Point of care ultrasound 3-point compression vs departmental scanning for lower limb DVT in ambulatory and internal medicine patients

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Abstract

Point of care ultrasound scanning (POCUS) is safe and effective in positively identifying lower limb DVT in emergency departments globally. In the UK, the requisite knowledge and skills are integrated into the FAMUS and FUSIC curricula.

Five FAMUS practitioners of varying experience performed 3-point compression POCUS on medical ambulatory and inpatients. Accuracy and timing of POCUS was compared between practitioners and with subsequent departmental scans.

89% sensitivity and 97% specificity were observed, with little difference between supervisors and candidates. Additionally, a significantly higher proportion of POCUS *vs* departmental scans (69% vs 7%, $p = 0.0001$) occurred within 24 hours of request.

Minimal experience was required to produce accurate results within ambulatory and internal medicine settings, and significant time savings can be made.

Keywords

DVT, POCUS, Diagnostic accuracy, Ultrasound

Key Points

- POCUS shows good correlation with departmental scanning in the diagnosis of DVT
- Accuracy is maintained for both experienced and relatively novice practitioners
- Scanning and reporting are both relatively quick, allowing integration into routine clinical practice
- Further work is required to test these findings in multiple sites and settings

Introduction

Point of care ultrasound scanning (POCUS) for the diagnosis of lower limb deep vein thrombosis (DVT) has been studied globally, but predominantly in the setting of the Emergency Department. It has been demonstrated to be a safe and effective tool in the positive diagnosis of lower limb DVT, with sensitivities and specificities ranging from 90-100%.[1-3] In the UK, the training necessary to acquire the knowledge and skills to perform three-point compression scans is integrated into two existing processes of accreditation, FAMUS and FUSIC.[4, 5]

Current NICE guidance on the diagnosis and management of proximal lower limb DVT (NG158) recommends that for patients with a high pre-test probability score (Wells Score ≥ 2 points) lower limb proximal venous ultrasound should be offered and that results should be available within 4 hours. Alternatively, if a scan is not available within 4 hours, it should be offered within 24 hours and interim anticoagulation given. In patients with low pre-test probability scores, similar time constraints for d-dimer results and subsequent imaging exist.[6]

Although many hospitals already have well established ambulatory pathways for the diagnosis and management of DVT, access to imaging may not be available outside of usual working hours or at times of particularly high demand, causing delays to diagnosis and potentially multiple hospital visits or clinician interactions. POCUS has the potential to reduce many of these inefficiencies. Such pathways are also usually less well-established in the inpatient setting, where departmental workloads can result in diagnostic delay, unnecessarily long hospital stays, exposure to the risks of thrombus and embolism without anticoagulation, as well as the risks of unnecessary anticoagulation.

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Finally, rapid diagnosis of DVTs can be of benefit in the management of acutely unwell patients with shock or respiratory failure, where positive identification may significantly alter immediate management.

In this local service evaluation involving FAMUS candidates and supervisors, we compare the accuracy of POCUS with departmental duplex venous sonography, to assess POCUS in the settings of an ambulatory care unit and in hospital inpatients in a UK district general hospital.

We show that POCUS is an effective and safe tool for the investigation of suspected lower limb DVT within our hospital inpatient and ambulatory patient population. We also show that it can be especially useful in reducing the time from clinical suspicion to diagnosis, and that even relatively inexperienced practitioners are able to scan with a high degree of accuracy.

Method

As this data was obtained as part of a local service evaluation, no ethical approval was required. Ambulatory patients were identified as being clinically suspected of having a lower limb DVT upon attendance to the ambulatory unit of a district general hospital and were included if they presented on a day when a practitioner was available to scan. Inpatients were identified from a central departmental list of patients awaiting venous sonography for suspected lower limb DVT, on days when practitioners were available to scan. All patients were scanned at the earliest opportunity and none were excluded on the basis of any patient characteristics.

Five practitioners were enlisted, comprising four FAMUS candidates and one FAMUS supervisor. The candidates each met the minimum requirement of having attended a one day FAMUS course within the last 12 months and having completed at least 5 supervised scans. The supervisor had over 3 years of regular point of care scanning experience. All POCUS were performed using a *Sonosite Xporte* ™ portable ultrasound machine initially using the linear probe (frequency 6-13 MHz) on 'venous' setting.

