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## Primary Superficial Vein Reflux with Competent Saphenous Trunk

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**Objectives:** because reflux in superficial vein tributaries is most often collectively reported with the main saphenous veins, its importance remains largely unrecognised. This study was designed to identify the distribution and extent of non-truncal superficial venous reflux and its association with the signs and symptoms of chronic venous disease (CVD).

**Patients and methods:** eighty-four limbs in 62 patients with signs and symptoms of CVD and evidence of reflux on continuous-wave Doppler were subsequently examined with colour-flow duplex imaging. Incompetent superficial vein tributaries were imaged throughout their extent and both ends were identified. Limbs with reflux in the main trunk of the saphenous veins or the deep, perforator or muscular veins, superficial or deep vein thrombosis, injection sclerotherapy, varicose-vein surgery, arterial disease and inflammation of non-venous origin were excluded from the study. The CEAP classification system was used for staging clinical severity of CVD.

**Results:** the prevalence of tributary reflux alone was 9.7% (84/860). Reflux was detected in 171 tributaries. The number of incompetent tributaries ranged from 1 to 5 per limb. Most prevalent were the tributaries to the greater saphenous (111, 65%  $p < 0.0001$ ), followed by those of lesser saphenous (33, 19%) or a combination of both (12, 7%). Incompetent non-saphenous tributaries were uncommon (15, 9%). Among the named tributaries in the lower limb the posterior arch vein was most often incompetent (46, 27%) followed by the anterolateral vein of the thigh (30, 18%), the medial accessory vein (16, 9%) and the anterior arch vein (14, 8%). Reflux in above-the-knee tributaries alone was found in 18 limbs (21%), in below the knee in 23 (28%) and in both sites in 43 (51%). The vast majority of the limbs (71%,  $p < 0.0001$ ) belonged to CVD class 2, 14% in class 3, 9% in class 1 and only 6% in class 4. Class 3 and 4 patients tended to have a longer duration of signs and symptoms, higher number of incompetent tributaries per limb and also a higher prevalence of combined above- and below-knee reflux.

**Conclusions:** these data indicate that reflux confined to superficial tributaries is found throughout the lower limb. Because this reflux is present without greater and lesser saphenous trunk, perforator and deep-vein incompetence or proximal obstruction, it shows that reflux can develop in any vein without an apparent feeding source. Greater saphenous tributaries are affected significantly more often than those of lesser saphenous, while non-saphenous reflux is uncommon. Most limbs have signs and symptoms of CVD class 2 and 15% belong in classes 3 and 4.

**Key Words:** Duplex scanning; Primary venous reflux; Superficial vein tributaries.

### Introduction

Saphenous vein reflux is the most common haemodynamic abnormality in patients presenting with symptoms and signs of chronic venous disease (CVD).<sup>1–3</sup> A patent, non-varicose greater saphenous vein (GSV) is the conduit of choice for infrainguinal bypass grafting. The longer the graft and the more distal the anastomosis the greater the benefit of using GSV.<sup>4,5</sup> Additionally, the GSV is also used for aortocoronary bypass grafting, carotid artery patching and other peripheral and visceral operations. Duplex scanning is the method of choice for detecting venous reflux and has the distinct advantage over other methods in

determining accurately the distribution and extent of venous pathology.<sup>6–8</sup> Various patterns of venous reflux in the different CVD classes have been demonstrated<sup>1–3,9–12</sup> and although surgery for saphenous non-truncal varicosities to spare the GSV has been reported,<sup>13–17</sup> the patterns of non-truncal saphenous reflux have not been studied. Therefore, this study was designed to determine the prevalence and distribution of primary, non-truncal superficial vein reflux and its association with the patients' signs and symptoms.

