The increasing role of ultrasound in OB-GYN practice: Present and future applications

Introduction

An ultrasound examination is undoubtedly one of the most commonly performed procedures in Obstetrics and Gynecology. This technology has been an important development in the diagnosis and management of many common disorders in obstetrics and gynecology. By reviewing its history, we appreciate how much it has revolutionized our clinical practice.

A Brief History of Ultrasound in Obstetrics and Gynecology

Ultrasound in Obstetrics and Gynecology began in June 1958 with the publication of Professor Ian Donald, John McVicar, and Tom Brown's paper entitled "The investigation of abdominal masses by pulsed ultrasound."[1] Professor Ian Donald was a Scottish obstetrician-gynecologist, while Tom Brown was an engineer. Together with an engineering company, they developed the world's first contact compound two-dimensional (2D) ultrasound scanning machine called the Diasonograph. This paper was notable in that it was entirely devoted to ultrasound studies in clinical obstetrics and gynecology. It contained the first ultrasound images of the fetus as well as gynecological masses. The ultrasound images were crude, bistable, and static. Looking at these images now, it is difficult to distinguish anatomic landmarks in the black and white dots compared to the images we now have with our modern ultrasound machines.

During the next decade, a large number of static scanning machines were made. These machines were initially built in research centers where it was essential to have dedicated physicists to attend to the more technical or electronic aspects of the machine, which were then prone to a number of faults. Compared to our modern real-time digital ultrasound machines, the diasonograph was a massive machine - it was 8 feet in height and occupied about one-third of the scanning room.[2] Clinical studies were made using these static scanning machines. There were breakthroughs in diagnosis, such as the assessment and growth of the early gestation sac, the diagnosis of early pregnancy complications,[3] and the description of the early diagnosis of hydatidiform mole with its snowstorm appearance.[4]

Over the next two decades (1970s–1980s), rapid technological advances in electronics and piezoelectric materials provided further improvements from bistable to grayscale images and from still images to real-time moving images. The introduction of the concept of real-time ultrasound in 1968 was followed by the development of gray-scale images. Huge advances in integrated circuit technology in the late 1970s led to smaller, less expensive ultrasound machines. The advent of commercially available systems allowed the wider dissemination of the practice of ultrasound. The first transvaginal transducer-generated A-mode images were produced in 1955 in Japan. However, models of transvaginal transducers similar to what we use today were produced much later. In 1985, Kretztechnic produced the first practical transvaginal mechanical sector transducer which was designed to improve the technique of oocyte collection in *in vitro fertilization*.[5] In the same year, Aloka had incorporated color Doppler imaging into their real-time equipment, and this was quickly followed by other major manufacturers. By 1990, color Doppler was available on the transvaginal probe for gynecological examination. By the end of the 1990s harmonic imaging was introduced, which further improved image resolution. Early studies on three-dimensional (3D) imaging began in Japan by Prof. Kazunon Baba in 1989, and soon after, the production of the third generation 3D and four-dimensional (3D/4D) imaging in the mid-1990's followed.[6] By 2000, the modern real-time ultrasound machine with high-resolution abdominal and transvaginal transducers, harmonic imaging, color and power Doppler facilities with a 3D/4D option was already commercially available.[2]

Obstetric and Gynecologic Ultrasound in the Philippines

As ultrasound became more accessible to clinicians worldwide, including Obstetrician Gynecologists, this eventually led to its beginnings in our country in 1993. This year marked the emergence of ultrasound in our practice when a number of Filipino Obstetrician-Gynecologists came back from fellowship and preceptorship training from countries such as Japan, the United States, the United Kingdom, and Spain. The Philippine Obstetrical and Gynecological Society (POGS) created a standing committee to answer the need for a body that would oversee the beginnings of this new subspecialty. This

was the Subcommittee on Obstetrical and Gynecological Ultrasound under the Committee on Internal Affairs headed by then vice president of the POGS.

The first chairman of this subcommittee was Dr. Trinidad Vera, and the members were Dr. Virgilio Castro, Dr. Lyra Ruth Clemente-Chua, and Dr. Gilda Germar-Martinez. The committee conducted information campaigns about the subspecialty through lectures given in postgraduate courses and in the midyear and annual conventions of the POGS.[7,8]

As the subcommittee continued its activities, it recognized the need to establish a society that would bring together all of the ultrasound practitioners in the subspecialty into one organization, and truly incorporate ultrasound into the practice of Obstetrics and Gynecology. Through this organization, policies and guidelines can be implemented to ensure a high standard of practice for the already an increasing number of OB-GYN ultrasound practitioners.

The Philippine Society of Ultrasound in Obstetrics and Gynecology was born with the Securities and Exchange Commission certified Articles of Incorporation and By – Laws in 1994. The first general meeting and induction of officers was planned and held in December 3, 1994, at the EDSA Shangri-La Hotel in Mandaluyong City with the following officers and incorporators.[7,8]

President	: Ma. Trinidad R. Vera, MD
Vice President	: Virgilio B. Castro, MD
Secretary	: Lyra Ruth Clemente-Chua, MD
Treasurer	: Ma. Lourdes Coloma, MD
Auditor	: Filomena S. San Juan, MD
P. R. O.	: Gilda G. Germar-Martinez, MD
	: Ana Marie R. Madamba, MD

Since then, the Society has grown from its beginnings as a subcommittee in POGS to one of the largest subspecialty societies of POGS, with 883 members and 17 accredited fellowship training institutions.

