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# Ultrasound in obstetrics and gynaecology: a perspective

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Ultrasound is widely used in obstetrics and gynaecology (O&G) because it is non-invasive, free of ionising radiation, easy to use, well accepted, cost-effective, and widely available. Advances in ultrasound technologies—including real-time high-resolution imaging, colour Doppler, transvaginal scanning with specialised probes, and three-dimensional (3D) and four-dimensional (4D) imaging—have improved diagnostic accuracy and monitoring capability. This perspective discusses the current use of ultrasound in O&G practice in Hong Kong, spanning antepartum, intrapartum, and postpartum care, as well as general gynaecology and its subspecialties. In addition to first-trimester and mid-trimester morphology scans, a third-trimester ultrasound scan should be offered to all pregnant women. Intra- and post-partum ultrasound should be performed selectively in high-risk women. Standardised terminology and measurements should be used in the assessment of uterine lesions. Prediction models should be applied in the evaluation of ovarian tumours, and detailed assessment should be undertaken for endometriosis. Selective use of 3D and 4D ultrasound and artificial intelligence functions may be helpful. To uphold standards of ultrasound practice, appropriate quality control measures should be observed.

*Keywords: Gynecology; Obstetrics; Ultrasonography*

## Introduction

Ultrasonography is widely used in obstetrics and gynaecology (O&G) because it is non-invasive, free of ionising radiation, easy to use, well accepted, cost-effective, and widely available. Advances in ultrasound technologies—including real-time high-resolution imaging, colour Doppler, transvaginal scanning with specialised probes, and three-dimensional (3D) and four-dimensional (4D) imaging—have improved diagnostic accuracy and monitoring capability[1,2]. This perspective discusses the current use of ultrasound in O&G practice in Hong Kong.

## Ultrasound in obstetrics

Ultrasound has shifted the focus of obstetrics from the management of labour to the antenatal diagnosis of adverse fetal conditions[3], as well as intra- and post-partum assessments. It provides accurate and clinically useful information to facilitate antenatal care for both pregnant women and fetuses. The Hong Kong College of Obstetricians and Gynaecologists (HKCOG) recommends offering pregnant women a first-trimester dating scan and a mid-trimester morphology scan (MTMS)[4,5].

### *First-trimester scan*

First-trimester ultrasound at 11 to 14 weeks' gestation enables determination of fetal viability and the number of fetuses, and screening for chromosomal abnormalities, major structural abnormalities, and preterm pre-eclampsia[6]. The incidence of fetal abnormalities is 2% to 3%, and approximately 40% to 50% of major abnormalities can be detected at this gestational age[6].

In the public sector, first-trimester ultrasound forms part of the routine combined first-trimester screening programme for Down syndrome. In some public hospitals, routine screening for pre-eclampsia has also been incorporated through Doppler assessment of the uterine arteries. In the private sector, non-invasive prenatal testing using cell-free DNA is widely used as first-line screening for chromosomal abnormalities. The International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) recommends offering a first-trimester ultrasound scan that includes measurement of nuchal translucency[7] and screening for pre-eclampsia.

### *Mid-trimester morphology scan*

The MTMS is common practice in Hong Kong, although it is not yet routinely provided in the public sector because of limited resources. Performing a MTMS at 18

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to 22 weeks' gestation enables evaluation of fetal cardiac activity, fetal number, gestational age, fetal anatomy, placental appearance and location, umbilical cord vessels, and amniotic fluid volume[8]. Approximately 60% to 80% of major anomalies can be detected by an experienced operator during the MTMS, depending on the organ system involved and scan protocol used[9]. Prenatal detection of fetal abnormalities before 24 weeks' gestation enables further genetic testing, counselling, and management. Additionally, early-onset fetal growth restriction (FGR) can be detected during the MTMS; it should be monitored and managed in hospitals with the highest level of neonatal care[10].

