Ann R Coll Surg Engl 1995; 77: 224–226

SURGICAL TECHNIQUE

Use of hand-held Doppler to identify 'difficult' forearm veins for cannulation

Mark S Whiteley FRCS
Lecturer in Surgery

Alun R Williams BA(Oxon)
Medical Student

Bernard Y P Chang MB ChB
House Officer

Hilary C Manton MB ChB
Senior House Officer

Howard P Marsh MB ChB
House Officer

Michael Horrocks MS FRCS
Professor of Surgery

Department of Surgery, Royal United Hospital, Bath

Key words: Doppler; Vein; Cannulation

Intravenous cannulation is a necessary procedure in many hospital patients. Some patients are regarded as having 'impossible' veins that are invisible and impalpable despite venous tourniquet. We investigated the use of a hand-held Doppler to identify veins suitable for percutaneous cannulation in such patients.

A total of 24 arms in 12 patient volunteers with invisible and impalpable forearm veins was studied by squeezing the ipsilateral hand and using a hand-held 8 MHz Doppler probe on the forearm. Each venous signal was noted and the loudest chosen. Classification as 'good' or 'poor' was made on signal strength. The best signal was then mapped and the direction was indicated by a line on the skin. Each forearm was examined using a colour-flow Duplex. All veins were noted and diameters measured with and without tourniquet. These results were compared with the best veins found by hand-held Doppler.

In all, 23 (96%) arms had the largest vein correctly identified by the hand-held Doppler. All 19 (100%) described as 'good' on signal had a diameter of 2.0–4.2 mm (mean 3.2 mm). All 4 (100%) described as 'poor' on Doppler signal had diameters of 1.4–1.7 mm (mean 1.6 mm).

Hand-held Doppler, used as described, can accurately identify forearm veins larger than 2.0 mm in diameter in patients with invisible and impalpable veins with venous tourinquet. These veins should be amenable to percutaneous cannulation.

Correspondence to: Mark S Whiteley, Department of Surgery, Royal United Hospital, Bath BA1 3NG

One of the most irksome tasks encountered by junior doctors in the hospital setting is the siting of intravenous cannulas. As with all similar skills, experience increases success.

Although it is said that practice makes perfect, there are patients who have forearms with no apparent superficial veins. Such forearms are often regarded as 'impossible' to cannulate.

The purpose of this study was to demonstrate that this need not be the case. A technique is described using a hand-held Doppler to accurately locate and map forearm veins that are clinically both invisible and impalpable.

Patients and method

A series of 12 inpatient volunteers from all specialties was selected by virtue of having neither visible nor palpable forearm veins on placement of an upper arm venous tourniquet. All had undergone unsuccessful attempts at venous cannulation during their admission. In this study 24 forearms from these 12 volunteers were investigated.

Each arm was examined by one of the two house officers or the medical student involved with this study, by the following technique.

The arm to be examined was held by the hand, with the examiner's thenar eminence covering the dorsum of the hand and the fingers curled around towards the volunteer's palm (Fig. 1). This allowed the hand to be squeezed firmly and rhythmically approximately every 2 s.

A line of ultrasound gel (Siel® sound gel) was applied

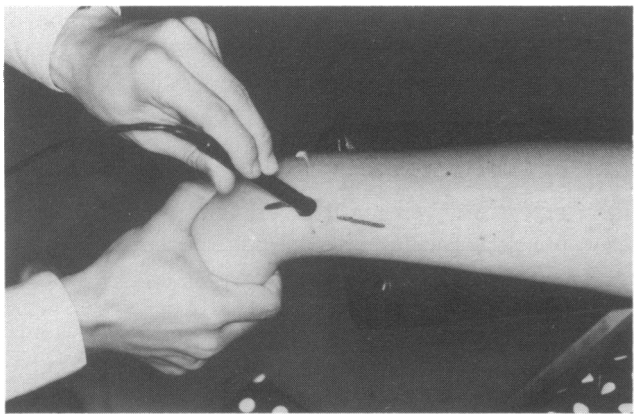

Figure 1. Technique for identifying 'difficult' forearm veins and marking their course on the skin.

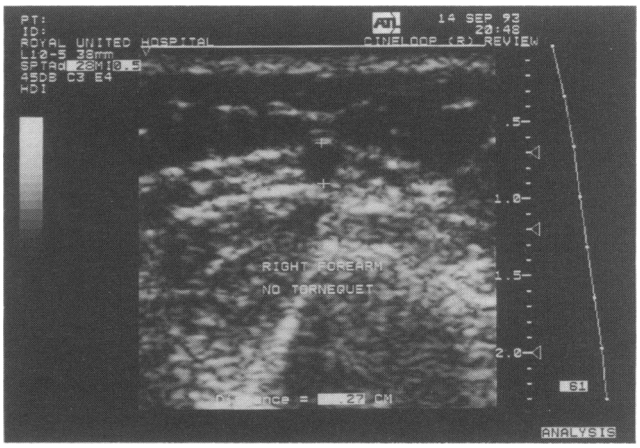

Figure 2. Duplex scan of forearm vein that was impossible to palpate, but was located accurately by the hand-held Doppler.

across the dorsum of the forearm, about 5 cm proximal to the wrist. An 8 MHz hand-held Doppler probe (SciMed®, UK) was then passed slowly across the gel, pointing up the forearm at 60° to the skin. The whole width of the dorsal forearm was examined from radial to ulnar artery at this level.

