DIAGNOSIS OF DEEP VENOUS THROMBOSIS: ACCURACY OF COLOUR DOPPLER ULTRASOUND COMPARED WITH VENOGRAPHY

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ABSTRACT

Doppler ultrasound is becoming increasingly accepted as an accurate, non-invasive means of imaging in suspected deep venous thrombosis (DVT).

Several studies done abroad have reported (combined) sensitivity of 95% and specificity of 98%. Locally, however, we have still been relying primarily on venography to diagnose lower limb DVT.

We performed a prospective study to assess the accuracy of ultrasound compared to venography, in the local context.

Forty-one limbs were studied by ultrasound within 24 hours of a venogram examination. We assessed grey-scale appearance, compressibility, presence or absence of flow, and flow characteristics. Seventeen venograms were positive for DVT, and ultrasound was positive in all seventeen cases. There were two false positive ultrasound examinations. Two cases of small localised thrombi in the superficial femoral vein only were accurately detected by ultrasound. One case of isolated calf thrombosis was also successfully diagnosed.

Overall, sensitivity and specificity for detection of lower limb DVT was 100% and 91.7% respectively. Overall accuracy was 95.1%.

Keywords: *colour Doppler, deep venous thrombosis*

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INTRODUCTION

Deep venous thrombosis (DVT) of the lower limbs and its possible fatal sequelae, pulmonary embolism, has long been a clinical problem for which accurate and simple diagnostic tests have been sought. The clinical evaluation of suspected DVT is notoriously inaccurate, being correct only approximately 50% of the time[1-4]. Homan's sign, long espoused as a highly accurate sign of DVT, is present in less than one-third of symptomatic patients with DVT. Half of patients with a positive Homan's sign do not have DVT[5]. The signs and symptoms which may be produced by DVT can also be caused by several other conditions, eg Baker's cyst, cellulitis, haematoma, etc[5].

Contrast venography has classically been the gold standard for the diagnosis of DVT. While its accuracy is generally accepted, it is an uncomfortable procedure requiring intravenous injection of contrast material. Practical problems have also been encountered while attempting to perform venography, eg inability to cannulate a foot vein in a patient with a severely oedematous leg, and difficulty in very ill patients with multiple injuries or on respirators. Other tests include plethysmography, thermography, fibrinogen-I 125 scanning, and radionuclide blood-pool scanning. These are not widely available in Singapore, and the last two also require intravenous injections.

In the last few years, ultrasound has become increasingly accepted as an accurate, non-invasive mode of investigation for suspected DVT in overseas centres. Initially relying mainly on compression techniques,[6-9] duplex and colour Doppler capability in present-day machines allow evaluation of flow characteristics as well. Assessment of calf veins is also made easier with colour Doppler[10,11]. This study was undertaken to assess its accuracy in the local context, as the technique is relatively new locally.

MATERIALS AND METHODS

We studied 38 patients and a total of 41 limbs. These were randomly selected from patients attending for contrast venography. The age range was from 20 to 97 years, with a mean of 54.6. There were 15 male and 23 female patients.

The ultrasound examination was done by either of 2 of the authors, within 24 hours of the venogram, and often within the same morning or afternoon. The clinical diagnosis and reason for the venogram request was not known to the person performing the ultrasound. The sonologist was also blinded to the venogram result, if this had been done first. (In some instances the ultrasound was done before the venogram).

The procedure was explained to each patient, and verbal consent obtained. Initially an ALOKA SSD 650 with a 5 MHz curved linear array probe was used. We relied on grey-scale appearance, compression techniques and spectral Doppler analysis to make our diagnosis. An ACUSON 128/XP10 with a 5 MHz linear array probe became available about a quarter-way through the study, and we had the added benefit of colour Doppler for 29 cases. Scanning was done according to techniques described by Zweibel et al[12-14]. The veins from the groin to at least the popliteal fossa were examined, and an attempt to study

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the calf veins was made in each patient. A conclusion regarding the absence or presence and extent of DVT, based on ultrasound findings, was made. This was later compared with the venogram.

Contrast venography was done by the radiologist or supervised trainee rostered for that day following standard techniques[15]. Filling defects and non-opacification of veins proximal to a thrombus was taken as evidence of thrombosis.

RESULTS (Table I and Fig 1)

Seventeen venograms were positive for DVT. Ultrasound correctly diagnosed DVT in all these cases, giving a positive predictive value of 100%.

There were no false negative ultrasound examinations. Two false positive ultrasound examinations were obtained from the 24 cases with negative venogram. Overall accuracy for ultrasound was 91.5%.

There were 30 patients who were symptomatic for DVT in this study. Of these, 17 or 56.7% were confirmed to have DVT on venogram (and ultrasound).