Whether to perform a basic or detailed MTMS depends on maternal risk factors, abnormal or suspicious scan findings, and the availability of time, equipment, and expertise[8,11,12]. A detailed MTMS (as recommended by American Institute of Ultrasound in Medicine guidelines) includes examination of 28 fetal structures or elements, although not all are assessed in every case[8,11,12]. In high-risk pregnancies or when a fetal abnormality is suspected, a detailed MTMS—including fetal neurosonography, echocardiography, and/or comprehensive evaluation of other fetal structures—should be performed by an experienced specialist or maternal-fetal medicine (MFM) subspecialist. Ultrasound operators should be aware of the updated 2022 ISUOG guidelines, in which eight basic and three optional fetal structures or elements were added to improve prenatal detection of fetal abnormalities[11,12]. Additional time, effort, and expertise are required[11,12]. In women with a low-risk non-invasive prenatal testing result, a basic MTMS should still be offered to screen for fetal abnormalities. However, assessment of soft markers for Down syndrome is not required due to their higher false-positive rate and lower positive predictive value[7].

According to the updated 2022 ISUOG guidelines, ultrasound screening for placenta accreta spectrum disorders should be performed in women with a history of Caesarean section and a low anterior placenta, or other risk factors[8]. If such disorders are suspected, a more detailed evaluation of the depth and site of placental invasion is required. A transvaginal scan is recommended to exclude vasa previa in pregnancies at risk, including twin pregnancy, conception by assisted reproductive technology, a low-lying or bilobed placenta, succenturiate placental lobes, and velamentous cord insertion[8]. It is more accurate than a transabdominal scan and is recommended for cervical length measurement, with a cut-off of ≤25 mm for the prediction of preterm birth[8]. However, transvaginal scanning may not be accepted by all women and should be used selectively in high-risk cases or when abnormal findings are identified on prior scans, after separate consent has been obtained.

***Third-trimester ultrasound scan***

The third-trimester ultrasound scan (TTUS) enables detection of breech presentation, fetal anomalies, small for gestational age, and large for gestational age, as well as adverse perinatal outcomes[13]. Generally, TTUS is indicated for antepartum bleeding, reduced fetal movements, and uterine size incompatible with gestational age on physical examination[13]. Point-of-care or handheld ultrasound at around 36 weeks' gestation is increasingly performed in the public sector to assess fetal presentation and other parameters.

Given increasing rates of stillbirth related to placental pathologies and FGR, as well as limitations of serial symphysis-fundal height measurement in identifying small for gestational age or FGR, a routine TTUS at 36 weeks' gestation should be offered to all women to improve detection of late-onset FGR through estimation of fetal weight and abdominal circumference, despite the potential increase in obstetric intervention[13]. In the private sector, TTUS is common practice, although evidence of improved perinatal or maternal outcomes in low-risk pregnancies remains insufficient[13]. Doppler ultrasound assessment of the middle cerebral and umbilical arteries, among other fetal monitoring modalities, should be performed to evaluate late-onset FGR[10].

In contrast to strain-based elastography, which requires manual movement of the ultrasound probe to generate stress on the cervix, shear wave elastography uses ultrasound pulses to generate shear waves across the cervix to measure cervical stiffness[14]. A study in Hong Kong involving 475 women showed that a combination of shear wave elastography and sonographic cervical length measurement was superior to digital assessment of the Bishop score alone in predicting failed induction of labour[14].

***Invasive procedures***

Invasive prenatal diagnostic procedures or fetal interventions should be performed by experienced specialists under continuous ultrasound guidance to reduce complications[15]. Additionally, ultrasound is used to guide external cephalic version for breech presentation.

***Multiple pregnancy***

According to ISUOG guidelines, women with

twin pregnancy should undergo a first-trimester scan for dating and determination of chorionicity and amnionicity[16]. Chorionicity should be determined before 13 + 6 weeks' gestation based on the intertwin septum, membrane thickness, and number of placental masses, thereby enabling appropriate ultrasound monitoring to be arranged[16]. In monochorionic twin pregnancy, ultrasound screening for twin-to-twin transfusion syndrome should begin at 16 weeks' gestation and be repeated every 2 weeks, or weekly if uncomplicated amniotic fluid discordance is identified[15]. Monitoring of monochorionic twin pregnancies should be performed or supervised by MFM subspecialists in a tertiary centre, given the risk of specific complications, including twin-to-twin transfusion syndrome, twin anaemia-polycythaemia sequence, selective FGR, fetal anomalies, and intrauterine death.

