Primary Varicose Veins: The Sapheno-femoral Junction, Distribution of Varicosities and Patterns of Incompetence

D. G. Cooper, C. S. Hillman-Cooper, Stephen G. E. Barker and S. J. Hollingsworth

The Academic Vascular Unit Department of Surgery, Royal Free and University College London Medical School, The Middlesex Hospital, London W1N 8AA, U.K.

Objective: to determine the patterns of long saphenous vein (LSV) disease in primary varicose veins (VVs).
Design: a retrospective analysis of venous duplex scans performed on patients referred for treatment of primary VVs.
Methods: analysis was made of sapheno-femoral junction (SFJ) incompetence, non-SFJ incompetence, segmental and perforating vein incompetence, distribution of varicosities, deep venous insufficiency, and short saphenous incompetence.
Results: four hundred and eighty-one patients were assessed (median age 50 (range 12–98) years; male:female ratio 1:1.95), comprising 706 limbs. Forty-six per cent of limbs had a competent SFJ, 64% of which had no incompetent perforating vessels associated. Disease was more widespread when the SFJ was incompetent. Varicosities were most common in the calf, occurring at or below the level of incompetence within the LSV. Incompetent segments occurred most commonly above-knee. There was no obvious correlation between incompetent perforators and distribution of varicosities, or incompetent segments. Short saphenous incompetence and non-SFJ groin recurrence were associated more with a competent SFJ, the converse being true for the Giacomini vein.
Conclusion: primary VVs develop in isolated segments of the superficial venous system (without connection to the deep system) at, or distal to, the underlying main trunk incompetence, suggesting a process of ‘spreading incompetence’ from one focal point, producing varicosities (mainly in tributaries).

Key Words: Primary varicose veins; Sapheno-femoral junction; Venous incompetence; Long saphenous vein.

Introduction

The observations that primary varicose veins (VVs) can develop in the presence of an intact and functional sapheno-femoral junction (SFJ),1–3 and that pathological changes are often first noted on the more distal surface of valves,4 has led to a number of more recent theories concerning the aetiology of primary VVs. However, the long-held “Trendelenburg” theory of progressive, descending, valvular incompetence,5 although often refuted, remains widely taught and accepted.

Numerous contributing aetiological risk factors have been described such as pregnancy,6 obesity,7 heredity,8 and ethnicity,9 but there is still no clear base mechanism explaining how this disease process begins and progresses. For example, although prolonged sitting or standing10,11 may exacerbate, contribute to, or initiate a process, what is the sequence of cellular or physiological events that occurs to render the vein ultimately diseased or dysfunctional? Furthermore, and perhaps of greater importance here, is that the clinical presentation of VVs seems at odds with our current understanding of the underlying superficial incompetence.

Over the last ten years, with colour flow duplex ultrasound examination becoming increasingly available as a tool for accurate and repeated imaging of the peripheral vascular system, there has been an increase in the understanding of the patterns of venous incompetence underlying VVs. It seems that a spectrum might exist in terms of anatomical extent of reflux, severity of clinical disease and physiological compromise.12–16 Limited areas of reflux underlie mild, sometimes asymptomatic, disease whereas more advanced clinical problems are often associated with more diffuse incompetence. It remains, however, unclear as to the exact relationship between underlying incompetence and the patterns of varicosities seen with primary VVs. Do indeed, as suggested, varicosities more commonly involve tributaries to the main trunk of the peripheral system,17 and does incompetence commence in the main trunk itself?14 Furthermore, although most often commented upon...
anecdotally as being due simply to vanity, the basis behind why significantly more females tend to be affected than males remains unanswered. Does this bias for example, actually represent the same underlying disease process and are the patterns of incompetence affected by gender?

Here, we have used a large database of venous duplex scans, undertaken for patients referred for assessment of primary VVs, to examine patterns of varicose disease and underlying venous incompetence. We have made particular reference to the relationship with competence at the SFJ and gender, in an attempt to delineate a possible pattern of disease development that might help suggest more clearly the prime sites for future (molecular) investigation.