Venous flow was easily detected by a loud 'whoosh' that was synchronous with the squeezing of the subject's hand. The point of maximum signal was then marked using an indelible marker pen. If more than one vein was found by this method, the vein with the loudest signal was selected. Once the vein had been marked, further examination with the probe delineated the direction of the vein, which was then marked by a line.

The examiner graded the quality of the Doppler signal as either 'good' or 'poor'. 'Good' indicated a loud, easily insonated signal which the examiner felt confident was a vein amenable to cannulation. 'Poor' was reserved for a weak, poorly defined signal that left the examiner uncertain as to the vein quality.

Once marked, the volunteer was then sent to a separate room. A colour-flow Duplex examination (Ultramark 9®, ATL) of the dorsum of the forearm from radial to ulnar artery at this level, was performed by another investigator experienced in Duplex examination. All veins revealed by Duplex were checked for patency and then measured in the anteroposterior diameter. The vein with the largest diameter was selected as potentially the most suitable vein for cannulation (Fig. 2). It was then noted whether this corresponded with the marks previously placed on the skin.

Once this vein had been identified and measured, a tourniquet was applied to the upper arm. After 1 min, the diameter of the vein was remeasured. This would correspond to the size that the vein would be before attempted cannulation.

Results

The 24 forearms in 12 volunteers with clinically invisible and impalpable veins were examined as described earlier. In all, 23 (96%) had the largest vein identified and marked correctly by the hand-held Doppler. In one arm (4%) the vein was missed because it overlay the radial artery and was indistinguishable from the arterial signal.

Four forearms (17%) had 'poor' veins identified by weak Doppler signal. On application of a tourniquet, each of these was found to measure under 1.7 mm (mean 1.5 mm) in the anteroposterior diameter. Nineteen (79%) had 'good' veins identified by strong Doppler signal and the diameter of these ranged from 2.0 mm to 4.2 mm (mean 3.2 mm) with a tourniquet in place.

All of the identified veins were found to be between 4 mm and 9 mm below the surface of the skin.

Only 7 (29%) of the largest identified veins occurred over the lateral border of the radius, the expected site of the cephalic vein.

Discussion

It is the duty of the junior doctors in hospitals to secure intravenous access for most of the sick patients under their care. Plastic cannulas are usually placed in the antecubital fossa, forearm or dosum of the hand. The antecubital fossa is not ideal for cannulation except in an emergency, as it restricts the movement of the elbow and is therefore very uncomfortable. Those cannulas placed in the dorsum of the hand are painful to site and are prone to 'tissue' due to the movement of the hand.

The forearm is thus the preferred place for intravenous cannulation. The superficial veins here are usually easily palpable and are of a reasonable size. In addition there is little movement of the forearm and so the cannula is easily secured in place.

Unfortunately, there are patients in hospital who have invisible and impalpable superficial veins in the forearm. This can be due to considerable adipose tissue overlying the vein or multiple previous cannulations. Thus, attempting to cannulate these patients can be both time consuming and frustrating for the juniors responsible for their care.

Previous investigators have used hand-held Doppler

ultrasound successfully for cannulation of the radial artery in hypotensive patients *(1,2)*.

We have described a simple method by which patent superficial veins can be located and marked in the difficult forearm, using only an 8 MHz hand-held Doppler. We have also found that by this method it is possible to judge whether a vein is greater than 2.0 mm, a size likely to be amenable to percutaneous cannulation.

It is pertinent to note that only 7 (29%) of the veins identified as the largest vein, were in the position expected for the cephalic vein. This is often referred to as the 'houseman's' vein as it is fairly constant in position and size. However, as we have shown above in our sample of difficult forearms, the cephalic vein would not have been the most appropriate vein for cannulation.

It must be noted that although the direction and quality of the vein can easily be detected, the depth of the vein is not measured by this technique. However, on Duplex examination, all of the marked veins were between 4 mm and 9 mm from the skin surface and should therefore be easily found by the correctly aligned cannula.

We have described a simple yet accurate method of identifying superficial forearm veins that do not otherwise present themselves; the so called 'impossible' vein. The only equipment required is an 8 MHz hand-held Doppler and a marker pen. The technique was easily learnt and quickly mastered by the authors of this paper. In patients with 'impossible' veins who require intravenous access, we would recommend this technique before attempting blind cannulation.

References

1 Nagabhushan S, Colella JJ Jr, Wagner R. Use of Doppler ultrasound in performing percutaneous cannulation of the radial artery. *Crit Care Med* 1976; 4: 327.

2 Maher JJ, Dougherty JM. Radial artery cannulation guided by Doppler ultrasound. *Am J Emerg Med* 1989; 7: 260–2.

Received 18 August 1994