A Comparison of Duplex Scanning and Continuous Wave Doppler in the Assessment of Primary and Uncomplicated Varicose Veins

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Objectives: To compare the findings of continuous wave Doppler (CWD) with duplex ultrasound in the assessment of primary and uncomplicated varicose veins, and to determine how their relative roles might be best applied.

Materials and Methods: One hundred consecutive limbs were studied in 73 patients with primary (no previous surgery) and uncomplicated (no significant skin change) varicose veins. CWD was employed by a single observer; followed by duplex scanning performed "blind" and independently.

Results: There were 87 limbs with long saphenous incompetence on duplex; all but four of which were correctly identified by CWD, by which technique there were no false positives. (Sensitivity 95%, specificity 100%.) There were 21 limbs with short saphenous incompetence on duplex, all but two of which were recognised on CWD. However, CWD incorrectly diagnosed reflux at the saphenopopliteal junction in five limbs (false positives) with what was, in fact, segmental reflux in the long saphenous trunk on duplex (sensitivity 90%, specificity 93%.) This would have led to inappropriate exploration of the saphenopopliteal junction had surgery proceeded without checking with duplex.

Conclusions: CWD is adequate for long saphenous incompetence. All "reflux" demonstrated on CWD in the popliteal fossa (about 25% of cases) should be checked by duplex. If this policy had been followed, all the patients in this study would have undergone the correct procedure. The only "errors" would have been missing coexistent short saphenous incompetence in two limbs undergoing appropriate long saphenous exploration.

Key Words: Primary varicose veins; Continuous wave Doppler; Colour duplex.

Introduction

The value of continuous wave Doppler (CWD) in the evaluation of primary and uncomplicated varicose veins is now well established. More recently it has been suggested that the use of duplex scanning may confer additional advantages. However, to deploy routine duplex scanning in all cases would obviously be time consuming with cost implications, and may not always be necessary.

This study, therefore, sets out to compare the findings on CWD with duplex, to evaluate the relative value and limitations of the two techniques, and to see how best the two might be applied.

It was felt appropriate to focus in this context on primary and uncomplicated varicose veins. Recurrent varicose veins pose specific problems in terms of the complexity of the underlying morphology, which would seem to differ from the previously unoperated patient. Some previous comparative studies of CWD with duplex have included such cases. Equally, limbs with significant skin change, and maybe even active ulceration, need in-depth study to determine the state of the deep system and specific evaluation for evidence of previous deep vein thrombosis.

Materials and Methods

One hundred limbs with primary and uncomplicated varicose veins in 73 consecutive patients referred to a single consultant vascular surgeon were assessed. Of these, there were 18 males and 55 female patients. The mean age was 47.5, and this ranged from 22 to 74. Twenty-seven had bilateral varicose veins, and 46 unilateral.

Continuous wave Doppler examination was carried out by a single observer (Huntleigh dopplex 500 Probe 8 MHz). The technique employed was as follows. Firstly, good "sonic contact" was made by placing the probe over a convenient prominent varicosity and squeezing and releasing the calf below that point. The patient was then requested to give a brisk cough. A refluxing signal demonstrated from that varicosity was
taken to indicate saphenofemoral incompetence with reflux in that system to the point of insonation. If no cough “impulse” could be demonstrated, then other varicosities were similarly checked to confirm this finding.

If these too demonstrated no reflux, then "sonic contact" was made over the long saphenous trunk; usually by placing the probe just above the knee, where its anatomical position is reasonably predictable; and squeezing and releasing the calf below. Competence at the saphenofemoral junction was once more tested by the absence of a cough signal in the trunk. However, a refluxing signal on calf squeeze/release (without a cough reflux signal) was taken to indicate incompetence in the saphenous trunk itself (although the saphenofemoral valve itself was competent). The absence of reflux even on calf squeeze/release was interpreted as competence throughout the long saphenous system, down to the point of examination.

Finally, “sonic continuity” between the long saphenous trunk and the distal varicosities was established by tapping the latter while still insonating over the trunk. A signal was interpreted as confirmation that the varicosities were derived from that system.

Irrespective of the outcome of the above tests, attention was then turned to the short saphenous system, to look for either the alternative source of, or for, coexistent incompetence. This particular technique is now well described and tried. Briefly, it consisted of a calf squeeze release test for reflux with insonation over the saphenopopliteal junction. (Unless the deep valves within the saphenopopliteal veins are incompetent, a positive cough signal cannot be demonstrated in the short saphenous even if the saphenopopliteal junction is incompetent.)