***Intrapartum***

Ultrasound examination is more accurate and reproducible than clinical examination for determining fetal head position and station, and for predicting arrest of labour and the outcomes of instrumental vaginal delivery[17]. Transabdominal scanning can be used to determine fetal head and spine position and engagement, whereas transperineal scanning can assess fetal head station and position at low stations[17]. Both approaches are well accepted by women. Fetal head station can be evaluated by measuring the angle of progression, head-to-perineum distance, and head direction[18]. A sonopartogram is an objective tool for graphical representation of labour; it requires serial ultrasound measurements of key labour parameters, including cervical dilatation, fetal head descent, and position[19].

Ultrasound examination has been increasingly used in labour management, particularly in public hospitals. Routine use of intrapartum ultrasound appears to be non-essential in uncomplicated labour. However, when ventouse or forceps delivery is required and clinical examination cannot accurately determine the fetal head position, ultrasound should be used, as recommended by the Royal College of Obstetricians and Gynaecologists[20].

***Postpartum***

Postpartum haemorrhage and maternal collapse are life-threatening emergencies. Management should be directed toward the underlying cause. Ultrasound is useful for prompt evaluation of potential causes, including retained placenta, placenta accreta spectrum disorders, uterine rupture, paravaginal haematoma, and uterine inversion[21]. It is also valuable in the diagnosis and management of acute pulmonary oedema, ventricular dysfunction, intra-abdominal free fluid, shock, and cardiac arrest[22]. Obstetricians generally should be able to make a prompt diagnosis through clinical and ultrasound examination and provide adequate management of postpartum haemorrhage. They should also receive training in maternal point-of-care ultrasound to increase awareness of various causes of maternal collapse.

Ultrasound can be used to detect anal sphincter injuries, which may not be identified on clinical examination after vaginal birth. 3D endoanal ultrasound is the gold standard for evaluation of the anal sphincter[23], whereas 3D transperineal ultrasound is an alternative with variable sensitivity[24]. 3D ultrasound should be used selectively in high-risk women after vaginal delivery to detect anal sphincter injuries.

## Ultrasound in gynaecology

Gynaecological ultrasound is initially used to localise pelvic masses and subsequently to evaluate ascites, ovarian tumours, cervical lesions, early pregnancy, intrauterine devices, malignancies, pelvic inflammatory disease, vulval cysts, and other pathologies[1,2]. Common indications include pelvic pain, abnormal uterine bleeding, early pregnancy assessment, and uterine or adnexal masses. The use of gynaecological ultrasound has expanded to subspecialties such as reproductive medicine, gynaecologic oncology, and pelvic floor disorders. Standardised terminology, definitions, and measurement techniques have been proposed to enhance consistency.

***Early pregnancy complications***

Ultrasound is essential in the evaluation of early pregnancy complications, including early pregnancy loss, pregnancy of unknown location, and ectopic pregnancy[25]. Clinicians should be aware of the updated diagnostic criteria for early pregnancy loss to avoid inappropriate evacuation of desired pregnancies while minimising unnecessary delay[25]. Transvaginal scanning, in conjunction with β-human chorionic gonadotropin monitoring, should be used for early diagnosis of ectopic pregnancy. In women with a previous Caesarean section, transvaginal scanning should be performed to exclude Caesarean scar pregnancy, although accurate and timely diagnosis may be challenging[26].

