient of 0.95). The number of incompetent

perforators per limb also increased with worsening of disease severity (correlation coefficient of 0.85) and it was significantly higher in CEAP classes 4–6 compared to CEAP classes from 1 to 3.

In our study we found that 4.1% of perforators with diameter in range of 2.1 to 3mm were incompetent, 38.5% of perforators with diameter in range of 3.1 to 4mm were incompetent and 98.2% of perforators with diameter in between 4.1mm to 5mm and all perforators with diameter more than 5mm were incompetent. In our study majority of perforators with diameter more than 4 mm were incompetent. In our study we found that average diameter of perforators with reflux more than 0.5 seconds (incompetent perforators) was 3.9 mm. Minimum diameter of incompetent perforators was 2.8 mm and maximum diameter of incompetent perforator was 5.2 mm. Receiver operating characteristic (ROC) curve was applied on this data to get the cutoff diameter of incompetent perforators.

Table No-02: Area Under The Curve

Area Under the Curve	Cut Off Value	P value	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.930	3.8	.001	.811	1.000

ROC curve was applied over diameter of all incompetent perforators (reflux >0.5 seconds) and it was found that best cutoff diameter for predicting perforator vein incompetence was 3.8 mm with sensitivity of >94% and specificity of >93%.

Table No-03: Average Diameter Of Incompetent Perforators And Clinical Severity Of Disease (Ceap Class)

CEAP classes	Total number of incompetent perforators	Average diameter of Incompetent perforators in mm	Correlation coefficient = 0.89
1	2	2.85	
2	28	3.72	
3	7	3.8	
4	52	3.9	
5	29	4.13	
6	26	4.24	

Our study shows that as the severity of disease progresses the average diameters of incompetent perforators also increases with a significant positive correlation coefficient (0.89) and it was significantly higher in CEAP classes 4 to 6 compared to CEAP classes from 1 to 3 (<0.05). For CEAP 1, the average diameter of incompetent perforators was 2.85 mm, for CEAP 2, the average diameter of incompetent perforators was 3.72 mm, for CEAP 3, the average diameter of incompetent perforators was 3.8 mm, for CEAP 4, the average diameter of incompetent perforators was 3.9 mm, for CEAP 5, the average diameter of

incompetent perforators was 4.13 mm, for CEAP 6, the average diameter of incompetent perforators was 4.24 mm.

## Discussion

The hemodynamic significance of perforator vein incompetence has been a subject of debate. Some studies reported that incompetent perforator veins have no role in development of venous insufficiency.<sup>8-10</sup> Whereas some studies suggested that it has important role in developing chronic venous insufficiency.<sup>11-14</sup> In contrast, presence of incompetent perforating veins increases the risk of varicose vein recurrence, particularly when the saphenous vein is preserved.<sup>15</sup> Role of perforator incompetence is one of the less explored areas in field of varicose vein surgery. The present study underlines the importance of perforator incompetence and its correlations with clinical severity of disease.

In our study total 364 perforators were found, among which 220 were having reflux less than 0.5 seconds and 144 were having reflux more than 0.5 seconds (incompetent perforators). Maximum number of incompetent perforators(74.3%) were found in CEAP 4, CEAP5 and CEAP 6 classes as compared with CEAP 1, 2 & 3 (25.7 %). Our findings were similar to study done by Prasad V.<sup>16</sup> He reported that eighteen out of 74 (23%) patients with CEAP classes 1 and 2, and 56(62%) out of 90 patients with CEAP class 3-6 had incompetent perforators. Study done by Labropoulos et al found similar results in their study. They reported that number of incompetent perforators were significantly higher in CEAP classes 4-6 compared to any CEAP classes from 1 to 3 ( $p < 0.0001$ ).<sup>17</sup> Study done by Delis et al found that 66% of incompetent perforators were found in CEAP class 4-6 as compared to CEAP Class 1-3.<sup>18</sup>

