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Placenta Position: A Sonographic Guide for Ultrasound Health Practitioners in Low-Resource Settings Utilising a Traffic Light System

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ABSTRACT

Introduction: Maternal haemorrhage from placenta praevia (PP) is a major cause of maternal and neonatal morbidity and mortality in low-resource settings (LRS). Ultrasound can be used to diagnose PP utilising a colour-coded traffic light system (TLS) to triage patients. The aim was to develop a placenta TLS tool to improve the obstetric ultrasound resources available in LRS and guide the diagnosis and sonographic management of PP.

Method: Literature search using the keywords 'placenta praevia, prenatal screening, ultrasound diagnosis' between the years 2013 and 2023 to inform the development of the TLS. QR codes were used to access videos developed on how to scan the placenta.

Results: The TLS demonstrates: Green (placental edge ≥ 20 mm), report normal/not low with no placental position follow-up needed. Orange (placental edge < 20 mm), repeat at third trimester, ideally 32 weeks. Red, first presentation in third trimester placental edge < 20 mm or placenta completely or partially covering cervix at > 16 weeks, refer for obstetric review.

Discussion: A standardised approach to scanning the placenta in transverse and longitudinal sonographic planes was developed for reinforcement of scanning skills after initial sonographic training for PP identification. The TLS can be used to triage patients according to placenta position findings using a 'Report, Repeat, Refer' mnemonic.

Conclusion: Providing training and referral for care can be prohibitive and costly in LRS. This resource aims to provide ongoing support for health providers in the ultrasound diagnosis and management of PP. Research on health practitioners' acceptance in LRS and use of this TLS resource is needed.

1 | Introduction

The placenta is an organ that supports the development and growth of the fetus in pregnancy by providing nutrients and oxygen and removing waste products [1]. Placenta position varies in each pregnancy, with a low-lying placenta diagnosed in about 1%–9% of pregnancies at the second trimester ultrasound

[2]. Factors contributing to the higher reported rate of low-lying placenta include an overfull bladder on transabdominal ultrasound or contraction of the lower segment [2]. Although most of the low-lying cases resolve in the third trimester, 5% will persist, especially if the placenta is positioned posteriorly [3]. If the placenta completely covers the internal os at the second trimester scan, it is likely to persist as a low-lying placenta in the third

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trimester [3]. A placenta is considered low-lying if the inferior edge is <20 mm from the internal os after 16 weeks' gestation and placenta praevia when it completely covers the internal os [4]. Placenta position is considered normal or not low when the placental edge is ≥ 20 mm from the internal os [4]. These definitions apply when the diagnosis is made with either transabdominal or transvaginal (TV) ultrasound [4].

The International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) practice guidelines for the second trimester scan recommend placental location should always be assessed by experienced sonography practitioners who regularly perform fetal sonography [5]. More recently, the ISUOG third trimester scan guidelines recommend assessment of placental position and the distance of the inferior placental edge to the internal cervical os be reported in every third trimester scan [6]. When placenta praevia is diagnosed antenatally, there is an increased risk of vasa praevia, placenta accreta syndrome, and maternal haemorrhage needing caesarean delivery [6]. In many low-resource settings (LRS) ante- and post-partum haemorrhage is a leading cause of fetal/neonatal and maternal morbidity and mortality [7], with 99% of worldwide maternal deaths occurring in low-resourced regions [8]. Placenta praevia is a major risk factor for placental haemorrhage with an odds ratio between 3.2 and 5.7 [9]. Even when a prenatal diagnosis of placenta praevia is made, there is still significant maternal and neonatal morbidity but less mortality [10, 11]. However, in well-resourced regions, delivery outcomes are similar irrespective of whether the diagnosis is made with prenatal ultrasound or at the time of emergency caesarean [12]. When the placenta is low-lying with a distance between 0 and 20 mm from the internal os at the time of delivery, there is a risk of maternal morbidity including blood loss and caesarean delivery, although there is a greater chance of a successful vaginal delivery compared with emergency caesarean if the distance is > 10 mm [13]. Recommendations in asymptomatic patients with a low-lying placenta suggest best practice is to refer the patient for an obstetric consultation for detailed counselling about the risks of a trial of labour [13].