Methods

We have reviewed, retrospectively, the venous duplex ultrasound scans performed on all patients referred to our vascular surgical out-patients for assessment of primary VVs. The scans were undertaken in the Vascular Laboratory, at the Middlesex Hospital, London, over a twelve-month period during 2000–2001. All scans were performed by senior technologists, and according to standard protocols and criteria. The diagnosis of primary VVs was made by the referring surgeon, confirmed by the technologist, and was defined as clinically evident VVs where (i) no previous surgery had been undertaken, (ii) there was no evidence of a thrombotic event within the deep veins, and (iii) there was no differential diagnosis. Examination of reflux at the SFJ was undertaken with patients standing and reported as incompetence only when reflux was manifestly apparent (not trivial, and at least moderate-to-severe). Reflux in all other veins was examined with patients lying supine. Only scans reporting VVs associated primarily with the long saphenous system and its tributaries were considered.

Those from patients with primary incompetence of the short saphenous system, and those with evidence of previous deep vein thrombosis, were excluded.

Patient demographics were recorded and an analysis made for each affected limb, of (i) competence at the SFJ, (ii) distribution of varicosities: thigh alone/calf alone/calf + thigh, (iii) the site of the incompetent segment of the main long saphenous trunk, or tributary: above-knee/below-knee/above + below-knee, (iv) the distribution of incompetent perforating veins (specifically, between the long saphenous system, or its tributaries and the deep veins): above-knee (Hunterian, medial/lateral/posterior thigh perforators)/below-knee (Cocketts’, Boyds’, medial calf perforator)/combined above- + below-knee, (v) the presence of associated short saphenous, Giacomini vein and non-SFJ groin incompetence, and deep venous insufficiency.

Female to male ratios were determined for both individuals and limbs (accounting for bilateral disease). To assess for any possible association or pattern, the relationships were examined between SFJ status, gender, site of varicosities, incompetent perforating vessels or segments of the long saphenous system, short saphenous reflux, Giacomini vein and non-SFJ groin incompetence, and deep venous insufficiency.

Statistics

Results have been summarised using descriptive statistics. These are presented as actual numbers of individuals or limbs, as percentages of total individuals or limbs, and for age, as medians with range. Graphically, results are presented as stacked bars, or as “exploded” pie charts, to indicate the contribution of each condition to each group and the total numbers per group studied. Comparisons between groups (for example, the distribution of varicosities in relation to SFJ competence) were made by cross-tabulation and analysed by Chi² test (for 2 × 2 or C × R tables, as appropriate). Statistical significance was accepted at p < 0.05; analyses yielding non-statistically significant results are not cited. Values are reported significant to the p < 0.05 or p < 0.01 levels.

Results

During the twelve-month period of study, 481 colour flow duplex scans were undertaken on patients presenting with clinically obvious primary VVs affecting the long saphenous system. Of these, 225 (47%) represented bilateral disease, resulting in a total of 706 affected limbs. Median age of individuals was 50 years (range, 12–98 years) and, for limbs, was 49 years (12–98 years). The male to female ratio was 1:2.0. There were 340 (48%) left legs and 366 (52%) right legs scanned.

Of the 706 limbs scanned, 383 (54%) had an incompetent SFJ. SFJ status was similar in male and female limbs. Overall, of the limbs scanned, 49% had varicosities present in the calf only and 45% (n = 319) had varicosities in both the calf and the thigh. A markedly lower 5.5% (n = 39) however, had varicosities present only in the thigh (Table 1). The distribution of varicosities was largely unaffected by gender. This pattern of varicosities was, however, affected by the status of the SFJ (see Table 1). With an incompetent SFJ, more
limbs overall had varicosities both in the calf and thigh than when the SFJ was competent (53% as compared to 37% for a competent SFJ; \(p < 0.01\)). Varicosities isolated to the calf only were mainly similar irrespective of SFJ status and those isolated to the thigh only were again uncommon. The pattern of varicosities was influenced also, by gender when in conjunction with the status of the SFJ. In male limbs, the distribution of varicosities was similar to that for limbs overall and being more widespread to both the calf and thigh when the SFJ was compromised (Fig. 1A; \(p < 0.01\)). In contrast, in female limbs the proportion of varicosities seen in both the calf and thigh combined was largely unaltered by competence at the SFJ (Fig. 1B).

**Distribution of incompetent perforating vessels**

VVs occurred overall, more frequently in the absence of any incompetent perforating vessels \((n = 442, 63\%\) of all limbs studied; \(p < 0.01\)). However, when VVs occurred with incompetent perforating vessels present, they were distributed predominantly below-knee \((n = 218, 31\%\) of all limbs; \(p < 0.01\)). Incompetent perforating vessels above-knee only \((n = 38, 5.4\%)\), or combined above- and below-knee \((n = 8, 1\%)\), were uncommon.