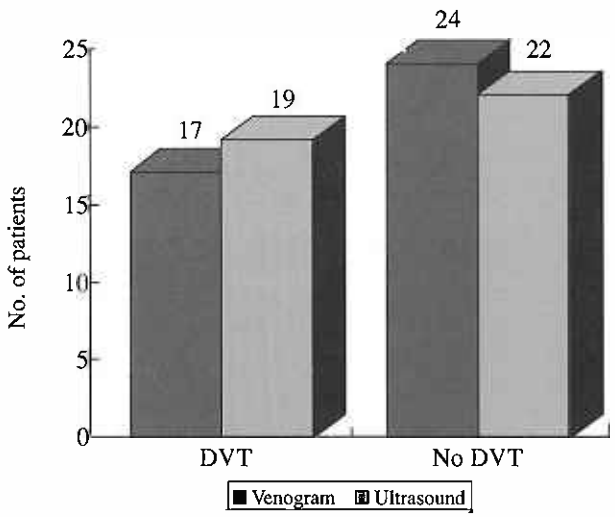
In two cases, there was only a small isolated thrombus in the superificial femoral vein. These were both detected on ultrasound.

In four cases in which thrombosis involving the popliteal segment did not extend up to the common femoral vein, the upper extent of the thrombus was accurately determined on ultrasound. In two cases, ultrasound overestimated the proximal extent of the thombosis, and in another two cases ultrasound underestimated.

Table I – Results

Specificity	= 91.5%
Sensitivity	= 100%
Accuracy	= 95.1%
Predictive value of a positive result	= 89.4%
Predictive value of a negative result	= 100%

Fig 1 – Comparison of duplex ultrasound with venogram results



Visualisation of the iliac vein in cases with clot in the common femoral vein was mostly unsuccessful. Limitations due to bowel gas were encountered.

Calf veins could be visualised at least with colour Doppler in twenty-three cases. Six of these had DVT on venogram, and ultrasound successfully detected this in all six. One patient had isolated calf vein thrombosis. This was correctly diagnosed on ultrasound.

DISCUSSION

Our results showed an encouraging 100% sensitivity with a negative ultrasound examination, giving a predictive value of 100%. The 2 false positive results lowered specificity to 91.5%. One patient was examined early in the study, and the false positive result was felt to be due to a combination of technical error (filter set too high) and patient factors (swollen leg limiting compressibility). The second patient had a suspicious venogram with very slow flow and suspected compression of the iliac vein. A CT scan of the pelvis however did not show any pelvic mass. The patient unfortunately died before we could repeat the ultrasound or venogram, and the discrepancy remained unexplained.

Cases with extensive thrombosis up to the proximal superficial and common femoral veins were usually easy to assess. Grey-scale appearance was often abnormal, with the vein appearing expanded and echogenic (Fig 2a, b), and loss of compressibility was evident (Fig 3). Minimal or no flow could be detected with colour Doppler. In non-occlusive clot, colour Doppler may show flow around the periphery of the clot in a manner analogous to venogram (Fig 4 a,b).

Fig 2a – Echogenic thrombus is seen within the distal iliac vein.

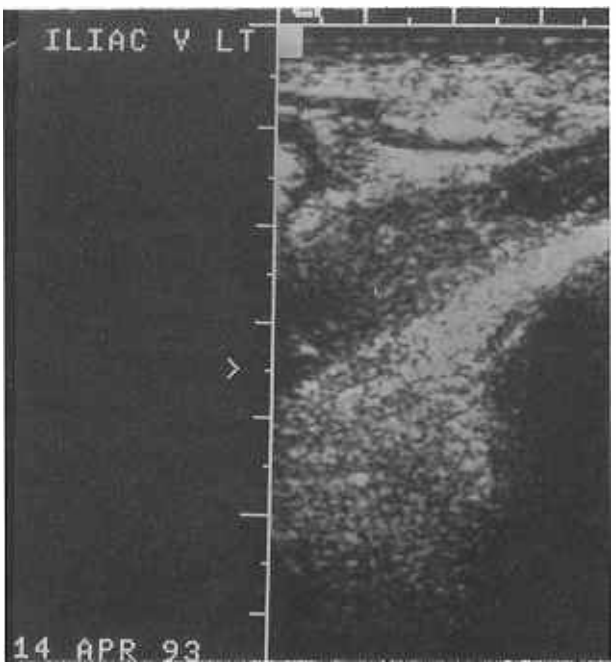


Fig 2b – The expanded, thrombus-filled vein (arrows) next to the smaller, anechoic artery (arrowheads) is clearly demonstrated on the transverse view.