Strategies to reduce perinatal morbidity and mortality in LRS identified community-based antenatal care services include using ultrasound to diagnose placenta praevia [8]. Ultrasound in pregnancy requires operator training to use the machines, scan the pregnant uterus, and to recognize pregnancy-related structures. In LRS, obstetric ultrasounds are often performed by health practitioners after minimal training [14]. Strategies to retain and improve learning after minimal training of sonographic techniques in LRS are needed to help with the retention of skills.

Colour-coded management systems based on traffic light colours have been used in obstetrics to promote early recognition of certain conditions and reduce maternal/fetal morbidity [15]. A traffic light system is a quick visual reference tool that can be used to triage patients for further care and/or reduce unnecessary referral to higher level care [15]. Referrals to higher level care may be prohibitive and costly for the patient in LRS [16]. A traffic light-based resource could also be used to help retain and/or improve learning for the diagnosis and management of placenta praevia for health care workers with limited ultrasound experience in LRS. This type of resource could be accessed

as online information through internet links or mobile phone service via a QR code. Alternatively, it could be distributed as printed posters or reference cards on lanyards, particularly since internet service can be limited in LRS [17]. The aim of this work was to develop a placenta praevia traffic light system tool to improve the obstetric sonographic imaging resources available in LRS and guide the diagnosis and sonographic management of placenta praevia.

2 | Method

A systematic search of the literature was performed by one author to ensure the diagnosis and management criteria for placenta position and placenta praevia were current for the development of the traffic light system. A search of library databases PubMed, Medline, ScienceDirect, EBSCOHost, Embase, and ProQuest and the search engine Google Scholar was conducted between the years 2013 and 2023. Keywords used included (placenta pr*evia) AND (prenatal screening) AND (ultrasound OR ultra* OR sonography) AND (diagnosis) AND (management). Inclusion criteria were guidelines including ultrasound assessment of placental position, text available in English, and text not behind a paywall. Exclusion criteria were placenta accreta spectrum and vasa praevia. A repeat search between 2023 and 2024 of Google Scholar using the same criteria was also performed to ensure guideline currency. Early design was done using PowerPoint (Microsoft Corporation, Redmond, WA); however, the final design of the traffic light graphics and generation of the QR codes for video access used Canva software (www.canva.com). Camtasia v2022.11 (TechSmith.com) was used to edit video clips. The scanning protocol was informed by the authors own practice and experience.

3 | Results

3.1 | Literature Search

Search of the university library databases resulted in 1432 articles with one relevant guideline found [4]. Search of Google Scholar resulted in 2590 articles with the first 20 pages reviewed. Three additional articles were reviewed and deemed not relevant or provided vague or outdated definitions of a low-lying or praevia placenta. A later repeat search from 2023 to 2024 of Google Scholar resulted in 766 articles; the first 20 pages were reviewed, which identified one additional article on guidelines for performing a third trimester ultrasound [6]. The authors consensus opinion was that the Jauniaux et al. [4] (Green Top Guidelines) provided the most relevant information for informing the traffic light system but did not provide information on the management of a low-lying placenta if presentation was in the third trimester. This information was deduced from later work by Jansen et al. [13].

3.2 | Poster

A traffic light poster system with labelled sonographic images and videos accessed by QR codes, diagnosis criteria and sonographic management for health practitioners with limited

obstetric ultrasound training was developed. A mnemonic of 'Report, Repeat, Refer' was used for sonographic management (Figure 1).

- Report (green colour coded):
 - Placental edge ≥ 20 mm from internal cervical os, normal or not low with no placental position follow-up needed [4].
- Repeat (orange colour coded):

- If placental edge is < 20 mm from the internal os at > 16 weeks gestation age (GA), ideally at GA of 32 weeks. Use TV scan if feasible, especially if the placenta is posterior [3, 6]. Feasibility includes availability of TV probe, a disposable probe barrier such as a glove or condom, the ability to disinfect the probe, and informed consent [18].
- Refer (red colour coded):
 - For obstetric review if first presentation is in third trimester and placenta < 20 mm from internal os [13].