### Patients and Methods

Eighty-four limbs in 62 patients with symptoms and signs of CVD were examined with colour-flow duplex

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imaging using a 4–7MHz and a 5–10MHz linear array (HDI 3000; ATL, Bothel, Wash., U.S.A.), or a 5.5/7.5MHz trapezoid linear array transducer (Sonos 2000, HP, Andover, MA, U.S.A.) There were 24 males and 38 females with a mean age of  $41 \pm 12$  years ranging from 18 to 77. Forty-three patients were referred for pain, swelling, heaviness and burning sensation. The other 19 were referred for cosmetic reasons. Seventeen patients had contralateral disease involving the main trunk of the saphenous veins, deep and perforating veins. Limbs with reflux in the main trunk of the saphenous veins and/or the deep, perforator or muscular veins, superficial or deep vein thrombosis, injection sclerotherapy, varicose-vein surgery, arterial disease and inflammation of non-venous origin were excluded from the study.

These 84 limbs were identified among the 860 limbs that were the total number of limbs studied. Although this is a cross-sectional study by design, of the 84 limbs examined 72 (84%) underwent surgery for their varicosities. Of these 72 limbs 43 had a repeat scan for preoperative marking. Therefore, follow-up with duplex scanning ranging from 3 to 19 months occurred in about the half of the limbs studied.

The duration of disease was determined in a subjective manner by questioning the patient about the onset of their symptoms and signs. The CEAP classification system was used for staging clinical severity of CVD.<sup>18</sup>

The method of examination for the superficial, perforating and deep veins has been described previously.<sup>12,19</sup> Briefly, the common femoral, saphenofemoral junction, superficial femoral and the above-knee segment of GSV were examined in the standing position and the popliteal, saphenopopliteal junction, anterior and posterior tibial, peroneal, gastrocnemial, lesser saphenous vein (LSV) and the below-knee segment of GSV in the sitting position. Reflux was induced by firm manual compression of the limb 10cm distal to the vein segment under investigation and it was followed by sudden release. Reflux was defined as a retrograde flow lasting over half a second.<sup>20</sup>

The presence and extent of reflux at all levels were noted. All the saphenous and non-saphenous incompetent tributaries were followed throughout their extent. Non-saphenous superficial tributaries were defined as all veins that did not empty into the GSV or LSV.

Reflux in any vein above the popliteal crease was considered as proximal or above knee, and reflux in any vein below the popliteal crease was considered as distal or below knee. Reflux confined to a single venous

**Table 1. Prevalence of reflux in the different tributaries.**

	<i>n</i>	%
Anterolateral vein	30	18
Medial accessory vein	16	9
Middle thigh tributaries	7	4
Lower thigh tributaries	9	5
Posterior arch vein	46	27
Anterior arch vein	14	8
Upper calf tributaries	10	6
Middle calf tributaries	18	11
Lower calf tributaries	6	3
Non-saphenous veins	15	9
Total	171	100

Posterior arch vein vs. anterolateral vein,  $p=0.051$ .

Posterior arch vein or anterolateral vein vs. any other tributary,  $p<0.04$ .

segment was defined as segmental and in more than one venous segments as multisegmental.

Statistical analysis was performed using Chi-squared test for the differences in proportions and Mann-Whitney rank sum test. Fisher's exact test was applied when the expected value in any of the cells was  $\leq 5$ .

## Results

The prevalence of tributary reflux was 9.7% (84/860). Reflux in the superficial veins alone was found in 612 limbs (71%). Therefore, the prevalence of tributary reflux among limbs with superficial incompetence only was 13.7% (84/612). The prevalence of reflux in the different tributaries is shown in Table 1. Among all tributaries the posterior arch vein was most often incompetent, followed by the anterolateral vein of the thigh (27% vs. 18%,  $p=0.051$ ). The prevalence of reflux in these two tributaries was significantly higher compared to any of the other tributaries ( $p<0.04$ , for all comparisons). Reflux in non-saphenous tributaries was uncommon (9%). Twelve (80%) of the 15 non-saphenous tributaries had no connection with the GSV or LSV. The remaining three were connected with tributaries of GSV away from the site of their emptying. The tributaries of GSV were more often incompetent than that of LSV as shown in table 2 (123, 79% vs. 33, 24%,  $p<0.0001$ ).