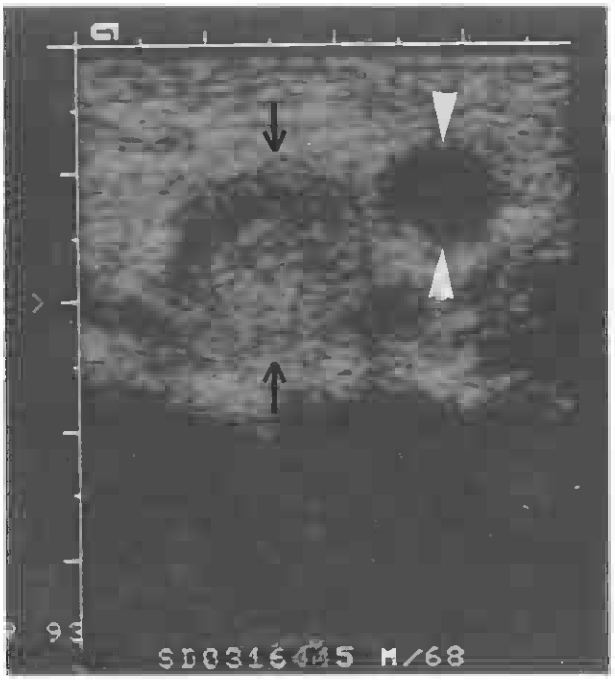
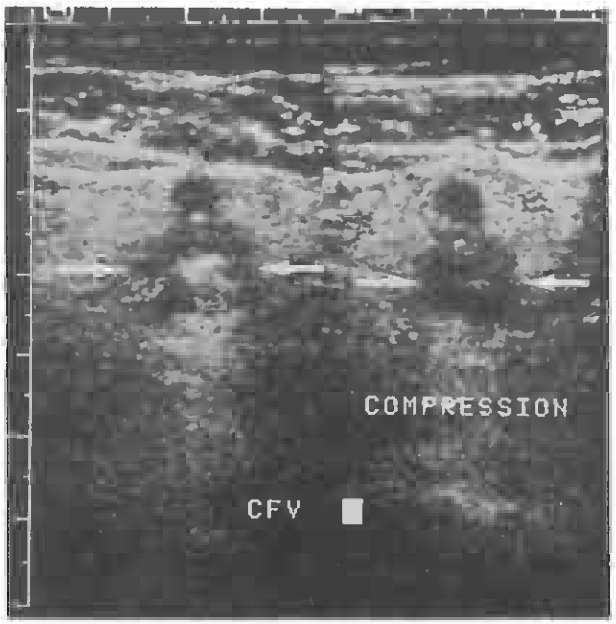


Fig 3 – Thrombus within the vein prevents the vein from being completely compressed (arrows).



We found loss of compressibility to be the most reliable sign as previously reported[7,8,13]. We had 2 cases with localised thrombus in only a segment of the distal superficial femoral vein, accurately diagnosed based on loss of compressibility and absent/partial flow in this segement. While it is known that there may be difficulty compressing the vein in the distal superficial femoral vein in Hunter's canal, supporting the back of the thigh and/or comparison with the opposite leg can usually overcome this problem. The need to examine the whole length of the deep veins and not just portions is illustrated by these 2 cases.

In another patient there was discrepancy between compressibility and Doppler findings. The veins appeared fully

Fig 4a – Colour Doppler shows flow around the periphery of the thrombus.