Placenta position diagnosis and sonographic management

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1. Normal (not low) placenta



20 weeks, placenta 52mm from the internal os

2. Low-lying placenta



20 weeks, anterior placenta reaching internal os

3. Placenta praevia



28 weeks, placenta completely covering internal os

REPORT

No placenta position follow-up needed, if placenta ≥ 20 mm from internal os at > 16 weeks¹



Normal placenta position

Scan here

REPEAT

In 3rd trimester * if placenta < 20 mm from internal os > 16 weeks¹

REFER

For obstetric review if first presentation in 3rd trimester and placenta < 20 mm from internal os²



Low-lying placenta

Scan here

REFER

For obstetric review, placenta completely or partially covers internal os > 16 weeks¹



Placenta praevia

Scan here

*Repeat ideally at 32 weeks gestation, using a transvaginal (TV) probe if feasible. Feasibility includes availability of TV probe, disposable probe barrier (glove or condom), ability to disinfect probe and informed consent.

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FIGURE 1 | Traffic light poster demonstrating labelled placenta images, colour-coded sonographic diagnosis and management for the normal, low-lying and praevia placentas with accompanying videos accessed via QR codes.

- For obstetric review if placenta completely or partially covers cervix at GA > 16 weeks [4].

3.3 | Images

The poster (Figure 1) has three ultrasound placenta images corresponding to the green, orange, and red traffic light symbols. Each image has an ultrasound probe orientation body marker in the bottom corner, demonstrating that the imaging is performed in the longitudinal midline plane. The normal posterior placenta (Figure 1, Image 1) demonstrates assessment of the placental edge to internal cervical os with the distance measured. The low-lying anterior placenta (Figure 1, Image 2) demonstrates the placenta reaching the internal os. The placenta praevia (Figure 1, Image 3) shows the placenta completely covering the internal os. All ultrasound images are labelled to demonstrate the anatomy seen with ultrasound.

3.4 | Videos

Three QR codes were embedded into the poster (Figure 1), which direct users to YouTube videos when scanned with a smart phone or tablet. The transverse scans are a sweep from the superior/mid uterus towards the maternal symphysis pubis/bladder in a maternal cephalic to caudal direction. The longitudinal scans are a sweep from right to left maternal adnexa in the lower uterine segment. Video S1 demonstrates a normally positioned posterior placenta scanned in transverse and longitudinal sweeps. The placenta can be seen to ‘disappear’ before the fetus in transverse. The placenta is clear of the internal os in the longitudinal sweep. An image demonstrates the measurement in the midline position. Video S2 demonstrates a low-lying anterior placenta scanned in a transverse plane from superior to inferior. The fetus ‘disappears’ before the placenta which extends into the lower segment. The longitudinal sweep demonstrates the placenta reaching the internal os which is verified by a TV scan and image. Video S3 demonstrates a posterior placenta praevia. The placenta is seen inferior to the fetus when scanning from the superior uterus to the lower segment in a transverse plane. The fetus ‘disappears’ before the placenta. In the longitudinal sweep, the placenta completely covers the internal os and extends onto the anterior uterine wall. A TV midline image of cervix and lower segment verifies the placenta praevia.

4 | Discussion

This work has developed a traffic light poster demonstrating ultrasound appearances, scanning techniques (accessible via QR codes) and management pathways for screening and diagnosis of a normally positioned placenta, low-lying placenta, and placenta praevia for health practitioners in LRS (Figure 1). This resource can be accessed on mobile internet devices such as a phone or tablet or printed for display in a clinic to assist in triaging patients for reporting of results, repeat of scan, or referral for obstetric review (Report, Repeat, Refer). Although second and third trimester ISUOG scanning protocols state placenta position should be assessed by experienced sonographers/sonologists, this assumes a level of sonographic knowledge and

expertise [5, 6]. Additionally, the protocols do not provide information on how to scan the placenta [5, 6]. The reality is in some LRS, health practitioners often lack formalized and ongoing ultrasound training with limited access to ultrasound imaging.