Combined proximal and distal reflux (43 limbs, 51%) was most frequently encountered, followed by proximal (18 limbs, 21%) or distal reflux alone (23 limbs, 28%) ( $p=0.0009$ ). Multisegmental incompetence was more prevalent than segmental (67, 80% vs. 17, 20%,  $p<0.0001$ ). Varicosities were present in the vast majority of the limbs (71/84, 85%,  $p<0.0001$ ).

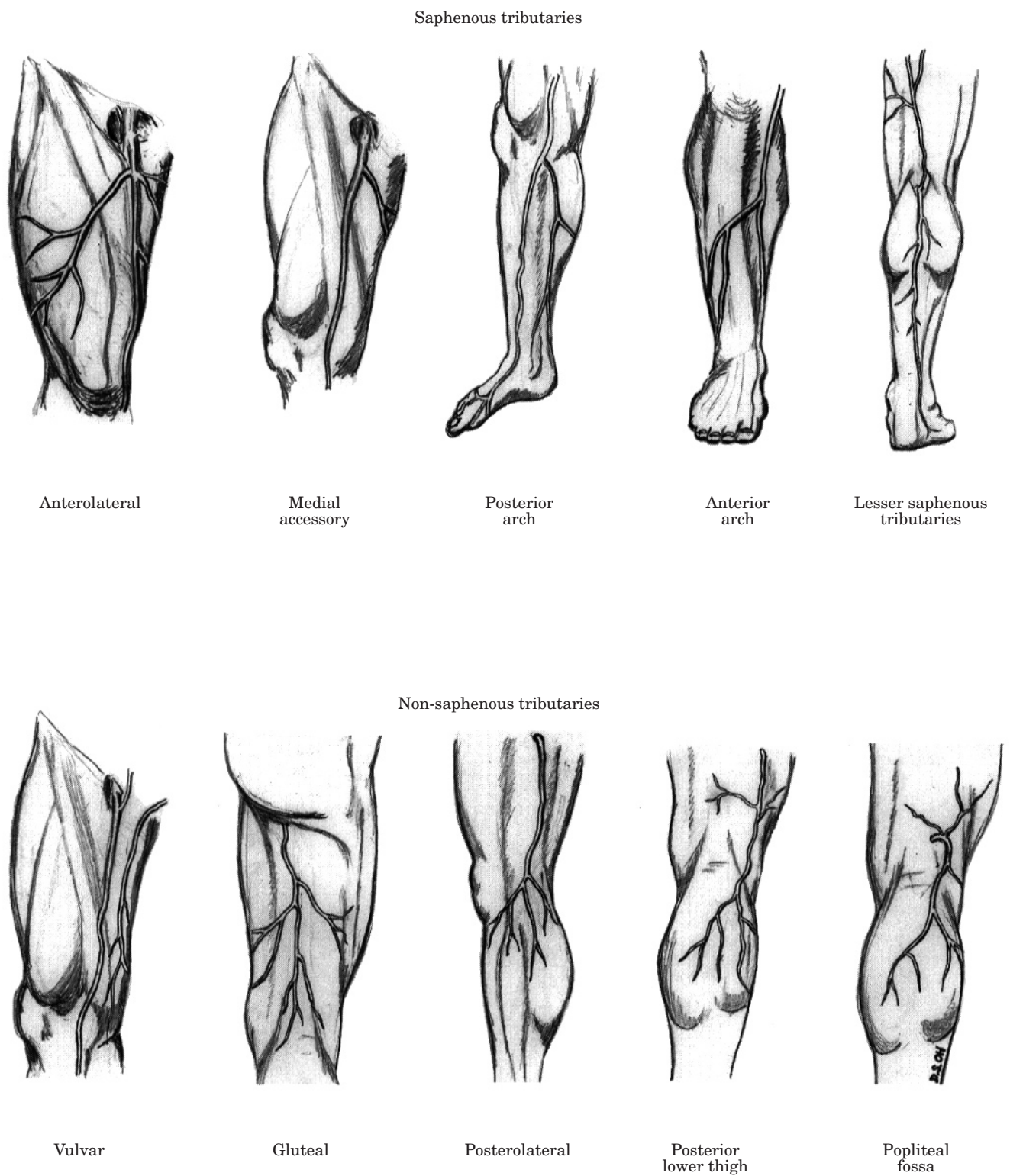


Fig. 1. Saphenous and non-saphenous tributaries in the human lower extremities. Gluteal and vulvar tributaries unite pelvic veins from the internal iliac system. Posterolateral, posterior lower thigh and non-saphenous popliteal fossa tributaries join atypical perforator veins.