In male limbs, incompetent perforating vessels \((n = 102, 44\%)\) were slightly more common than in females \((n = 162, 34\%)\), a difference accounted for largely by increased numbers of incompetent perforators sited below-knee.

When the status of the SFJ was reviewed, incompetent perforators sited below-knee only were more common when the SFJ was incompetent \((n = 136, 62\%)\) than when it was intact and functional \((n = 82, 38\%)\) \((p < 0.01)\). The converse was evident however, when incompetent perforators were sited above-knee only; \(n = 28, 74\%\) in the presence of a competent SFJ as compared to \(n = 10, 26\%\) when the SFJ was compromised \((p < 0.01)\); [above-knee only incompetent perforators were considerably fewer in number, however, than those below-knee only].

**Distribution of incompetent segments of the long saphenous system**

For all limbs overall, the majority \((n = 438, 62\%)\) had incompetence at sites both above- and below-knee \((p < 0.01)\). Incompetence, isolated to above-knee only \((n = 185, 26\%)\) was more common than that of below-knee only \((n = 83, 12\%)\) and this pattern remained similar irrespective of gender.

When the SFJ was competent, similar proportions of limbs demonstrated incompetence isolated to either just above-knee \((31\%)\), or below-knee \((25\%)\) segments, whilst slightly more limbs \((44\%)\) had incompetence in both above- and below-knee segments. When, however, the SFJ was incompetent, the majority of limbs \((76\%)\) demonstrated incompetence in both above- and below-knee segments of the LSV main trunk or tributaries \((p < 0.01);\) above-knee segment

---

**Table 1. Distribution of varicosities.**

<table>
<thead>
<tr>
<th>Site of varicosities</th>
<th>Calf (%)</th>
<th>Thigh (%)</th>
<th>Calf + Thigh (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>113 (49)</td>
<td>12 (5)</td>
<td>106 (46)</td>
</tr>
<tr>
<td>Female</td>
<td>235 (49)</td>
<td>26 (5)</td>
<td>214 (45)</td>
</tr>
<tr>
<td>Competent SFJ</td>
<td>180 (56)</td>
<td>25 (5)</td>
<td>118 (37)</td>
</tr>
<tr>
<td>Incompetent SFJ</td>
<td>168 (44)</td>
<td>14 (4)</td>
<td>201 (52)</td>
</tr>
</tbody>
</table>

Number of limbs with site of varicosities (calf only, thigh only, calf + thigh) per gender, and SFJ status (competent, or incompetent). Numbers are total numbers of limbs, with percentage of total per gender or SFJ status in parenthesis. ‘\(n\)’ = total limbs. SFJ, sapheno-femoral junction.
incompetence occurred in 22% of limbs, whilst isolated below-knee only disease was rare (<1%).

**Distribution of varicosities and incompetent perforators**

The correlation between varicosities and perforating vessels was examined by recording the site of varicosity, in combination with the presence of at least one incompetent perforating vessel. The results are summarised in Table 2.

With incompetent perforating vessels isolated to either above- or below-knee segments only, or no incompetent perforating vessels present at all, approximately equal proportions of limbs had varicosities in the calf only, or in both the calf and thigh (see Table 2); thigh only varicosities were less common. If however, perforating vessels were incompetent both above- and below-knee, the pattern of varicosities was different, although it has to be appreciated that in comparison, the numbers involved are small (n = 8).

**Distribution of varicosities and incompetent long saphenous segments**

When the long saphenous system was incompetent above-knee, either in isolation or in combination with incompetence below-knee, similar proportions of varicosities were seen in the calf to those in both the thigh and calf, with fewer varicosities seen in isolation in the thigh (see Fig. 2A and C). In contrast, with an isolated below-knee segment of the long saphenous system incompetent, varicosities predominated in the calf only (82%, Fig. 2B; p < 0.01). Collectively, thus, varicosities would seem to develop just at, or below, the level of underlying (superficial) venous incompetence.