5 | Challenges of Providing Ultrasound Services in Low-Resource Settings

In higher resource settings and/or metropolitan cities, standardised ultrasound examinations to check for placenta praevia are performed by trained professionals such as sonographers or medical practitioners across all trimesters of pregnancy. In LRS, pregnant patients often first present in the third trimester for prenatal care and ultrasound [14]. An obstetric ultrasound is often performed on portable ultrasound machines by health professionals such as midwives after a short period of training [14]. Despite limited training, this approach has demonstrated a reduction in maternal and neonatal morbidity and mortality [14]. However, to retain and enhance learning, feedback after initial training is essential for building skills and reaching personal potential [19]. Participants from a LRS with limited ultrasound experience have previously indicated further training and feedback were needed after initial ultrasound training to reinforce their learning. (Personal communication, email, Radiology Across Borders (RAB) Vital Program, December 2023) Ongoing training is costly and time-consuming for volunteers and attendees, with alternative strategies needed to address this deficit. Suggestions to improve the provision and access to obstetric ultrasound include the donation of ultrasound machines and telemedicine [8]. The problems with donations include: first, a lack of familiarity with the machine, with the operator manual often not included with the donation. Second, the donation of older machines without access to service contracts for parts and repair. Third, donated machines may not be fit for purpose; for example, no suitable ultrasound probes included with the donation (RAB Vital Program, Personal Experience, 2023, <https://radiologycrossborders.org/>). Telemedicine provision is often limited because of inadequate access to reasonable internet connections, internet speed, and bandwidth capacity [17] (RAB Vital Program, Personal Experience, 2023, <https://radiologycrossborders.org/>). This highlights the need to provide cost-effective and easily accessible tools for training and retention of ultrasound skills, particularly in LRS. The use of a traffic light system to assist in the diagnosis and sonographic management of placenta praevia is one tool that can be of use and proposes to bridge this gap in knowledge. The following sections detail how to scan the placenta to supplement the information in the poster.

6 | Scanning the Placenta

A systematic approach is required when scanning the placenta to assess the size, texture, number, and location of the organ. The placenta is typically a single mass; however, variations in the number and size of additional lobes are relatively common and are related to anomalous placental cord insertions [20, 21]. Identifying a central placental cord insertion can exclude an anomalous cord insertion, reducing the risk of vasa praevia [22]. An obstetric ultrasound should also involve obtaining a good clinical history regarding previous pregnancies and uterine

surgery, especially if the placenta is low-lying, to assess for placenta accreta spectrum (PAS) disorders [23]. A guide to screening for PAS for LRS has recently been published [23]. Although the identification of the placental cord insertion, presence of additional lobes, and PAS have not been addressed in this paper, it is important to be aware of these variations when scanning the pregnant uterus.

The placenta should be scanned in more than one ultrasound plane using both longitudinal (Figure 2) and transverse imaging (Figure 3). For screening purposes, a transabdominal transverse sweep with an appropriately filled maternal bladder, from the fundal area to the cervix can provide a good overview of placental location and assess if there is more than one placental mass. Although appropriate filling of the bladder is difficult to quantify and can vary with individuals, a volume of at least 200 mL measured by ultrasound, has provided good visualisation of the uterus-bladder wall interface and placenta in the lower segment [24]. If the placenta position is normal, the placenta will 'disappear' before the fetus when scanning from superior to inferior in a transverse plane (Figure 1; Video S1). If the placenta

is low-lying or a placenta praevia, the fetal part will disappear before the placenta with the placenta visualised in the lower uterine segment (Figure 1; Videos S2 and S3). An exception to this is if the fetus is in a transverse lie at the fundus. In this scenario if the placenta is normally positioned, the fetus and placenta will disappear before the maternal bladder and cervix are seen. However, the placenta should not be visible in the lower uterine segment.