Current Applications of Ultrasound in Obstetrics and Gynecology

Ultrasound as an imaging modality has several advantages: it is noninvasive, with higher spatial resolution than computed tomography and magnetic resonance imaging, excellent anatomical definition for superficial and deeper structures, real-time imaging capabilities, and wide availability. At the same time, ultrasound has no ionizing radiation and is significantly less expensive.[9]

At present, we cannot think of practicing OB-GYN without access to ultrasound. Indications for ultrasound in obstetrics and gynecology have expanded from its initial use for evaluation of the fetal head and recognition of an ovarian mass. Fetal biometry was born when Stuart Campbell published the first description of measurements of the fetal biparietal diameter in 1968.[10] The introduction of transvaginal ultrasound in 1985, with its higher transducer frequencies, allowed for earlier pregnancy assessment, screening for fetal anomalies, uterine artery Doppler to predict preeclampsia and preterm birth, detection of ectopic pregnancy or pregnancy of unknown location, evaluation of pelvic masses and use in reproductive medicine.[11]

There have been numerous improvements in ultrasound in the past years. These include Doppler ultrasound, 3D-and 4D ultrasound, harmonic imaging, high-contrast resolution, speckle reduction, one-touch image optimization, and increased automation, all of which have increased its application in clinical practice. Ultrasound-guided procedures also have an essential role in the diagnosis and treatment of Obstetric and Gynecologic conditions. Ultrasound-guided procedures in obstetrics include amniocentesis, chorionic villus sampling, and percutaneous umbilical blood sampling, which help establish a prenatal diagnosis.[12] Intraoperative ultrasound has become a part of gynecology to facilitate various operations. These may be minor procedures such as retrieval of a lost contraceptive impant[13] or displaced intrauterine device,[14] or it may be a more complex procedure such as hysteroscopy, laparoscopic myomectomy,[15-17] or ultrasound guidance during fertility-sparing surgery.[18]

Miniaturization of ultrasound machines has also made advancements, from huge static-scan consoles to large but movable machines to much smaller and movable real-time instruments, to laptops, hand-held scanners, and now to using a tablet or smartphone as a monitor.[11] Together with the increased portability of ultrasound and access to technology to support data transmission, there has also been an emergence of tele-ultrasound, especially in low-resource settings and during the time of the COVID-19 pandemic.[19,20] This involves an ultrasound practitioner performing bedside ultrasound at one location and sending images to be interpreted by another ultrasound practitioner located in a geographically distant location. This process can be conducted either in a synchronous manner wherein an ultrasound scan is done in real time over a live video feed; or in an asynchronous manner, where ultrasound images or videos are sent at a later time.[19]

Future Applications of Ultrasound in Obstetrics and Gynecology

Ultrasound continues to grow as its technology develops. More recent developments that show promise for future

applications in our practice include elastography and artificial intelligence (AI).

Elastography

Conventional ultrasound is based on the acoustic properties of tissues and allows the evaluation of pelvic organs. Ultrasound elastography or sonoelastography (SE) has been developed over the last three decades to display information on tissue stiffness. The technique is based on tissue deformation or strain when applying a certain force or stress.[21] This change in elasticity is detectable and imaged using elastography. In obstetrics and gynecology, the use of SE has been reported in the evaluation of the myometrium (myoma, adenomyosis), endometrium (polyps, endometrial cancer), cervix (prediction of preterm delivery, cervical cancer), and pelvic endometriosis.[22-24] Implementation of this technique in a structured and standardized manner in future trials is still needed to discover its added value in obstetric and gynecological ultrasound.

Artificial intelligence (AI)

AI is described as the ability of a computer program to perform processes associated with human intelligence, such as reasoning, learning, adaptation, sensory understanding and interaction.[25] In clinical medicine, AI technologies have the potential to change healthcare by deriving new and important insights from the vast amount of digital data generated during the delivery of health care. Promising medical AI applications are emerging in the areas of screening, prediction, triage, diagnosis, drug development, treatment, monitoring, and imaging interpretation. AI in medical imaging has had major advances in deep learning-based "computer vision." These computers can interpret and understand visual inputs. In obstetric and gynecological ultrasound, promising workload-changing advancements include automatic detection of standard planes and quality assurance in fetal ultrasound, detection of endometrial thickness in gynecology and automatic classification of ovarian cysts. While there are many potential benefits with AI, it is still an emerging technology with many factors to be considered before its full application in our daily practice. These include its impact on jobs, ethical issues, and potential professional liability when AI is used.[26]

Summary

Obstetric and gynecologic ultrasound has made a great impact on improving the health of women and babies in the second half of the 20th century and continues to do so in the 21st century. Looking back at the beginnings of ultrasound and where we are today, one cannot help but be amazed and grateful for this amazing technology that we have within our reach. Along with its advances, we should also remember that ultrasound needs dedicated education and training to optimize its use as an imaging modality.

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Conflicts of interest

There are no conflicts of interest.

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