***Ovarian tumours***

Transvaginal ultrasound is used to detect and characterise adnexal lesions as benign or malignant. In 2021, the European Society of Gynaecological Oncology,

ISUOG, International Ovarian Tumour Analysis (IOTA) group, and European Society for Gynaecological Endoscopy jointly published statements regarding ultrasound differentiation between benign and malignant ovarian tumours[27]. This differentiation can be achieved using ultrasound-based diagnostic models, including the IOTA Simple Rules risk model and IOTA ADNEX model. In the Simple Rules risk model, tumours are classified as benign, inconclusive, or malignant based on five benign and five malignant features[27]. In the ADNEX model, predictor variables include age, maximum diameters of the lesion and largest solid component, number of papillary projections (ordinal), presence of acoustic shadows, ascites, >10 cyst locules, and type of oncology centre[27]. The Simple Rules risk model can be applied in routine clinical practice, whereas the ADNEX model is more suitable for use in oncology centres. Proper patient selection, including valid indications and absence of contraindications, is required before image-guided biopsy in gynaecological oncology[28]. The prognosis of ovarian cancer remains poor because most patients are diagnosed at an advanced stage. Transvaginal ultrasound and serum CA125 testing have been used for ovarian cancer screening[29]. However, findings from the UK Collaborative Trial of Ovarian Cancer Screening did not support screening for ovarian and tubal cancer in average-risk women[29]. Such screening did not reduce mortality from ovarian and tubal cancer, despite earlier detection and an increased incidence of early-stage disease[29].

***Uterine masses***

Greyscale sonography and colour or power Doppler, with or without 3D ultrasound imaging, are commonly used to assess the myometrium and myometrial lesions, including fibroids and adenomyosis[30]. For standardisation, sonographic features should be described using the terms and measurements proposed in the Morphological Uterus Sonographic Assessment statement[30]. The site of a fibroid in relation to the myometrium should be reported according to the International Federation of Gynecology and Obstetrics classification[31]. It is important to distinguish between direct and indirect sonographic features of adenomyosis[32]. Although some terms and definitions are especially detailed and may be less practical for routine use, accurate myometrial lesion characterisation (benign or malignant) and localisation (eg, subserosal or submucosal) are essential before operative procedures such as laparoscopic or hysteroscopic myomectomy[30]. Ultrasound identification of a typical fibroid is straightforward; differentiation between an atypical fibroid and uterine sarcoma remains challenging[30].

***Endometrial pathology***

Ultrasound (greyscale and colour Doppler) is commonly used to assess abnormal uterine bleeding before and after menopause, although its utility in premenopausal women is less clear[33]. Sonographic features of the endometrium and uterine cavity can be reported using the terms and measurements defined by the International Endometrial Tumor Analysis group[33]. Features not suggestive of endometrial cancer include endometrial thickness <3 mm, a three-layer pattern, a linear midline, and a single non-branching vessel[33]. Compared with low-risk tumours, high-risk tumours tend to be larger and are more likely to demonstrate an irregular endometrial-myometrial junction, non-uniform echogenicity, a multifocal vessel pattern, and a moderate or high colour score[34]. These features can be used for reporting in routine clinical practice. In 2021, the American Institute of Ultrasound in Medicine published practice guidelines on saline infusion sonohysterography[35]. Compared with transvaginal sonography, saline infusion sonohysterography provides superior visualisation of the endometrial cavity via transcervical injection of saline under aseptic precautions[35]. It facilitates evaluation of endometrial cavity lesions, including leiomyomas, polyps, synechiae, and Caesarean scar niches, differentiation between focal and diffuse endometrial abnormalities, and assessment of congenital or acquired uterine abnormalities[35].

***Endometriosis***

Endometriosis is common; it is characterised by infertility and chronic pelvic pain. Ultrasound can detect endometriosis and assess its location and severity. A 2024 meta-analysis showed that diagnostic accuracy for endometriosis was similar between ultrasound and magnetic resonance imaging, although it varied according to operator expertise and scanning protocol[36]. Ultrasound can be more accurate than magnetic resonance imaging in identifying the depth of bowel wall invasion, but it may be less accurate in detecting pelvic wall and extraperitoneal disease[36]. Approximately 20% of women with endometriosis have deep infiltrating endometriosis[37]. Routine pelvic ultrasound can be extended to include assessment of the posterior and anterior pelvic compartments for structural mobility and deep infiltrating nodules[38]. The sliding sign on transvaginal ultrasound can be used to detect pouch of Douglas obliteration and bowel involvement in women with suspected endometriosis[39]. These approaches enable earlier diagnosis, appropriate classification, and improved surgical outcomes in women with deep infiltrating endometriosis[37,38].