**Distribution of incompetent perforators and long saphenous segments**

There was seemingly little, or no obvious, association between the position of incompetent perforators and

**Table 2. Distribution of varicosities and incompetent perforators.**

<table>
<thead>
<tr>
<th>Incompetent perforator</th>
<th>Site of varicosities</th>
<th>Calf (%)</th>
<th>Thigh (%)</th>
<th>Calf + Thigh (%)</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above-knee</td>
<td></td>
<td>14 (37)</td>
<td>4 (11)</td>
<td>20 (52)</td>
<td>38</td>
</tr>
<tr>
<td>Below-knee</td>
<td></td>
<td>120 (55)</td>
<td>7 (3)</td>
<td>91 (42)</td>
<td>218</td>
</tr>
<tr>
<td>Combined</td>
<td></td>
<td>1 (13)</td>
<td>0 (0)</td>
<td>7 (87)</td>
<td>8</td>
</tr>
<tr>
<td>None</td>
<td></td>
<td>213 (49)</td>
<td>28 (6)</td>
<td>201 (45)</td>
<td>442</td>
</tr>
</tbody>
</table>

Number of limbs with varicosities (calf only, thigh only, calf + thigh) and incompetent perforating vessels (above-knee only, below-knee only, combined above- and below-knee, or none). Numbers are total numbers of limbs, with percentage of total per incompetent perforator in parenthesis. *n’* = total limbs per incompetent perforator.

We examined long saphenous system incompetence in limbs in which there was no evidence of incompetent perforating vessels (calf or thigh), and in relation to SFJ status.

For limbs overall, not accounting for SFJ competence, in the absence of incompetent perforating vessels, reflux in the long saphenous system most commonly involved both combined above- and below-knee segments (Fig. 3, upper panel; p < 0.01). With a competent SFJ, reflux in the long saphenous system was present in approximately equal proportions between isolated above- or below-knee whilst slightly more limbs presented with reflux in both above- and below-knee segments (Fig. 3, lower left panel). When the SFJ was compromised, however, the majority of limbs demonstrated incompetence in combined above- and below-knee segments (Fig. 3, lower right panel; p < 0.01); notably, few limbs had isolated below-knee long saphenous system incompetence.
Patterns of Incompetence in Primary Varicose Veins

the distribution of overlying superficial incompetence (Table 3). For all limbs, most demonstrated incompetence throughout the limb, regardless of the distribution of any incompetent perforating vessel. Indeed, superficial incompetence occurred in segments of the long saphenous system both above and below the level of underlying incompetent perforating vessels.

Short saphenous insufficiency and deep venous incompetence

From all limbs examined, 20% demonstrated associated incompetence involving the short saphenous vein in addition to the long saphenous system. Notably, less than a quarter of these limbs had an incompetent connection between the short and long saphenous systems. When the SFJ was functional, 27% of these limbs demonstrated short saphenous incompetence, but only 14% when the SFJ was incompetent. Deep venous insufficiency was uncommon and was unaffected by incompetence at the SFJ.

Discussion

Why should a vein become “dilated, tortuous and elongated”, i.e. varicose? Commonly, the underlying abnormality is venous incompetence, principally within the long saphenous system, the pattern and nature of which has become more clear since the introduction of colour flow duplex ultrasound examination. It would seem that a spectrum of severity of clinical disease mirrors a corresponding spectrum of underlying anatomical extent of reflux, for example, asymptomatic individuals generally have reflux involving a limited length of the superficial system (part of the main trunk of the LSV) whilst “severe” disease of diffuse varicosities, skin changes (ulceration) and limb oedema has a correspondingly diffuse underlying incompetence involving far longer lengths of the superficial system, perforators and the deep venous system. The suggestion, therefore, is of a disease process that is progressive in nature starting from an initial point of incompetence within the venous system. The belief has been long held that this initial incompetent focal point was the SFJ. However, as varicose disease occurs regularly in the absence of reflux at the SFJ, thus indicating an intact sapheno-femoral valve, the question is raised as to whether incompetence can develop at any position within the venous system, and if so, does incompetence “spread” from there onwards? This of course, still leaves the question of how this initial incompetence develops in the first place. To understand more clearly how this process may progress, it is important to understand the relationship and patterns between presentation of varicosity and the associated underlying incompetence within the venous system. Here, we have examined this association and address some of the currently held thoughts as to varicogenesis.

In our study, patient demographics were typical for primary VVs, with a predominance of disease affecting females compared to males (at a ratio of approximately 2:1). Additionally, the numbers of individuals with VVs in the presence of an intact, functional SFJ were approximately equal to those where the SFJ was compromised. Notably, it appears

---

**Table 3. Distribution of incompetent perforators and long saphenous segments**

<table>
<thead>
<tr>
<th>Incompetent segment</th>
<th>Incompetent perforator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above-knee (%)</td>
<td>Below-knee (%)</td>
</tr>
<tr>
<td>Above-knee</td>
<td>8 (21)</td>
</tr>
<tr>
<td>Below-knee</td>
<td>9 (24)</td>
</tr>
<tr>
<td>Combined</td>
<td>21 (55)</td>
</tr>
</tbody>
</table>