Finally, sonic continuity with a distal varicosity with the saphenopopliteal junction was tested in a similar manner to that described above in the long saphenous system, thus confirming or refuting the origin of that varicosity. The absence of demonstrable sonic continuity between the varicosities and either saphenous system was taken to imply direct origin from a perforator into the deep system, independent of either saphenous trunk.

The technique of duplex examination was undertaken using an Acuson 128/10 colour duplex scanner with a 7 MHz Linear Array probe, “blind” to the results of the CWD findings, by one of two medical technologists, between whom there was constant collaboration and consistency of technique. The mode of examination was standard, and has been described in detail elsewhere. Briefly, a longitudinal image of the long or short saphenous vein in its proximal segment was first obtained. An initial assessment of reflux was made with colour, by angling the colour box such that the angle of flow relative to that of the Doppler beam was minimised. With calf squeeze and release, the colour denoting flow in the vessel was noted. Reflux was recognised by colour change between calf squeeze and release.

Objective evaluation was then deployed, using pulsed Doppler. The gate was placed over the vessel, once more calf squeeze and release was performed, and the Doppler trace frozen on screen after the anti-grade and any retrograde flow (if observed). Reflux was then classified according to the following criteria:

(i) no reflux: no or trivial reflux consistent with valve closure (less than 0.5 s);
(ii) minor reflux: the duration and peak velocity of the reflux signal less than the augmented signal;
(iii) moderate reflux: reflux time and peak velocity similar or slightly longer than the augmented. This includes long reflux time (“trickle incompetence”), but in this case the peak velocity of the reflux signal was lower than the augmented signal;
(iv) severe reflux: peak velocity and duration of reflux time equal to or exceeded augmented.

If reflux was not detected in the proximal portion of the long/short saphenous vein immediately below their junction with the deep system, then the probe was moved sequentially more distally, until a point at which reflux by the above criteria was or was not demonstrated.

For the purposes of this study only moderate and severe reflux as described were taken to be significant. If any doubt existed as to the origin of superficial varicosities, they were traced back, usually to either the long or short saphenous system. If this was not the case then a local and independent perforator was sought.

Results

For the purposes of this study, the findings on duplex were taken to be “correct”. The distribution of venous morphology is summarised in Table 1. The comparison between the findings on duplex and CWD are analysed separately for the long and short saphenous systems.

Long saphenous

Of the 87 limbs with long saphenous incompetence, CWD correctly identified 83. There were thus four
Table 1. Distribution of incompetence on duplex.

<table>
<thead>
<tr>
<th>Incompetence</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long saphenous alone</td>
<td>77</td>
</tr>
<tr>
<td>Combined long and short saphenous</td>
<td>10</td>
</tr>
<tr>
<td>Short saphenous alone</td>
<td>11</td>
</tr>
<tr>
<td>Superficial veins only*</td>
<td>2</td>
</tr>
<tr>
<td>Total long saphenous incompetence</td>
<td>87</td>
</tr>
<tr>
<td>Total short saphenous incompetence</td>
<td>21</td>
</tr>
</tbody>
</table>

* Both derived from a competent long saphenous trunk.

Table 2. Summary of outcome: duplex compared with continuous wave Doppler.

<table>
<thead>
<tr>
<th>System</th>
<th>Potential sites for exploration</th>
<th>Long saphenous</th>
<th>Short saphenous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duplex</td>
<td>&quot;Missed&quot;</td>
<td>87</td>
<td>21</td>
</tr>
<tr>
<td>Continuous wave Doppler</td>
<td>&quot;Missed&quot;</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>&quot;Inappropriate&quot;</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>

Discussion

The distinction between incompetence confined to the long saphenous trunk (what could be termed “segmental” reflux) and incompetence commencing at the saphenofemoral junction descending downwards (termed “contiguous” reflux) has been mentioned in the method section.

The results of a comparison between the findings on CWD and duplex in this respect was as follows: of the 87 limbs with long saphenous incompetence, there were 60 with contiguous reflux on duplex. Of these there was concurrence with CWD in all but 10, which were thought to be "Truncal". Of the remaining 27 with segmental reflux on duplex, 10 were thought to be contiguous on CWD. Of the five limbs with long saphenous incompetence that were incorrectly identified as being of short saphenous origin (mentioned above), all were demonstrated to have “segmental” reflux on duplex.

A summary of the outcome for the two systems reviewed together is shown in Table 2. This is presented as the operative strategy that would have been employed on the basis of CWD alone, compared with that based on duplex findings.