***Pelvic inflammatory disease***

Pelvic inflammatory disease is common, and early diagnosis prevents severe complications. Although the diagnosis is often made clinically, ultrasound can confirm the diagnosis. Sonographic features are heterogeneous and vary according to disease stage. Transabdominal and transvaginal ultrasound with Doppler can identify salpingitis or pyosalpinx (characterised by bilateral adnexal disease with a tubular configuration and blurred margins), tubo-ovarian complex or abscess, and extension of disease into the abdominal cavity with fluid collection[40]. Ultrasound also helps exclude other conditions, including complications of ovarian cysts, endometriosis, ectopic pregnancy, and appendicitis.

***Reproduction***

Ultrasound is widely used in the investigation of female infertility, including evaluation of pelvic masses, Müllerian anomalies, diminished ovarian reserve, polycystic ovarian syndrome, and impaired tubal patency[41,42]. It is also important for assisted reproduction, including monitoring of follicular development, oocyte retrieval, endometrial assessment, and embryo transfer during in vitro fertilisation[41]. Transvaginal scanning, with or without 3D imaging and Doppler, is commonly performed to assess endometrial blood flow, ovarian reserve, follicular maturity, and polycystic morphology[42]. Ultrasound is also helpful in defining the relationship of fibroids to the endometrial cavity, determining the position of polyps and other anatomical structures relative to the implantation site, diagnosing adenomyosis, identifying and classifying congenital uterine malformations, and differentiating ovarian from extraovarian cystic structures[42]. In 2021, the American Institute of Ultrasound in Medicine published guidelines on air/saline hysterosalpingo-contrast sonography for assessment of tubal patency using ultrasound[43]. Although this technique has a high negative predictive value for tubal patency, the addition of an appropriate hyperechoic contrast agent, 3D image acquisition, and high-frequency Doppler can improve predictive accuracy[43].

***Pelvic floor disorders***

Pelvic floor disorders are common, with diverse causes and clinical presentations. Accurate assessment is essential, particularly before surgical management[44]. Pelvic floor ultrasonography includes two-dimensional (2D), 3D, and 4D imaging by transvaginal, endoanal, and transperineal approaches[44]. A multicompartmental perspective is preferred over a compartmentalised approach[44]. Common indications include urinary incontinence, pelvic organ prolapse, and other related urogenital or bowel symptoms[44]. However, ultrasound findings may not be correlated with clinical findings or patient-reported symptoms, and anatomical correction does not necessarily equate to functional improvement[44].

## Three- and four-dimensional ultrasound and fetal heart quantification

Although the MTMS can largely be performed using 2D ultrasound alone, 3D multiplanar or multislice analysis in standard planes can be used to assess normal and abnormal fetal structures[45]. Common examples include the fetal brain, spine, face, heart, and placenta[45,46]. 3D/4D rendered imaging, with or without rotation, can assist in counselling when fetal malformations (eg, cleft lip) are detected and can reassure at-risk women when findings are normal[45]. Uterine anomalies can be more accurately delineated using 3D ultrasound with a standardised approach[47]. 3D ultrasound performs better than routine 2D ultrasound in diagnosing and defining endometrial pathologies and fibroids, and in localising intrauterine devices[47]. A 3D volume dataset also allows subsequent offline review through multiplanar or multislice approaches[47]. Furthermore, a 3D volume dataset of a fetal face or heart can be exported in the Standard Triangle Language format from modern ultrasound machines[48]. The file can be viewed on a personal computer using common software and used for 3D printing[48], which is valuable for simulation, preoperative planning of complex procedures, education, counselling, and research[48,49].