The longitudinal plane is used to sweep from one maternal adnexa to the other across the uterus to assess where the inferior edge of the placenta is situated in relation to the cervix and to measure the distance using callipers. A longitudinal image of the inferior placental edge to cervix is used to measure this distance (Figure 4b). If the placenta is in the lower uterine segment, an appropriately filled maternal bladder may be needed to clearly visualise and measure this distance. The longitudinal plane is also used to document placenta praevia. A combination of transverse and longitudinal planes can be used to assess if the placenta is anterior (Figures 2 and 3), posterior (Figure 4) or lateral (Figure 5).

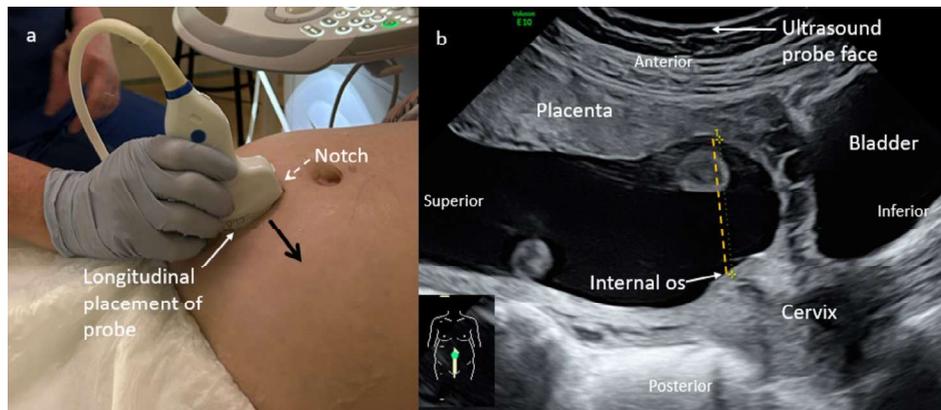


FIGURE 2 | (a) Placement of the ultrasound probe on maternal abdomen when scanning in a longitudinal plane. Notch on probe side (indicated by dashed arrow), is positioned towards maternal head so orientation of ultrasound image is correct. Right to left scanning direction is indicated by black arrow. (b) Ultrasound image of anterior placenta demonstrating anatomical positions in a longitudinal plane, the probe face position and maternal skin line (arrow). Body marker indicates longitudinal plane. Distance from placental edge to approximate internal os is 70 mm (dashed line).

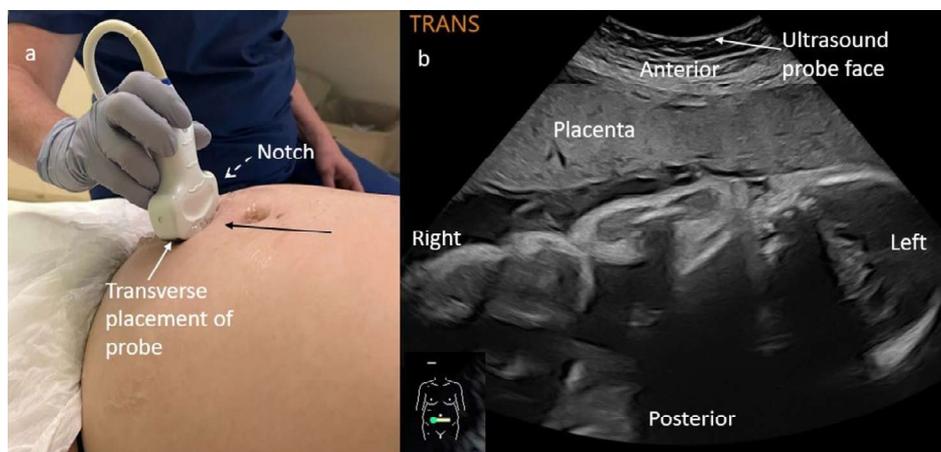


FIGURE 3 | (a) Placement of the ultrasound probe on maternal abdomen when scanning in a transverse plane. Notch on probe side (dashed arrow) is positioned towards maternal right and operator, so orientation of ultrasound image is correct. (b) Ultrasound image demonstrating anatomical positions in a transverse plane, probe face with maternal skin line (arrow), and anterior placenta. Body marker indicates transverse plane.