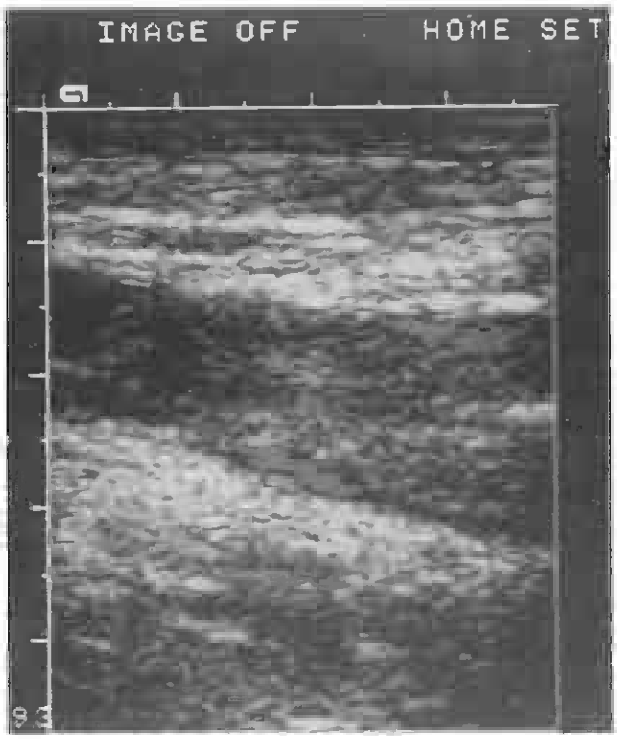
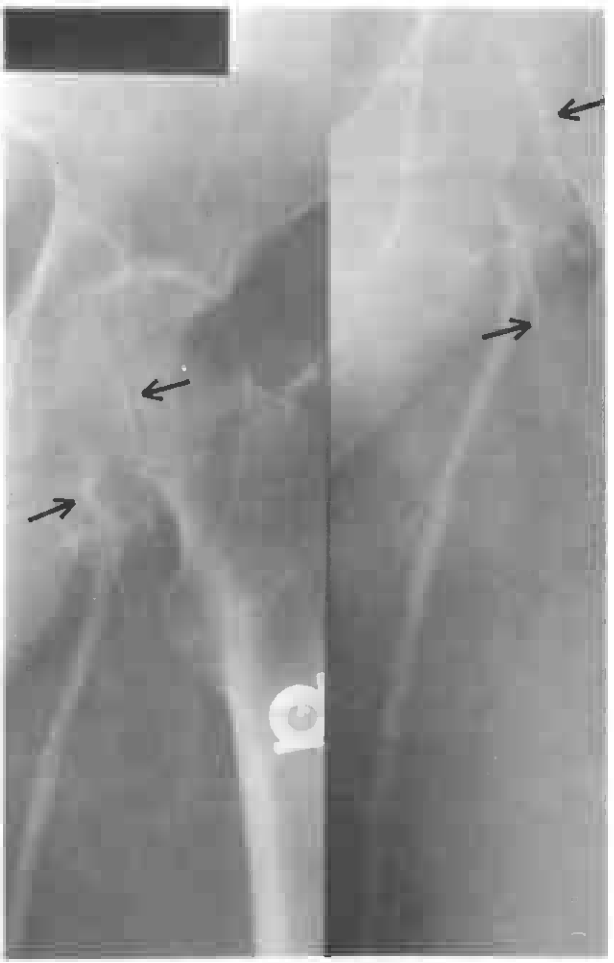


Fig 4b – Venogram in the same patient shows a similar picture of contrast streaming around the thrombus (arrows)



compressible, but no evidence of flow could be obtained with colour or spectral Doppler. We diagnosed that the patient did not have DVT based on the normal compressibility, and venogram subsequently confirmed this. It is known that absence or presence of colour flow can be affected by technical factors. In particular, colour can 'wash out' clot.

The need to diagnose/treat isolated calf vein thrombosis has long been debated. Many physicians feel that treatment is only needed if there is propagation into the popliteal vein, as the risk of pulmonary embolism from isolated calf thrombosis is low[16-19]. Ultrasound therefore need only assess the veins till the popliteal level, with a follow-up ultrasound being recommended if there is any doubt or suspicion of propagation[14]. However in our institution the physicians will treat isolated calf thrombosis, and we therefore attempt to assess the calf veins in all cases. Some recent studies have reported that the use of colour Doppler, with or without other manoeuvres like augmentation or standing the patient up, allows adequate visualisation of calf veins[11,20]. In our study, we could usually visualise the proximal veins in the upper calf, and the posterior tibial veins at the ankle (Fig 5 a, b). The results of some initial trials comparing the accuracy of ultrasound with venography in calf DVT show promise[21-25]. We hope to gain more experience in this area.

We also noted the lack of accurate correlation between clinical symptoms and DVT. In our series, 30 patients had signs and symptoms of DVT. Of these, only 17 or 56.7% actually had DVT on venogram (Table II). This corresponds to the accepted view that clinical assessment of DVT is highly unreliable, and correct only about 50% of the time[1-4].

Fig 5a – Expanded calf veins containing low-level echoes within. No evidence of flow was detected within them on colour Doppler or spectral analysis.

Table II – Patients with clinical features of DVT

Confirmed DVT	17 (56.7%)
No DVT	13 (43.3%)

CONCLUSION

Our results, despite the small series, compare favourably with the many previously published studies done overseas, with sensitivities ranging from 88 – 100% and specificities from 94 – 100%[8,26-32]. We had intended to study 50 patients, but increasing

Fig 5b – Venogram shows multiple filling defects in the calf veins, indicating extensive thrombosis.

confidence in Doppler ultrasound on the part of both ourselves and our hospital physicians, led to dwindling venogram requests. Doppler ultrasound is now almost always the requested examination of choice for patients with suspected DVT in our hospital.

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