

# Doppler ultrasound improves pulse identification

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## Article points

1. The standard method of assessing foot pulses used in annual foot screening for people with diabetes may be unreliable.
2. Doppler ultrasound may more reliably assess foot pulses than manual palpation alone.
3. In this study, adding Doppler ultrasound to manual foot assessment significantly improved the accuracy of pulse identification in the sample population and resulted in more appropriate GP reviews and referrals to hospital.

## Key words

- Diabetic foot assessment
- Preventing vascular complications
- Foot pulses
- Doppler ultrasound

Author details are given at the end of this article.

It is recommended that people with diabetes undergo annual neurological and foot pulse assessment as part of screening for complications of diabetes (NICE, 2004). It has been suggested by Brearley et al (1992) and Lundin et al (1999) that there may be a degree of unreliability in the use of the manual palpation technique to assess foot pulses. The authors conducted a study in a primary care practice to see if Doppler ultrasound would result in more accurate pulse assessment and, therefore, more appropriate diabetes management.

Foot pulse assessment as part of screening for complications of diabetes is usually carried out by the GP or practice nurse. However, there is evidence that the standard method of pulse assessment, manual palpation, can be unreliable (Brearley et al, 1992; Lundin et al, 1999), as the technique requires considerable training and experience to perform properly. More reliable methods of assessing blood flow, such as colour duplex sonography, Doppler ankle-brachial pressure index (ABPI) and toe pulse oximetry, are unsuitable for use in general practice owing to the cost, need for expertise and time constraints (Johansson et al, 2002). Studies indicate that identification of pulses by Doppler ultrasound might be more reliable than manual palpation alone in assessing foot pulses (Magee et al, 1992; Boyko et al, 1997), but this method has

not been tested in people with diabetes visiting their GP as part of the annual review process within the UK. This study was conducted to determine the most appropriate methods for screening for foot pulses in diabetes and fits with the DoH and Medical Research Council (2002) recommendations for further research.

## Aims

The purpose of this study was to investigate whether or not the addition of Doppler ultrasound to manual palpation improved the accuracy of foot pulse assessment in people with type 2 diabetes in general practice and how this impacted upon management decisions. The specific aims were as follows.

- To compare the assessment of pulses by the practice nurse, specialist vascular nurse,

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1. All people with a duration of type 2 diabetes of more than 10 years who were registered at the general practice were invited to take part in the study
2. For each assessment pulses were recorded independently as normal, diminished or absent.
3. Sixty individuals agreed to take part in the study and eight were excluded owing to missing data.

GP and vascular registrar using manual palpation, Doppler ultrasound, or Doppler ultrasound and manual palpation combined (Doppler+manual).

- To assess the effect of Doppler ultrasound on the appropriateness of referral and follow up in people with diabetes.

**Methods**

Three centres were involved in the study: Tylorstown GP Surgery in Rhondda Cynon Taf; the Vascular Unit at the Royal Glamorgan Hospital, Llantrisant; and the School of Care Sciences, University of Glamorgan. Ethical approval was obtained from the School of Care Sciences Ethics Committee, University of Glamorgan and Bro Taf Local Research Ethics Committee. The surgery is in a rural setting with high levels of social and economic deprivation: the staff consists of five GPs and two practice nurses who provide care for approximately 6200 people.

In the summer of 2004, all people with a duration of type 2 diabetes of more than 10 years who were registered at the general practice were invited to take part in the study (n=100). Four foot pulses (dorsalis pedis and posterior tibial) per person were assessed by a practice nurse, specialist vascular nurse, GP and vascular surgical registrar in random order using manual palpation, Doppler ultrasound (Dopplex 8MHz hand-held probe, Huntleigh Healthcare, Luton) and Doppler+manual.

Clinicians identified individuals by an identification number and the same limited medical history details were available to each of them (duration of diabetes; smoking status; and if the person suffered from claudication, cramp, ulcers, swollen feet, pins and needles or numbness). Each healthcare professional did not know which other clinicians had already

examined the person with diabetes, how the other clinicians had rated pulses or their referral decisions.

For each assessment, pulses were recorded independently as normal, diminished or absent, and each clinician's intended decision to refer to the hospital or review at 6 or 12 months was documented.

Waveform print-outs of all pulses were then obtained by the specialist vascular nurse and the print-outs, medical history details and registrar's assessments were reviewed blindly by a consultant vascular radiologist who rated pulses as before.