7 | Potential Challenges When Scanning the Placenta

Pitfalls to avoid when assessing placenta position include an overfilled bladder (Figure 6a), which can elongate the cervix, falsely reducing the distance of the internal os to the placenta [2]. In this scenario, the maternal bladder can be partially or fully emptied and placenta position reassessed transabdominally or transvaginally if appropriate (Figure 6b,c). The presence of lower segment uterine contractions (Figure 7a) can also distort the location of the internal cervical os and falsely reduce

the distance of the placenta to the cervix. These contractions can mimic placental tissue to the less experienced observer and give the appearance of placenta praevia [2]. The uterine contraction will eventually relax, and placenta position can be reassessed (Figure 7b). Acoustic shadowing from the bladder wall can make identification of the internal os difficult (Figure 8). To rectify this requires either scanning from a different angle or filling the maternal bladder. Finally, the presence of blood or a subchorionic haematoma in the lower uterine segment is also a potential source for misidentifying the placenta and should be considered if the clinical history aligns with this scenario.

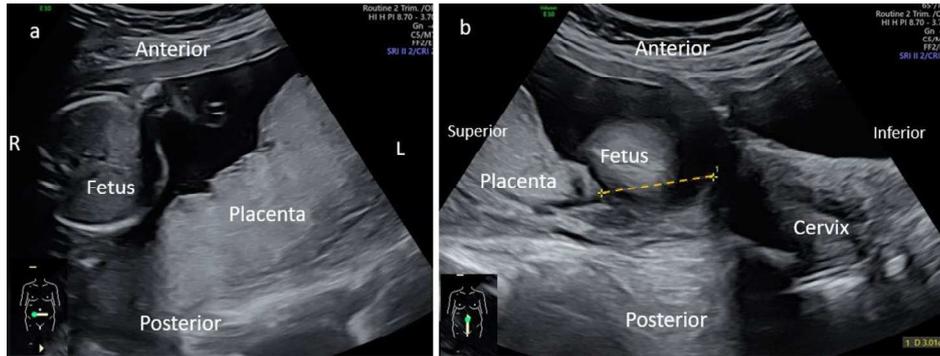


FIGURE 4 | Posterior placenta with anatomical landmarks imaged in (a) transverse plane and (b) longitudinal plane. Distance from placental edge to internal os measured in longitudinal plane (dashed line). The posterior placenta edge is 30 mm from the internal os at 19 weeks 3 days, which is not low-lying. I, inferior; L, left; R, right; S, superior.

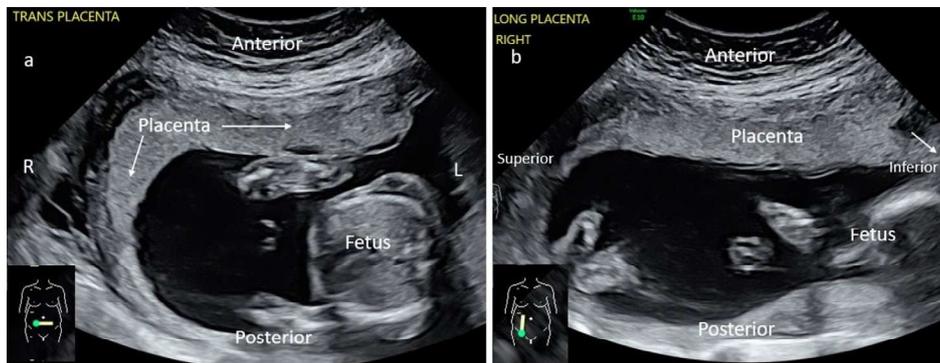


FIGURE 5 | Right lateral placenta with anatomical landmarks imaged in (a) transverse plane. Placenta extends from anterior to right lateral side of uterus (arrows) and (b) longitudinal plane. The placenta edge is not visible in the inferior aspect of image, (b) (arrow) further imaging is needed to evaluate placental inferior margin and distance to internal os. L, left; R, right.