The study period comprised 3 months from December 2019 to February 2020 and another 3 months from May 2020 to July 2020 with a significant period of disruption due to the COVID-19 pandemic. Patients had a POCUS performed by one of the five practitioners using a three-point compression method (compression at the saphenofemoral junction, mid femoral vein and popliteal trifurcation) and the following was documented.

- Time that the DVT was first clinically suspected
- Time that each point of care scan was commenced
- Results of the POCUS, whether or not the practitioner considered the scan diagnostic and any other findings or observations of note.
- Results of the departmental scan
- Time of reporting of the POCUS and departmental scans.

Where the practitioner did not confidently achieve the three views required to make a full assessment, the POCUS was considered non-diagnostic and was not included in the comparative analysis.

The results of the diagnostic POCUS and departmental scans were compared, and rates of concordance, false positivity and false negativity noted. A second analysis was then made comparing the accuracy and speed of supervisor scans to those of candidates' scans.

For the inpatient population, the time that elapsed between first documented clinical suspicion of DVT to reporting of the POCUS and departmental scans was compared to identify any potential reduction in waiting time, and any improvement in concordance with existing guidelines.

Results

In total 51 patients (21 males and 30 females with an age range of 30 to 95, median 74 years) underwent a POCUS lower limb DVT scan during the study period. Five patients were excluded from comparative analysis as they did not receive a subsequent departmental scan. In one case, the clinical probability of DVT was sufficiently low that the supervisor felt a further scan unwarranted. In another, a departmental scan was unnecessary due to a low pre-test probability and subsequently negative D-dimer. A third was cancelled by the ultrasound department due to a lack of clinical information and the responsible team did not re-organise a scan. There was no data as to why no scan was performed for the final two. No DVT was detected on POCUS in any of these patients and there was no subsequent venous thrombosis or related adverse outcome recorded on the trust electronic patient record over the subsequent six months.

Of the remaining 46 scans, 42 (91.3%) of the POCUS were considered diagnostic by the scanning practitioner at the time and so were included in our analysis. 34 of 46 scans were performed by FAMUS candidates, the remaining 12 scans being performed by a supervisor. Candidate and supervisor operators deemed scans diagnostic in 91.2% and 91.7% of cases respectively. Within the analysis sample, 9 DVTs were diagnosed (prevalence 21.4%). Of the 42 diagnostic scans, 40 (95.2%) produced results which were directly comparable with the results of the corresponding departmental scan, with a sensitivity

Table 1. Test statistics for POCUS and departmental lower limb DVT scans

	DVT +ve 9	DVT -ve 33
POCUS +ve 9	8	1
POCUS -ve 33	1	32

of 88.9%, specificity of 97.0%, a positive predictive value of 88.9% and negative predictive value of 97.0% (positive likelihood ratio LR+ of 29.3 and negative likelihood ratio LR- of 0.11).

Timings are presented as medians [1st Quartile, 3rd Quartile]. Overall scans took 7 minutes [4 minutes, 10 minutes] to complete and 2 minutes [1 minute, 4 minutes] to report. Candidate scans took 10 minutes [5 minutes, 11 minutes] to complete and 2 minutes [45 seconds, 3 minutes] to report. Supervisor scans took 4 minutes [4 minutes, 6 minutes] and 3 minutes 30 seconds [2 minutes, 4 minutes] to report.

Within the inpatient population the time from initial clinical suspicion to reporting of POCUS was 5 hours and 32 minutes [53 minutes, 13 hours 44 minutes] whereas the time to reporting of departmental scans was 23 hours 30 minutes [8 hours 8 minutes, 47 hours 57 minutes].

Of the 26 cases from the inpatient population, 18 (69%) of POCUS occurred within the recommended 24 hours of first documented clinical suspicion, whereas only 7 (27%) of departmental scans occurred within 24 hours of first documented clinical suspicion.

The distributions of time from initial clinical assessment to POCUS and departmental scans, both being positively skewed, were compared with a Mann Whitney U test and, due to sample sizes, Z scores and absolute p values were then calculated. A significant difference was found between the time from first documented clinical suspicion to report publication for POCUS *vs* departmental scan, with a Z score of 3.86 and two tailed p-value of 0.0001.

Discussion

In this service evaluation, POCUS produced high levels of sensitivity (88.9%) and specificity (97.0%) within the ambulatory and inpatient settings, similar to a recent meta-analysis on the subject[2]. Additionally, we showed little difference in accuracy of scanning between relatively experienced and inexperienced practitioners. This is reassuring for centres beginning to incorporate POCUS into regular clinical practice, even when there is a relative lack of pre-existing experience, as high-quality outcomes may be expected from an early stage. Only a small proportion (8.7%) of attempted scans were considered to be non-diagnostic, with no difference seen between practitioners of varying experience; implying that relatively few attempted scans would need repeating due to inadequate POCUS images.