Data were analysed in SPSS (SPSS Inc., Chicago) using the non-parametric Chi-square test. The outcome measures were as follows.

- Pulse assessment. For the four clinicians, three approaches (manual, Doppler and Doppler+manual) were compared with the radiologist's opinion.
- Follow-up decisions. For the four clinicians, three follow-up decisions were compared: referral to the vascular surgeon or diabetologist at the hospital; follow up at 6 months; follow up at the annual review.

**Results**

**The sample**

Sixty individuals agreed to take part in the study. Eight were excluded owing to missing data, giving a sample of 52 people (28 male, 24 female; mean age 66 years [range 29–92 years]; mean duration of diagnosis 13.8 years [range 2–52 years]). Nine people were current smokers, 21 had never smoked and 22 had given up. Thirty-five individuals experienced cramp, one had skin ulcers and 19 reported pins and needles, claudication, swollen feet or numbness.

**Pulse assessment**

Manual assessment was most accurate when undertaken by the vascular nurse specialist with 66.8% agreement with the radiologist, followed by the registrar (53.6%), GP (44.2%) and practice nurse (35.1%; *Table 1*). By adding a Doppler probe to the manual assessment, the accuracy of pulse assessment in all clinicians showed a mean improvement of 17.8% (range 9.6–24.8%). The accuracy of pulse assessment was not significantly

Table 1. Agreement of pulses (n=208) with the radiologist's assessment (%).

	Manual	Doppler	Doppler + manual	P-value†
Vascular nurse	66.8	75.5	76.4	0.03
Registrar	53.6	78.8	78.4	<0.001
GP	44.2	66.3	65.8	<0.001
Practice nurse	35.1	50.0	50.2	0.004

†P-values relate to manual versus Doppler

different when comparing Doppler alone with Doppler+manual.

Of the 208 pulses analysed by the radiologist, 73.1% were rated as normal, 22.1% as abnormal and 4.8% as absent. The hospital practitioners recorded a higher proportion of normal pulses using Doppler+manual palpation than the practice staff. The data in Table 2 are expressed in terms of predictive values where the positive and negative prediction is respectively displayed in terms of the proportion of abnormal and normal pulses identified correctly in agreement with the radiologist's assessment. The results show an interesting difference in the skills of the general and hospital practitioners based on their ability to detect normal and abnormal pulses.

**Follow-up**

The use of Doppler+manual assessment for foot pulses significantly reduced the number of intended referrals and reviews from the 208

patient-clinician consultations (Table 3). The introduction of combined Doppler and manual assessments resulted in each clinician intending to refer between 66.7% (vascular nurse) and 100% (practice nurse) fewer people to hospital. With combined Doppler+manual assessment, there were four intended referrals to the specialist clinic by all clinicians in comparison to the 38 by manual assessment only. In addition, the clinicians reported they would request 35 fewer follow-ups at 6 months (41 versus 76) and 68 more at 12 months (162 versus 94). Differences in intended referrals for manual versus Doppler+manual were significant for each clinician (GP and vascular nurse,  $P=0.025$ ; registrar and practice nurse,  $P<0.001$ ). There was no significant difference in the intended management of people with diabetes when using Doppler only in comparison to Doppler+manual.

We asked the four clinicians and the radiologist to list, in order of importance, the criteria that they used for immediate referral and for follow-up at 6 and 12 months. We found no obvious agreement between them in terms of the criteria they used for standards of referral. For example; rest pain, claudication (varying from 10–100 yards) and ulceration or gangrene were in the top four criteria for immediate referral in four out of the five clinicians (all but the practice nurse), although the order of their importance varied. Absent pulses were considered important by the practice nurse, specialist vascular nurse and the GP; but not by the consultant vascular surgeon or the registrar.

Brookes (2001) similarly reported the absence of standardised foot assessment tools and referral standards within the community and general practice settings. A study in which the referral patterns and criteria of GPs and nurse practitioners are examined would enable well-defined referral guidelines to be established where there are currently none.

**Discussion**

Pulses were most accurately assessed using Doppler or Doppler+manual. There was little difference between Doppler alone and Doppler+manual in the accuracy of pulse detection. It is possible that the Doppler-alone assessment was very similar to

Table 2. Analysis of pulse data (Doppler + manual palpation versus radiologist's opinion).