FIGURE 6 | (a) Overfull maternal bladder demonstrated in longitudinal plane with posterior placental edge close to internal os (dashed line). (b) Demonstrates partially emptied bladder with placental edge potentially still low-lying (dashed line). (c) Transvaginal scan demonstrating emptied bladder and posterior placental edge 26 mm from internal os and not low-lying (dashed line).

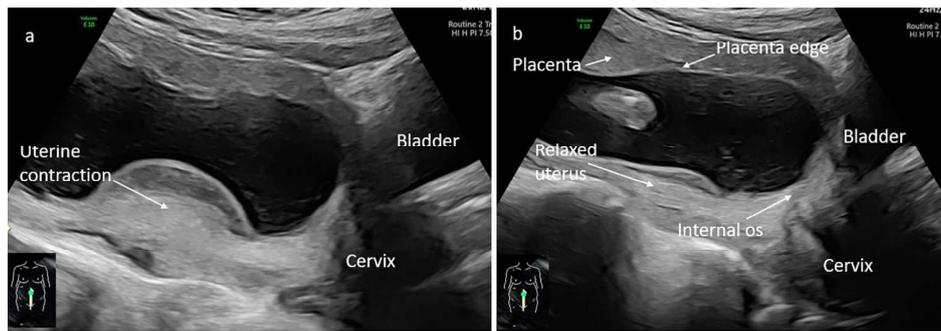


FIGURE 7 | (a) Posterior wall uterine contraction (arrow) demonstrated in longitudinal plane close to cervix which inexperienced operators may mistake for placenta. (b) Demonstrates relaxation of uterus and placental edge on anterior wall of uterus.

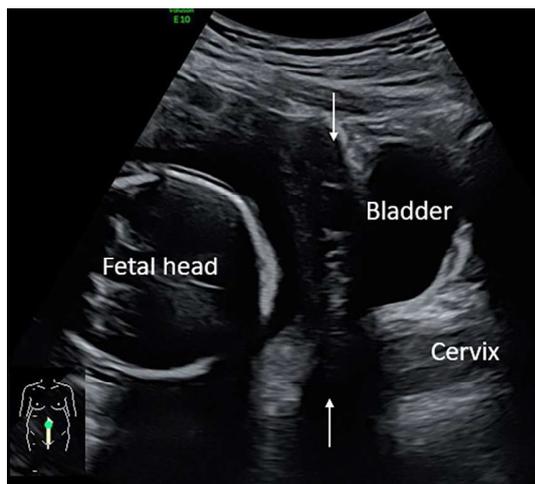


FIGURE 8 | Longitudinal image demonstrates partially filled bladder with bladder wall acoustic shadow making the area of the lower segment and internal os difficult to visualise (arrows).

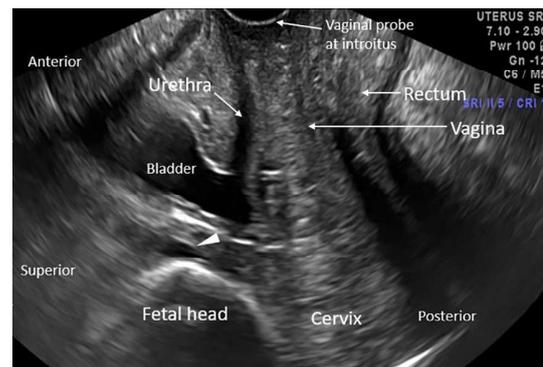


FIGURE 9 | Translabial scan performed in longitudinal plane with transvaginal probe. The fetal head is applied to the maternal cervix. A small amount of amniotic fluid is visible (arrowhead) and outlines the lower segment with placenta not visible.