Fetal heart quantification facilitates assessment of fetal heart shape, size, and contractility using speckle tracking to analyse fetal heart motion at multiple points[50]. It has been applied in the evaluation of fetal heart defects and FGR[50,51]. However, additional data are required to confirm its routine clinical utility[51].

## Artificial intelligence and machine learning

Machine learning, particularly deep learning, enables ultrasound image recognition and facilitates automated identification, annotation, and measurement of fetal biometry, as well as assessment of fetal structures[52,53]. Automation of biometric measurements, with fine-tuning of calliper placement on 2D images or 3D volumes, is clinically useful. AI-assisted assessment of normal and abnormal fetal structures, particularly in fetal echocardiography, has been explored to improve prenatal diagnosis[53,54]. AI-assisted assessment shows promise, but

further data and development are required before routine clinical implementation.

## Training, maintenance of skills, and certification

According to ISUOG guidelines, ultrasound operators should (1) receive appropriate training in diagnostic ultrasonography for pregnant women, (2) regularly perform fetal ultrasound examinations, (3) participate in continuing medical education activities, and (4) routinely undertake quality assurance and quality control measures[8]. Currently, all O&G trainees are required to complete training in ultrasonography during specialty training before independently performing a basic morphology scan. Further subspecialty training in MFM enables acquisition of skills required for detailed morphology scans. The European Federation of Societies for Ultrasound in Medicine and Biology has published minimum training and scanning requirements for gynaecological ultrasound practice in Europe, with three levels of training and expertise: Level I (basic) and Levels II and III (expert)[55]. For O&G doctors in Hong Kong, advanced ultrasound techniques in gynaecological oncology, reproduction, and pelvic floor disorders are acquired through corresponding subspecialty training and clinical practice.

## Safety

2D and 3D ultrasound examinations do not cause adverse effects in embryos or fetuses when used appropriately[1,56,57]. Ultrasound exposure should be limited to the shortest duration necessary to obtain adequate clinical information. The As Low As Reasonably Achievable principle should be observed; mechanical and thermal indices should be monitored to minimise potential thermal effects[1,56,57]. Prolonged use of high intensities or high sound pressure, extended application of Doppler ultrasound, use of contrast agents, or scanning in pregnant women with high fever should be avoided[1,56,57]. Non-medical use of ultrasound for psychosocial or entertainment purposes should be discouraged[58].

## Medicolegal issues

Professional liability risks exist in the practice of O&G ultrasound, particularly when a major fetal anomaly is missed prenatally. O&G practitioners should be aware of three types of errors: (1) technical or procedural, (2) perception or interpretation, and (3) communication or documentation[58]. These errors can be prevented or minimised through adequate ultrasound training, regular practice, continuing education, and knowledge of the updated guidelines[58]. Proper instrumentation, adequate image acquisition and storage, thorough documentation, and appropriate patient counselling—including discussion of ultrasound limitations—are essential. Follow-up actions should include effective communication with referring doctors and appropriate rescanning or referral when necessary[58].

## Conclusion

Ultrasound is widely used in O&G practice, spanning antepartum, intrapartum, and postpartum care, as well as general gynaecology and its subspecialties. In addition to the first-trimester scan and MTMS, a TTUS should be offered to all pregnant women. Intra- and postpartum ultrasound should be performed selectively in high-risk women. Standardised terminology and measurements should be used in the assessment of uterine lesions. Prediction models should be applied in the evaluation of ovarian tumours, and detailed assessment should be undertaken for endometriosis. Selective use of 3D/4D ultrasound and AI functions may be helpful. To uphold standards of ultrasound practice, appropriate quality control measures should be observed.

## Contributor

The author designed the study, acquired the data, analysed the data, drafted the manuscript, and critically revised the manuscript for important intellectual content. The author had full access to the data, contributed to the study, approved the final version for publication, and takes responsibility for its accuracy and integrity.

## Conflicts of interest

As an editor of the journal, KYL was not involved in the peer review process.

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## Data availability

All data generated or analysed during the present study are available from the corresponding author upon reasonable request.

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