	(%) positive prediction	(%) negative prediction
Vascular nurse	30.4	96.1
Registrar	46.4	94.1
GP	60.7	71.7
Practice nurse	53.6	52.0

Table 3. The influence of Doppler ultrasound on clinicians' follow-up decision of 208 consultations, n(%).

Outcome	GP	Practice nurse	Vascular nurse	Registrar	All clinicians combined
<b>Refer</b>					
Manual	12(23.1)	16(30.8)	3(5.8)	7(13.5)	38(18.3)
Doppler	5(9.6)	1(1.9)	2(3.8)	1(1.9)	9(4.3)
Doppler+manual	2(3.9) <sup>†</sup>	0(0.0)	1(1.9)	1(1.9)	4(1.9)
<b>Review 6 months</b>					
Manual	20(38.5)	22(42.3)	12(23.1)	22(42.3)	76(36.5)
Doppler	21(40.4)	13(25.0)	5(9.6)	7(13.5)	46(22.1)
Doppler+manual	21(41.2) <sup>†</sup>	10(19.2)	3(5.8)	7(13.5)	41(19.8)
<b>Review 12 months</b>					
Manual	20(38.5)	14(26.9)	37(71.2)	23(44.2)	94(45.2)
Doppler	26(50.0)	38(73.1)	45(86.5)	44(84.6)	153(73.6)
Doppler+manual	28(54.9) <sup>†</sup>	42(80.8)	48(92.3)	44(84.6)	162(78.3)
<b>P-values<sup>‡</sup></b>					
Manual versus Doppler	0.20	<0.001	0.20	<0.001	
Manual versus Doppler+manual	0.025	<0.001	0.025	<0.001	
Doppler versus Doppler+manual	ns	ns	ns	ns	

ns = non-significant

<sup>†</sup>n=207 consultations; <sup>‡</sup>Practitioner change in patient management (Chi-squared test);

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1. The introduction of Doppler ultrasound resulted in more appropriate patient follow-up.
2. The Doppler probe is now used routinely in the assessment of the diabetic foot in surgery.
3. The addition of a simple hand-held Doppler investigation improved the accuracy of pulse identification.

the Doppler+manual assessment, as it occurred immediately after the manual assessment. In the clinical setting, it is highly unlikely that a Doppler assessment would ever take place without a manual assessment as clinicians will need to locate the area of the pulse by hand and will also be checking for other signs such as temperature of the limb.

The introduction of Doppler ultrasound resulted in more appropriate follow-up with clinicians intending to refer significantly fewer people to hospital, as well as review fewer at 6 months and more at 12 months. This outcome is beneficial to people with diabetes and service providers as it means those with diabetes do not have to undertake unnecessary visits to their GP or hospital clinic; and healthcare professionals' time is better utilised, therefore providing a more efficient and potentially a more cost-effective service.

The study is limited by its size; only one general practice surgery was included and just over half of those who were eligible took part. Therefore, the results cannot be extrapolated to a wider population. A larger study including more general practices over a wider geographical area and including a cost-benefit analysis, appears indicated. Five per cent of pulses were rated as absent by the radiologist which was too small a number to enable further analysis and Doppler ultrasound appeared to be the most useful in identifying normal pulses. A larger study would enable the usefulness of Doppler ultrasound in people with absent or abnormal pulses to be explored further.

The practice nurse underwent an afternoon of training in manual palpation and the use of Doppler ultrasound in preparation for this study as she was inexperienced in its use compared with the other clinicians. This training was carried out by the specialist vascular nurse as part of her normal clinical role. The need for standardised training of community nurses in the use of Doppler ultrasound has already been called for (French, 2005).

### Conclusions

The addition of a simple hand-held Doppler assessment significantly improved the accuracy

of pulse identification and resulted in more appropriate GP reviews and referrals to hospital in the sample group. In light of these results, continuing the current practice of assessing pulses manually within the study surgery cannot be justified and the Doppler probe is now used routinely in the assessment of the diabetic foot. This only takes an extra couple of minutes compared with ABPI, which can take around 20 minutes. People with diabetes now benefit from improved care and more appropriate follow up.

Further investigation is needed to determine if this finding is similar in general practices in other areas. Studies are warranted that focus on the usefulness of Doppler ultrasound in assessing absent or abnormal pulses; the training requirements of practice nurses in running annual review clinics; and the establishment of standards for the referral and review of people with diabetes attending these clinics. In addition, further study into neurological assessment and a multidisciplinary approach to detecting diabetic foot complications would also be beneficial. ■

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