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## The Role of Popliteal Vein Incompetence in the Diagnosis of Saphenous-popliteal Reflux Using Continuous Wave Doppler

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**Introduction:** continuous wave Doppler (CWD) has good discriminatory power at the groin in the assessment of saphenous femoral junction (SFJ); however, it is not as accurate as duplex ultrasound scanning (DUS) in the popliteal fossa for assessment of saphenous popliteal junction (SPJ) in patients with primary short saphenous vein incompetence.

**Aim:** the aim of this study was to compare the findings of CWD with those of DUS at the SPJ and assess the role of popliteal vein incompetence in the accuracy of CWD.

**Method:** prospective study of consecutive patients presenting to a vein clinic requiring a duplex scan of their SPJ. Each patient was examined by one surgeon using CWD and by one radiologist using DUS. Each observer was unaware of the other's findings. Additional information on the competence of the popliteal vein on DUS was also recorded.

**Results:** some 171 limbs in 128 patients with varicose veins were studied. One hundred and sixteen limbs had reflux at SPJ on CWD whilst 55 did not. Their mean age was 54 (range 18–85). Female to male ratio was 3:1. Spearman's rank correlation between CWD and DUS has 0.49 ( $p=0.0001$ ). CWD has a sensitivity of 92% and specificity of 53% (PPV = 62%, NPV = 89%, accuracy = 70%). Twenty-nine limbs had an incompetent popliteal vein (IPV). Of those, 12 limbs also had incompetence on CWD and competence on DUS at the SPJ, which represent 28% of the total number of limbs with these findings ( $n=43$ ).

**Conclusion:** CWD is sensitive in detecting incompetence at SPJ, though its specificity is low. In this study 17% ( $n=29$ ) of all patients had incompetence of popliteal vein. Up to 25% ( $n=12$ ) of patients with SPJ incompetence on CWD (Doppler +) and competence on DUS (duplex -) had incompetence of the underlying popliteal vein, which may explain the low specificity. The presence of SPJ incompetence on CWD should be confirmed on DUS prior to surgery.

**Key Words:** Popliteal vein incompetence; Saphenous-popliteal vein incompetence; Continuous wave Doppler; Duplex scanning; Varicose vein surgery.

### Introduction

Duplex ultrasound (DUS) imaging has been recommended before all operations for varicose veins,<sup>1</sup> as it is considered the gold standard prior to decision making in varicose vein surgery.<sup>1–3</sup> However, others have recommend the use of selective criteria for duplex scanning for varicose veins in order to decrease the workload in the vascular laboratory, without compromising patient care.<sup>2,4</sup> Duplex imaging requires expensive equipment and expertise,<sup>1</sup> and unrestricted access to duplex imaging is not feasible logistically in some hospitals. It should be unnecessary if continuous wave hand-held Doppler (CWHHD) could be shown to be an adequate screening test for venous reflux.<sup>3</sup>

Hand-held Doppler is a simple, non-invasive technique, which can be readily used in an outpatient assessment of venous disease to assist planning for venous surgery in selected cases.<sup>2</sup> Hand-held Doppler has been shown to have good discriminatory power at the groin in the assessment of the saphenous-femoral junction (SFJ)<sup>2–4</sup> with a sensitivity of 91%,<sup>3</sup> 92%<sup>5</sup> and 95%.<sup>6</sup> However, its accuracy at the saphenous popliteal junction (SPJ) varies widely from a sensitivity of 36%,<sup>7</sup> 44%,<sup>5</sup> 77%,<sup>1</sup> 80%,<sup>2</sup> 91%,<sup>8</sup> to 98%.<sup>6</sup> This may be due to the inability of the hand-held Doppler probe to differentiate between the popliteal vein and the short saphenous vein, or due to the anatomical variation in the site of saphenous popliteal junction, or because of reflux in the Giacomini vein which connects the long and short saphenous system.<sup>2</sup>

There are already some published studies examining the role of popliteal vein (PV) incompetence in venous disease. They have shown that popliteal vein incompetence predisposes to postoperative deep vein

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thrombosis,<sup>9</sup> is an important factor in the pathogenesis of venous disease<sup>10</sup> and its presence is an indicator of poor response to compression therapy for venous ulceration.<sup>11</sup> However, there is a lack of evidence explaining the wide range of accuracy of CWHHD at the SPJ. Our presumption is that popliteal vein incompetence may account for some of the wide variation in the accuracy of CWHHD in the diagnosis of SPJ incompetence.

### Aims

- To determine the accuracy of hand-held Doppler assessment of patients with saphenous popliteal junction (SPJ) reflux compared with duplex scanning.
- To assess the role of popliteal vein reflux in the accuracy of hand-held Doppler at the popliteal fossa.