**Table 2. Prevalence of saphenous and non-saphenous tributary reflux.**

	<i>n</i>	%
GSV	111*	65
LSV	33	19
GSV + LSV	12	7
Non-saphenous veins	15	9
Total	171	100

GSV: greater saphenous vein; LSV: lesser saphenous vein.  
\* $p < 0.0001$  for all comparisons.

The repeated ultrasound exam in the 43 limbs before the operation was comparable to the baseline exam in all but three limbs (7%). The change observed in these limbs was extension of reflux in the saphenous trunk and new tributaries. Therefore no false negative or positive exams were identified.

The number of incompetent tributaries per limb was significantly higher in classes 3 and 4 compared to classes 1 and 2 ( $p < 0.01$ , Table 3). The duration of disease ranged from 5 months to 21 years. The mean duration was significantly longer with increasing degrees of clinical severity (Class 1 vs. 2, highest  $p = 0.02$ ; Class 1 vs. 4, least  $p < 0.0001$ ; Table 3).

### Discussion

Reflux in superficial veins and particularly in the GSV and its tributaries is the most frequent pathology in all CVD classes<sup>2,3</sup> including patients with skin changes or ulceration.<sup>1,3,9,11,12</sup> Because reflux in the superficial veins is being most often collectively reported as GSV or LSV incompetence, the prevalence of reflux in the non-truncal superficial veins has not been described. Additionally, the prevalence and distribution of such reflux in the presence of a normal GSV and LSV have not been studied. This study was performed to identify non-truncal superficial venous reflux in view of targeting treatment at appropriate sites.

The prevalence of tributary reflux was 9.7%. Although there are no data in the literature for tributary reflux, the above prevalence is probably overestimated, because in one centre over 85% of the referred patients had signs and symptoms of CVD class 2. The posterior arch vein was the most common site of reflux. This was also shown in two recent studies in which consecutive patients with different patterns of reflux involving any of the lower limb veins were examined.<sup>21,22</sup> Clinically-apparent varicosities are most often found in the medial and posteromedial aspect of the calf and our findings explain this observation.

Reflux confined to tributaries arising from the GSV was significantly more prevalent compared to LSV tributaries. Several studies using duplex scanning have shown that in all CVD classes reflux in the GSV system is the most prevalent.<sup>1-3,9,12</sup> Although there is no explanation for this, anecdotally it has been associated with the length of GSV, which is the longest continuous venous column in the body. Reflux in non-saphenous tributaries was uncommon. The majority (80%) of these tributaries were completely independent of the saphenous tributaries and were emptying in atypical perforating veins, in vulvar or gluteal veins. At least a third of these tributaries were thought to be part of the saphenous veins during clinical examination, while in the rest of the limbs it was not always certain where these tributaries might come from.

The number of tributaries per limb was significantly higher in classes 3 and 4. Other studies that examined unselected patients with different classes of CVD have demonstrated that the patterns of reflux become more complex with the disease progression.<sup>2,3,9,11</sup> Because in this study all patients had reflux confined to tributaries alone, this is evidence that reflux can develop in the absence of saphenous junction or saphenous trunk incompetence. According to our findings reflux can be isolated in a single venous segment or it can be multifocal, often at different sites that do not communicate with or affect each other. Such data indicate a local or multifocal progression of reflux and would