Number of limbs with an incompetent perforating vessel (above-knee only, below-knee only, or combined above- and below-knee) and an incompetent segment of the long saphenous system (above-knee only, below-knee only, or combined above- and below-knee). Numbers are total numbers of limbs, with percentage of total per incompetent segment in parenthesis.
that varicosities tend to be more widespread, involving both the calf and thigh, when the SFJ was incompetent (see Table 1), a difference that was more pronounced in males than females (see Fig. 1). A similar trend was apparent, furthermore, for incompetent segments of the long saphenous system, occurring both above and below the knee, when the SFJ was compromised. In support of these observations, other studies report an increasing incidence of SFJ incompetence when associated with increasingly severe clinical disease.\textsuperscript{14} Collectively then, might it be that incompetence at the SFJ reflects a stage where disease is more widespread rather than being the initiating factor in the development of venous incompetence?

Previous studies report that in the long saphenous system, regardless of severity of symptoms (if any), incompetence was more common below the knee.\textsuperscript{13} We have seen here, however, that the above-knee segment of LSV was more often affected than that below-knee, and particularly when the SFJ was incompetent. In addition, as few if any individuals with an incompetent SFJ had LSV incompetence isolated below the knee, the suggestion is that venous incompetence might develop as a continuum. Varicosity formation is reported as patchy and irregular, even within the same vessel,\textsuperscript{1,20} and in our study tended to occur at, or below, the level of underlying incompetence, being more commonly found below the knee (see Fig. 2).

Overall then, with underlying incompetence developing as a continuum and varicosity formation as patchy, a primary vessel wall abnormality might thus act as a "hot spot" for the subsequent development of varicosity.

As primary VVs in the presence of a competent SFJ have been documented,\textsuperscript{1-3} the suggestion has been that an incompetent perforator elsewhere may be the cause of superficial incompetence and VVs development.\textsuperscript{21} If so, it would be reasonable to expect incompetent perforating vessels to predominate when the SFJ was functional. Here, incompetent perforators were most common below the knee and when the SFJ was compromised. Notably, when incompetent perforators occurred above-knee only, these were more common in the presence of an intact and functional SFJ. Possibly, incompetent perforators, when the SFJ is compromised, represent a consequence of the underlying venous incompetence, whereas those in association with a functional SFJ might act as an initiating focal point. However, as almost a third of limbs had VVs without incompetent connections to the deep system and the distribution of both incompetent superficial segments and varicosities were largely unaltered by incompetent perforating vessels (see Table 2), their importance in the development of varicosity remains questionable.

In the absence of incompetent perforating vessels with a direct connection to the deep system, reflux in the LSV may originate also from the short saphenous vein via the Giacomini vein.\textsuperscript{22} Short saphenous incompetence occurred in combination with long saphenous disease more commonly when the SFJ was intact but, however, the Giacomini vein was affected more commonly when the SFJ was compromised (15% (8/53) as compared to 8% (7/86) of limbs with a competent SFJ). It remains to be seen, therefore, how the disease develops in these patients. LSV incompetence may result also, from incompetence in the groin but via a site not directly connected to the SFJ. Previously, this has been reported to be twice as common without SFJ reflux as with, although the study did consider both primary and recurrent disease.\textsuperscript{23} Similarly, in our study here, this form of incompetence was significantly more prevalent when the SFJ was competent (30/323; 9\%) than when compromised (1/383; <1\%). As such, although this might be a potential source of disease in limbs with a competent SFJ, it does not, however, account for individuals with VVs but without an incompetent connection to the deep system.

It appears increasingly unlikely that VVs develop (certainly in all cases) from dysfunction of the valves of the superficial venous system, or in a descending fashion. Furthermore, it is perhaps unlikely that reflux involving primarily veins communicating between the superficial and deep veins has a significant aetiological role. Our results seem more consistent with the thought of a primary wall abnormality predisposing to venous dilatation, as a precursor to later valvular incompetence and, finally, reflux. As this incompetence predominates in areas that would not be anticipated to suffer the greatest pressures, then a more complex interaction between luminal forces, and perhaps an un-controlled molecular "signal" for vessels to dilate, may be fundamental to the genesis of VVs. To understand these processes more clearly will undoubtedly improve our ability to treat and manage VVs more effectively.

References

Patterns of Incompetence in Primary Varicose Veins


Accepted 17 September 2002