In present study we found that as the severity of disease progresses (CEAP) number of perforators per limb increases. In CEAP 1 number of perforators were 4 per limb, in CEAP 2 number of perforators were 6.23 per limb, in CEAP 3 number of perforators were 7.5 per limb, in CEAP 4 number of perforators were 7.8 per limb, in CEAP 5 number of perforators were 8.5 per limb and in CEAP 6 number of perforators were 12 per limb. Our results were consistent with results of various studies documented in literature. Study done by Labropoulos et al found that number of perforators per limb increases with worsening of disease severity.<sup>17</sup> Study done by Delis et al reported that prevalence of perforators increases with increase in clinical severity of disease.<sup>18</sup> Study done by Sandri et al also established that number of perforators per limb increases with worsening of disease severity.<sup>15</sup> Study done by Krnic et al reported that number of perforators increases as the CEAP grade increases.<sup>19</sup>

In our study we found that the average diameter of incompetent perforators increases as the clinical severity of disease (CEAP) increases and it was significantly higher in CEAP classes 4 to 6 compared to CEAP classes from 1 to 3. For CEAP 1 the average diameter of incompetent perforators was 2.85 mm, for CEAP 2 the average diameter of incompetent perforators was 3.72 mm, for CEAP 3 it was 3.8 mm, for CEAP 4 it was 3.9 mm, for CEAP 5 it was 4.13mm and for CEAP 6 it was 4.24mm. Study done by Prasad V found that average diameter of perforators was more in class 3-6 patients (3.45mm) when compared to class 1

and 2 patients (1.44mm).<sup>16</sup> Study done by Labropoulos et al found that diameter of both competent and incompetent perforator veins increases with increasing severity of disease (CEAP Classes)<sup>17</sup>. Sandri et al found that average diameter of perforators in CEAP 2 was 2.6 mm and in patients with healed and active ulcer, diameter was 4.5 mm.<sup>15</sup> Study done by Krnic et al reported that diameter of incompetent perforators increases as the CEAP grade increases.<sup>19</sup> But study done by Delis reported that the diameter of incompetent perforators did not change with CEAP class.<sup>18</sup>

In our study we found that the best cutoff diameter for predicting perforator vein incompetence was 3.8 mm with sensitivity of >94% and specificity >93%. Study by Labropoulos et al found that best cutoff diameter for predicting perforator vein incompetence was 3.9mm.<sup>17</sup> Study by Phillip et al found the average diameter of incompetent perforator was 3.9 mm.<sup>21</sup> Study by Hanrahan reported the average diameter of incompetent perforators as 3.5 mm.<sup>20</sup> Study done by Sandri et al found that diameters of 3.5 mm or larger in the calf and thigh were associated with reflux in more than 90% of cases.<sup>15</sup> Study done by Krnic et al reported that diameter of 3.9 mm or greater was sufficient for predicting the perforator incompetence (the accuracy was 91%).<sup>19</sup> Study done by Yamamoto et al found that a diameter larger than 3.0 mm was 80.4% predictive of reflux.<sup>22</sup> Average diameter for predicting incompetent perforators in various studies in literature is shown in table no. 04:-

Table no-04: Average diameter of incompetent perforators (reflux >0.5 seconds)

Serial No.	Study	Average diameter for predicting incompetent perforators
1	Labropoulos et al <sup>17</sup>	3.9mm
2	Phillip et al <sup>21</sup>	3.9mm
3	Hanrahan et al <sup>20</sup>	3.5mm
4	Sandri et al <sup>15</sup>	3.5mm
5	Prasad V16	3 mm
5	Krnic et al <sup>19</sup>	3.9mm
6	Yamamoto et al <sup>21</sup>	3.0mm
7	Present study	3.8mm

## Conclusion

In our study incompetent perforators were present in majority of patients of varicose veins; however the number of incompetent perforators went on increasing with increase in clinical severity of disease (CEAP classes). The diameter of perforators also went on increasing with increasing severity of disease and it was significantly higher in CEAP classes 4 to 6 compared to CEAP classes from 1 to 3 ( $p < 0.05$ ). The best cutoff diameter was 3.8mm to predict the perforator vein incompetence. Hence, patients with advanced severity of disease (CEAP 4, 5 and 6) and perforators with diameter more than 3.8mm require treatment of perforators during primary surgery to prevent recurrence of disease.

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