Long saphenous system; contiguous vs. segmental reflux

false negatives (sensitivity 95%). In three of these patients long saphenous incompetence was incorrectly attributed to the short saphenous system. In the final patient, combined long and short saphenous incompetence demonstrated on duplex was recognised in only the latter system on CWD. There were no false positives (specificity 100%).

Short saphenous

Of the 21 limbs with short saphenous incompetence, CWD correctly identified 19. There were two false negatives (sensitivity 90%). In both of these patients combined long and short saphenous incompetence was present on duplex, the former being correctly identified and the latter missed on CWD.

There were five false positives, (specificity 93%), of which three were long saphenous incompetence wrongly attributed to the short saphenous system. Three of these are the same limbs as mentioned above under the long saphenous system. The final two limbs had been wrongly attributed to combined long and short saphenous incompetence, when on duplex the reflux was in fact confined to the long system alone. (This long saphenous component had thus been correctly identified on CWD.)

A summary of the outcome for the two systems reviewed together is shown in Table 2. This is presented as the operative strategy that would have been employed on the basis of CWD alone, compared with that based on duplex findings.

Discussion

The outcome of a study such as this will depend on a number of factors, not least of which will be the technique of CWD assessment and the type of patients studied. For instance, DePalma found a relatively poor correlation when looking at the saphenofemoral junction. However, the patients included a number of recurrences, and the insonation with CWD probe was placed at groin level and a number of false positive results arose from other veins close to the bulb of the femoral vein. Furtheronere, recurrent varicose veins present a more complex morphology.

In the final analysis, CWD, deployed in the manner described here, would seem to be a quick and adequate method for examining the long saphenous system. The only significant area of disparity was the status of the actual saphenofemoral junction, where there was disagreement either way as to the state of competence of the uppermost valve(s). But whether or not the reflux is confined to the trunk alone, or whether this extended up to and included incompetence at the saphenofemoral junction would seem, in practical terms, to be of little more than an academic distinction. What is needed for planning surgical strategy is the correct identification of the system of origin of the varicosities and the presence of reflux within that saphenous system. Indeed, the point at which a particular valve begins to "reflux" is to some extent
arbitrary. It is a function of the degree to which it is stressed, e.g. by coughing, and the criteria pre-determined as indicative of “incompetence”.

When it comes to the saphenopopliteal junction, however, the outcome of CWD evaluation was less satisfactory. Although it demonstrated the majority of cases with reflux at this site, there were five limbs in which reflux in the long saphenous system was incorrectly diagnosed as saphenopopliteal reflux. This would have led to an inappropriate exploration of the popliteal fossa.

In retrospect, could any additional test have been applied in the light of these findings to improve on this serious deficiency of CWD assessment? A positive cough impulse was not tested for, and might have alerted suspicions, suggesting an origin from the groin. But this, in fact, would not have been helpful. Interestingly, and perhaps significantly, the reflux in the long saphenous system in all five patients incorrectly misdiagnosed as of short saphenous origin on CWD was segmental and confined to the trunk. The saphenofemoral junction itself was competent, and thus there would not have been a positive cough impulse even if tested for.

It would seem prudent, therefore, that all “reflux” found in the popliteal fossa on CWD should be checked with duplex before proceeding to surgery. This observation is underscored by the variety, complexity and multiplicity of patterns of reflux in the popliteal fossa that can be demonstrated on duplex.⁶

In a similar study reported by McMullin and colleagues, of 136 patients CWD detected 73% of those with long saphenous incompetence, but only 33% of those with saphenopopliteal reflux.⁷ Thus the findings, although similar in some respects to those reported here, showed that CWD was generally less effective. This may be a reflection of the manner in which it was used.

A by-product of this study is that it gives information into the pathogenesis and morphological development of varicose veins. No patients were found in whom varicosities arose directly from a perforating vein independently of either saphenous system. This may seem in contrast to the report of Quigley.⁸ In this study on similar clinical material they concluded, on the basis of duplex examination, that 28% of varicosities were derived from “perforator incompetence”. However, they did not specify whether or not these were transmitted via a segment of locally incompetent saphenous system, either long or short. It seems likely that this was indeed the case.

On the basis of the findings in this study, it seems that the majority of varicose veins are derived from one or other saphenous system and that incompetence emerges with time at some point in that trunk, to spread down and up to involve the saphenofemoral/popliteal valve in due course. It is likely that in a proportion the process may start at those junctions and descends downwards. Varicosities arising directly from perforating veins independently of either saphenous system would seem, on the basis of the patients studied here, to be uncommon in primary (non-recurrent) varicose veins.

References


Eur J Vasc Endovasc Surg Vol 14, December 1997


Accepted 9 May 1997