**Table 3. Number of tributaries per limb and duration of disease in each CVD class.**

Class	Number of limbs	%	Number of tributaries	%	Tributaries per limb	Duration of disease (years)	
						Range	Mean
1	7	8.3	12	7	1.7	0.4-2.5	1.6
2	60	71.4	110	64	1.8	0.5-17	2.8
3	12	14.3	31	18	2.6	3-14	4.4
4	5	6	18	11	3.6	3-21	7.5
Total	84	100	171	100	2.0	0.4-21	4.1

Number of incompetent tributaries per limb; CVD classes 1 or 2 vs. 3 or 4  $p < 0.01$ .  
Duration of CVD; CVD class 1 vs. 2, highest  $p = 0.02$ , CVD class 1 vs. 4 least  $p < 0.0001$ .



indirectly support that local vein wall changes (weakening of the vein wall theory) are responsible for the development of primary CVD. These data are supported from recent studies that found similar patterns of reflux to occur in both selected and unselected patients with CVD.<sup>22-24</sup>

The duration of disease was significantly longer with increasing degrees of clinical severity. Because this was a cross-sectional study and the duration of disease was determined in a subjective manner, it is likely that the duration might have been underestimated as reflux can occur in asymptomatic patients.<sup>24</sup> Several studies have shown that in patients with reflux in the main superficial or deep veins the duration of disease is also longer with increasing severity of CVD.<sup>5,10</sup>

Over 80% of the limbs had varicose tributaries. This is not surprising since varicosities in tributaries are more often seen even in patients with GSV or LSV involvement. Previous reports using venography, duplex scanning and operative findings have shown that the main trunk of GSV and LSV can be intact in patients presenting with varicose veins.<sup>25-27</sup> Cotton elegantly demonstrated tortuous tributaries overlying a straight non-varicose GSV using corrosion casting. The fascial course of the main trunk of GSV and LSV is variable. In over 80% of limbs in cadaveric studies the GSV was found to lie within the fascial canal for most of its length.<sup>28,29</sup> The areas at which the fascial canal is absent are the uppermost and lowermost quarters of GSV. The LSV was found within the fascial canal or under the deep fascia in over 90% of limbs in cadaveric studies.<sup>28,30-33</sup> The LSV pierces the deep fascia in about 7% in the lower third of the calf, in 50% in the middle and in 32% in the upper third. On the other hand, the tributaries are closer to the skin in an area where the fat deposition is higher. We believe that as the affected tributaries dilate, without the protection of the strong collagenous fascia, there is no resistance to vein enlargement and therefore they are more prone to develop varicosities.

Of the 43 limbs scanned before the operation, in only three limbs (7%) the results changed compared to initial study. Two patients developed reflux in an additional tributary and in one of them reflux extended into the main GSV trunk. In the third patient reflux extended into the LSV main trunk. From this short follow-up it appears that ultrasound results are reliable and that the progression of the disease is small.

The clinical examination or the use of physiologic testing alone cannot identify accurately the distribution and extent of reflux: particularly, the involvement of GSV and LSV that lie deeper and often

are not visible. In order to target intervention at appropriate sites, colour-flow duplex imaging should be used before planning treatment: particularly in patients like these in our study because the main trunk of the saphenous veins can be spared and even ligation of the saphenous junctions can be avoided.

## Conclusions

Reflux confined to the tributaries alone is most frequently found in the GSV distribution and particularly in the posterior arch vein and the anterolateral vein of the thigh. Reflux in non-saphenous tributaries is uncommon. Because this reflux is present without greater and lesser saphenous trunk, perforator and deep-vein incompetence or proximal obstruction, it shows that reflux can develop in any vein without an apparent feeding source. Most limbs have signs and symptoms of CVD class 2 and up to 15% belong in classes 3 and 4. Class 3 and 4 patients tend to have a longer duration of signs and symptoms, higher number of incompetent tributaries per limb and also a higher prevalence of combined above- and below-knee reflux. Varicosities are found in over 80% of these patients. Identification of these patterns of reflux is important because treatment can be directed to the tributaries alone, sparing the main trunk of the saphenous veins.

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