The potential use of pocket-sized ultrasound machines in obstetrics and gynecology

Pocket-sized ultrasound machines (PUM) have very recently been introduced into clinical practice. In this article we highlight the significance, benefits and limitations of this new technology in obstetrics and gynecology.

Since its introduction into the field of obstetrics and gynecology by Ian Donald in 1958, the role of ultrasonography has grown to encompass most areas of clinical practice [1]. Over time, the market for ultrasound machines has moved towards high-end machines with extensive specifications at one end of the spectrum, with portability and utility at the point of care being the priority at the other. To date, ultrasound machines have been reduced to what might be termed a large “laptop”, offering portability relative to conventional cart based systems. Such machines have in general still been too large for clinicians to carry around routinely.

The introduction of pocket sized ultrasound machines (PUM) has opened the possibility of a truly portable ultrasound machine being available. However questions arise as to how well the diagnostic performance of this equipment is in clinical practice and in what clinical context they may have utility.

The anticipated utility of PUM has been as an adjunct to physical examination, for initial screening in an emergency setting, for use in more remote healthcare environments, as an initial triaging tool to select patients for examination with higher specification machines and as a teaching tool for both patients and clinicians [2]. According to the European Association of Echocardiography, there are currently four types of ultrasound machine: (i) stationary high-end equipment (i.e. full specification with 3D and other advanced modalities), (ii) mobile trolley-based machines which are not equipped with all the advanced modalities (iii) portable “laptop” based machines which can be carried by a person and are not equipped with all advanced modalities (iv) pocket-sized, hand-held ultrasound devices (PUM) [2]. In the literature, the use of PUM was initially described by cardiologists [2-9] where there is good evidence to demonstrate the utility of PUM [2-7]. For example, Skjetne et al have found that rapid cardiovascular ultrasound screening using a PUM accurately assessed vascular and cardiac size and function leading to a correction in the diagnosis for 16% of patients admitted to a cardiac unit [3]. The authors recommended that it would be appropriate to implement strategies for using PUMs as part of routine cardiovascular examinations for patients attending cardiology units [3].

Recently we compared the performance of a PUM to high specification ultrasound machines [8]. This was carried out in an observational cohort study on 204 unselected women (110 in early pregnancy, 53 in later pregnancy, and 50 with possible gynecological pathology) [8]. In obstetric practice, there are many situations where PUM could add diagnostic value at the point of care. Clinical questions

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such as fetal viability, number and presentation as well as placental location and the amniotic fluid index are all simple but important pieces of information that can be obtained using a PUM. In addition this can be done no matter whether it is in the ward, outpatient clinic, emergency department or outside the hospital setting in primary care or in emerging countries [Figure 2].

In our study, we showed very good agreement between transabdominal ultrasound scans carried out with a PUM and a high specification ultrasound machine (Voluson E8 Expert, GE healthcare, Wisconsin, USA and Medison Accuvix XG, Samsung Medison, Seoul, South Korea) for fetal presentation and placental location (fetal, anterior, posterior). There was good agreement for placental position (low, high) (kappa coefficient, 0.924, 0.924 and 0.647, respectively; P < 0.0001) [8]. Similarly, we found very good agreement for femur length measurements with an intra-class correlation coefficient (ICC) of 0.968 (95% CI: 0.938–0.983) which was the continuous variable studied in the obstetric cohort of our study. Similarly, in another study when the PUM was modified for transvaginal use, a high correlation was found for biparietal diameter measurements [9].

**THE USE OF PUM IN EARLY PREGNANCY (LESS THAN 14 WEEK GESTATION)**

For women in early pregnancy there is a good correlation between using a PUM transabdominally (with an empty bladder) and a high-end machine transvaginally for establishing embryo location, viability, and number [Figure 3] [8]. Similarly, we found a high correlation in the measurements obtained using a PUM and high specification machines for mean gestational sac diameter (MSD) and crown rump length (CRL) ((ICC > 0.90; P < 0.001) [8]. In the early pregnancy group, the PUM disagreed with high specification machines in 15.8% of cases, but these would not have led to a change in the final management plan if the PUM had been imaging used to triage patients [8].

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**THE USE OF PUM IN GYNECOLOGY**

For patients presenting with a possible pelvic mass, abdominal distension or suspected intra-abdominal bleeding a PUM may have a useful triage role to play. Again the utility relates to the advantages of being able to use a PUM at the point of care. In our study we demonstrated that PUMs are able to accurately identify ovarian masses [Figure 4], fibroids, ascites or fluid in Morrison's pouch (the basis of the focused assessment with sonography for trauma scan or FAST scan). We have shown that there was a very good agreement in mean and maximum diameter of ovarian masses (ICC > 0.90; P < 0.001) [8]. Although it is possible sometimes to diagnose endometrial lesions using a PUM (Figure 5), we found moderate agreement for measurements of endometrial thickness (ICC = 0.712) [8]. In the same study, there were two cases (4%) in which a simple ovarian cyst would have been missed if a PUM had been used as the primary diagnostic tool [8]. We were surprised how well PUM

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**FIGURE 2.** Examples of the use of pocket-sized ultrasound machine in obstetrics. a: cephalic presentation and measuring biparietal diameter (BPD) in the second trimester of pregnancy. b) measurement of the depth of a pool of amniotic fluid in a polyhydramnios.

**FIGURE 3.** PUM in early pregnancy. a: Embryo crown rump length measured in an intrauterine pregnancy. b: intrauterine dichorionic diamniotic (DCDA) twin pregnancy.
performed transabdominally with an empty bladder [8]. In a study where a PUM was modified for transvaginal use, as might be expected, a higher correlation with a high specification machine was obtained (Pearson’s correlation coefficient=0.99) [9].

**FUTURE USE OF PUMS**

In our view the principal role for PUM is as a triaging rather than a primary diagnostic tool [8]. We have shown that the performance of PUM stands up well in comparison to high specification top-of-the-range equipment; however a formal cost-benefit analysis for the use of PUM has yet to be carried out [10]. It is important to note that in our study the PUM was used by clinicians with appropriate training for carrying out ultrasonography with standard machines. There is a temptation to equate the small size of a PUM with a need for less training. This is not the case. Our experience is that PUMs are a very useful tool, particularly for triage. However uptake by poorly trained physicians — if permitted — will inevitably bring the technology into disrepute. PUM should not be seen as a tool that anybody can just pick up and place on the patient.

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Nevertheless, we believe PUMs may be used to triage patients with early pregnancy bleeding or pain either on the ward or in emergency department [8]. They also will have a valuable role evaluating placental location and fetal presentation either antenatally or on the delivery ward.

In the event of a suspected pelvic mass PUM should be able to exclude the presence of such a mass and — if a mass is present — offer a reasonably accurate specific diagnosis [8, 9]. PUMs are small and much cheaper than higher specification ultrasound machines. Another exciting application for PUM may be in emerging countries. They may be adapted to enable charging using solar power or a car battery [8]. Using PUMs in the community in such environments to select patients for transfer to hospital, for example in the event of placenta previa, has the potential to save lives [8, 10].

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**REFERENCES**