8 | TV and Translabial Scanning of the Placenta

A TV ultrasound is the preferred method in the third trimester when the placenta appears low-lying and/or is posterior (Figure 6c) [6]. Although the second trimester ISUOG guideline uses a TV cut-off distance of ≤ 15 mm for a low-lying placenta and recommends follow-up in the third trimester [5], for consistency and ease of communication we have chosen to use the 20-mm cut-off as recommended by Jauniaux et al. [4] in the BJOG Green Top guidelines. Studies recommending reducing the cut-off for a low-lying placenta have significant methodological issues with study design and sample size indicating more research is needed before a lower limit can be incorporated into guidelines [6]. The 20-mm cut-off was also chosen as TV probes are not always available and not all ultrasound operators have the expertise or training to use a TV probe. A TV probe also requires high-level disinfection [18], which is not always available in LRS. Additionally, poor communication by health practitioners, anxiety due to fear and embarrassment of the procedure, potential discomfort and pain, tension and loss of dignity, constitute further barriers to TV scanning [25]. Cultural beliefs also play an important role in the acceptance of TV scanning and need to be recognised and treated sensitively by health professionals [25]. If the inferior edge of the placenta is difficult to see in the lower segment, especially if the fetus

is cephalic and a TV scan is not acceptable, other options are available. Either an attempt to move the fetal head to visualise the lower uterine segment could be made by gentle manoeuvring of the fetal head with suprapubic pressure, further filling of the maternal bladder, or a translabial ultrasound could be considered. Translabial ultrasound requires an empty bladder, a covered transabdominal probe or TV probe (a glove can be used), with placement of the probe in the longitudinal plane onto the maternal introitus. Practice is required to be able to identify the anatomical landmarks to successfully use this technique (Figure 9). There is limited evidence on patient acceptance of translabial scanning, although most patients found it acceptable during labour [26]. Further research is needed to determine patients' attitudes to translabial scans during pregnancy.

9 | Strengths and Limitations

This work provides a standardised systematic approach to scanning the placenta across both the second and third trimester. Key pitfalls and problems are identified, with potential solutions provided. The work is supported by videos and images that enable healthcare professionals with limited ultrasound training to scan placenta position in LRS. This work is not designed to be a comprehensive guide for the formally trained and experienced sonographer or sonologist, although it may be useful for trainees. A limitation of this work is that

the imaging was collected by experienced ultrasound practitioners on high-end machines. Furthermore, the quality of the imaging may be difficult to reproduce, especially in LRS. The poster was designed as a supplementary resource to be used after basic training has been provided. Research to assess practitioner acceptance and experience of this tool is needed. Future research using the flipped classroom pedagogical model [27], where this resource is provided prior to basic training to teach novice and/or early ultrasound practitioners or students, would be of value.

10 | Conclusion

This work provides a resource for LRS health practitioners designed to supplement initial training and to use as an aid for assessing placenta position, diagnosing placenta praevia and assisting in obstetric sonographic management. The poster uses the familiar colour coding of green, orange and red to simplify the message for the normally positioned, low-lying and praevia placentas, with the mnemonic 'Report, Repeat, Refer' for sonographic management. Placenta praevia can be excluded when the placental edge is ≥ 20 mm from the internal os at a gestational age > 16 weeks. When the placenta is < 20 mm from the internal os, third trimester follow-up or obstetric review if the patient presents initially in the third trimester is recommended. Labelled images and videos have been provided demonstrating the ultrasound probe position and scanning technique when assessing placenta position. A systematic technique to screen for placenta praevia using a transverse superior to inferior sweep of the uterus has been described with complementary videos. Research to evaluate the effectiveness of the traffic light system in assisting in the diagnosis of placenta position is needed.

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Conflicts of Interest

Ann Quinton is an editorial board member for Sonography. Ann Quinton was not involved in the peer review process; management of the peer review process and decision-making for this article was undertaken by Dr Kerry Thoirs, Editor in Chief, acting as Handling Editor. The other authors declare no conflicts of interest.

Data Availability Statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.