Scanning of patients in ambulatory and inpatient settings does not take up a lot of practitioner time (median 7 minutes to perform and 2 minutes to report), and the speed of scanning improves appreciably with experience, suggesting that POCUS could be integrated into routine medical review. It is our belief that the initial additional time taken to perform these scans can lead to large downstream benefits. Making point of care diagnoses can remove the need for subsequent departmental imaging, clinical review and patient transfers and can reduce patient and clinician waiting times. These benefits may be particularly apparent where patients present or are necessarily managed outside of well-defined ambulatory pathways. Further work would be required to confirm these potential benefits and to assess the true impact on clinician workload.

POCUS may also provide a way to reduce inpatients' waiting times, and potentially reduce the burden of workload upon urgent imaging departments. It is important to stress that as a 'rule in' test, only positive POCUS would result in a direct reduction in numbers of departmental scans required. However, on the basis of a negative POCUS - and in the context of a low level of clinical suspicion - it may be possible to reduce the number of urgent departmental scans required, and this is an area where we would certainly recommend further study. It is also important to state that patients were only included in our study if they had not already had a departmental scan, therefore the true overall reduction in delay is likely to be smaller than our findings suggest.

Another clear limitation of this study is that our results are only in fact relative to those of duplex venous sonography (as our gold standard) which

Table 2. Sensitivities, specificities, positive and negative probability values, and positive and negative likelihood ratios for POCUS when compared to departmental sonography.

	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	LR+	LR-
Candidate	75	100	100	96.4	∞	0.25
Supervisor	100	83.3	83.3	100	5.99	0
Combined	88.9	96.97%	88.9	96.97	29.3	0.11

itself is imperfect.[7] Furthermore, as a local service evaluation, our findings are not generalisable to other departments or patient populations and should be considered as hypothesis-generating, rather than as definitive evidence.

A few individual cases of interest are now discussed.

The falsely positive POCUS performed by a supervisor practitioner was felt to demonstrate an occlusive popliteal DVT. Although the departmental imaging did not agree, in this particular case thrombus was also found in the patient's contralateral leg on POCUS and departmental scan, therefore the finding did not alter the patient's management. It is also possible, although unproven, that the POCUS-imaged thrombus had displaced by the time of departmental scan, since this scan was undertaken 18 hours later.

In the case of the falsely negative POCUS scan, performed by a candidate practitioner, two departmental scans were performed for the same patient 1 week apart, the first demonstrating a thrombus in the distal femoral vein and the second finding no thrombus. The second departmental scan was arranged due to clinical diagnostic uncertainty unrelated to the POCUS findings. The patient was subsequently not treated for DVT. It is unclear whether the first departmental scan was in fact falsely positive or whether a short course of anticoagulation was sufficient to disperse the thrombus.

Another scan of note performed by a supervisor practitioner demonstrated thrombus in the great saphenous vein, in close proximity to the saphenofemoral junction. This was therefore treated as a DVT due to a high risk of thrombus propagation, per NICE guidance. The departmental scan also demonstrated a proximal great saphenous vein thrombus but found an additional, more proximal thrombus within the external iliac vein. This POCUS was considered to be truly positive in this analysis, as the proximal thrombus was outside the remit of a three-point compression scan but a correct diagnosis of DVT was made by POCUS nonetheless. Although the management of this patient was not altered by the finding of the proximal thrombus, this case does highlight one of the main limitations of the 3 point compression method: the potential to miss an isolated proximal thrombus.

In summary, in addition to the growing body of evidence supporting the use of POCUS in the Emergency Department, we have shown that the results are reproducible within the settings of ambulatory care and internal medicine within a single hospital. We hypothesise that the use of POCUS can potentially reduce patient waiting times and imaging departmental workloads, especially for inpatient populations. We have also shown that these results can be expected early in the adoption of POCUS, even where there is limited pre-existing experience. We therefore recommend that these findings are the basis for further study of POCUS in DVT within ambulatory and internal medicine, and that they help support the idea of routine integration of POCUS in these settings. In time, this may extend to routine integration of POCUS into internal medicine curricula to maximise the availability of these skills and the positive impact that they can have on patient care.

Declaration of competing interests

Nothing to declare.

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