### Methods

This was a prospective study of consecutive patients attending a vein clinic. Patients were examined by one consultant vascular surgeon using continuous wave hand-held Doppler (Huntleigh Technologies, Cardiff, U.K.) with an 8 MHz probe or a 5 MHz probe. The patient was asked to stand on a stool and weight bear on the side not under investigation. The popliteal fossa was examined by first locating signals from the popliteal artery. The probe was then moved whilst squeezing and releasing the calf to detect signals from the short saphenous vein and the SPJ. On calf release, the presence of reflux was noted. Reflux lasting one second or greater was deemed significant.

At a separate appointment each patient underwent venous duplex ultrasound scanning by a consultant radiologist. The radiologist was unaware of the hand-held Doppler findings. Duplex scans were performed using a Toshiba SSA-278A machine, with a 7.5 or 5 MHz probe. Patients were examined in the same position as for CWHHD. SPJ reflux, SSV incompetence and popliteal vein incompetence were assessed visually on colour flow imaging with intermittent manual calf compression. Retrograde flow of greater than 1 s was considered significant. Pulse wave Doppler scans were performed for confirmation in borderline cases.

### Results

There were some 171 limbs with varicose veins in 128 patients. The mean age was 54 years (range 18–88

**Table 1. The saphenous popliteal junction findings on CWHHD and DUS.**

	DUS+	DUS–	Total	IPV
CWHHD+	73	43	116	27
CWHHD–	6	49	55	2
Total	79	92	171	
IPV	17	12		29

IPV, incompetent popliteal vein.

**Table 2. Accuracy of SPJ findings of CWHHD versus DUS.**

Sensitivity	Specificity	PPV	NPV	Accuracy
92%	53%	62%	89%	70%

years). The female to male ratio was 3:1. Table 1 compares the SPJ findings of CWHHD versus DUS.

One hundred and sixteen limbs showed reflux at SPJ using CWHHD, but only 73 of those are true positive (reflux at SPJ) using the “gold standard” DUS. Fifty-five limbs did not have reflux at SPJ using CWHHD, with 49 of those shown to be true negative (no reflux at SPJ) using DUS.

The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of continuous wave hand-held Doppler assessment compared with duplex ultrasound scanning are shown in Table 2.

CWHHD is sensitive (92%) in detecting incompetence at SPJ, though its specificity is low (53%). In this study 17% ( $n=29$ ) of all patients had incompetence of the popliteal vein. Up to 28% ( $n=12$ ) of limbs with SPJ incompetence on CWHHD and competence on DUS had incompetence of the underlying popliteal vein. If those limbs with incompetence of popliteal vein ( $n=12$ ) were subtracted from those with CWHHD positive and DUS negative then the specificity would have been 61% (49/80) and the accuracy would have improved up to 82%.

### Discussion

Varicose veins provide a significant workload for the vascular surgeon: 85 000 new patients are seen and 55 000 operations for varicose veins per annum are performed in the U.K. and Ireland.<sup>12</sup> The introduction of CWHHD and the availability of duplex ultrasound have led to changes in management, with more patients having secondary investigation before treatment and fewer patients being placed directly on waiting lists.<sup>12,13</sup>

Duplex imaging is time consuming (examination takes 15 min for one leg; 30 min for both) and costly

both in terms of the capital cost of the equipment and in manpower costs. Accuracy of the results using duplex depends on the experience of the operator and should be performed as close to the time of surgery as possible if its benefits are to be maximised. Invariably, when duplex is performed a waiting list develops because of the workload volume.<sup>1,4,10</sup>

CWHHD could address the above by reducing the volume of workload, improving waiting lists and reducing the overall costs if it could be relied on solely for decision-making prior to surgery planning. This has already been the case in the assessment of SFJ incompetence in patients with primary varicose veins in the groin.<sup>4</sup> However, CWHHD has not been shown to be accurate enough at the SPJ in the popliteal fossa to be relied on prior to surgery planning.

In this study some inaccuracies in detecting reflux have been demonstrated despite attempts to minimise observation errors by restricting assessment to one examiner. This study suggests that popliteal vein reflux is responsible to some extent for the poor accuracy of CWHHD in the diagnosis of SPJ reflux. The prevalence of popliteal vein incompetence was 17% in this group of patients, which is similar to other studies.<sup>14</sup> Up to 28% of limbs with CWHHD reflux and DUS competence at SPJ had incompetence of the popliteal vein. This may not be surprising, as the signal from the popliteal always appears to be stronger from that of the saphenous vein on duplex examination. It therefore seems likely that the CWHHD is demonstrating reflux from the popliteal vein on interrogating the popliteal fossa. Thus, in this subgroup of patients with CWHHD reflux and DUS competence, surgery would have been inappropriate in over a quarter (28%) cases if the CWHHD information was the basis for the operative decision making.

We conclude that popliteal vein incompetence is influencing the accuracy of CWHHD on the popliteal fossa. Therefore, even in an overworked vascular service, all patients with SPJ incompetence detected on

CWHHD should have additional DUS evidence in order to avoid unnecessary operations.

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