Three-dimensional Ultrasound in Prenatal Diagnosis and Reproductive Medicine

In this special issue of *J Med Ultrasound* (September, 2012), recent advances in three-dimensional (3D) ultrasound in obstetrics and gynecology, especially with a focus on prenatal diagnosis and reproductive medicine, are intensively reviewed and comprehensively discussed.

The ovary has been one of the most challenging issues in reproductive medicine for several decades, either in assessment of functional anatomy or evaluation of pathophysiology. Recent advents in 3D ultrasound have contributed substantially to the improvement of ovarian assessment. In this issue, Wu et al [1] present a detailed and thorough review on the clinical use of 3D ultrasound in the evaluation of the human ovary. With the recent advent of modern technology, 3D ultrasound has emerged as an important and noninvasive method in the clinical practice of obstetrics and gynecology for differential diagnosis of ovarian disease. The application of higher-frequency scanning probes can evaluate the ovary in the analysis of morphological anatomy and volume measurement, and is highly reproducible. In addition, the potential of power Doppler ultrasound with vascular indices that can further depict and quantify the microcirculation of the ovary is extensively explored.

In 2002, Pan and coworkers [2] first reported quantification of Doppler signals in polycystic ovary syndrome (PCOS) using 3D power Doppler ultrasonography. They found that quantification of the Doppler signal in the ovary appeared to be greater in the PCOS group compared with the normal group. The mean ovarian volume was significantly higher in women with PCOS compared with the normal ovaries. The vascularization index (VI), flow index (FI) and vascularization flow index (VFI) were significantly higher in women with PCOS compared with those with normal ovaries. They have concluded that a quantification study of the vascular flow, including the VI, FI, and VFI of the ovary using 3D power Doppler, is more accurate than the previously reported quantification analysis using two-dimensional (2D) imaging, and may be a possible new marker for diagnosis. Subsequently, ovarian flow decreasing along with the aging process was observed by using 3D power Doppler [3]. Another study has shown a significant increase in ovarian stromal flow indices after 3 months of hormone replacement therapy, but not in the controls [4]. The researchers have suggested that monitoring the ovarian flow changes by 3D Doppler may be of clinical importance when hormone replacement therapy is given [4]. Moreover, 3D power Doppler can be applied in *in vitro* fertilization [5,6]. The 3D power Doppler indexes of ovarian blood flow in poor responders was significantly lower than that in normal responders [5]. This phenomenon may help to explain the poor response during human chorionic gonadotropin administration in controlled ovarian stimulation [5]. However, quantification of ovarian Doppler signals in hyper-responders during *in vitro* fertilization treatment using 3D power Doppler ultrasonography showed the serum estradiol levels on the day of human chorionic gonadotropin administration, the number of oocytes retrieved, and the ovarian volume were significantly higher in the hyper-responders than in the normal groups [6]. Besides, the VI, FI and VFI of the ovaries were significantly higher in the hyper-responders compared to the women with a normal response [6]. This implies the increased flow of the ovary might help to explain the excessive response during gonadotropin administration in the hyper-responsive women [6].

In a previous review in 2007, Wu et al [7] reported their series of studies using 3D ultrasound and 3D power Doppler in infertility and reproductive endocrinology. They concluded that 3D ultrasound and 3D power Doppler can be used in the analysis of morphological anatomy and volume measurement, and are highly reproducible [7]. In this issue, Wu et al [1] further review the updated results of 3D ultrasound in the medical literature and report the present status and recent development of 3D ultrasonography in evaluation of the ovary. In conclusion, Wu et al [1] recommend that 3D ultrasound may be of great help in investigating the functional and potential roles of ultrasonography in clinical examination of the ovaries. Furthermore, 3D ultrasound may provide more substantial assistance in the differential diagnosis of various physiological or pathological conditions of the ovary.

In fetal medicine, obstetrics and perinatology, fetal growth restriction (FGR) or intrauterine growth restriction (IUGR) is another important issue and has remained
resolved for several decades. To date, ultrasound is one of the most important tools in prenatal diagnosis of FGR or IUGR. In this special issue, Lee et al. [8] review the recent literature on the prenatal assessment of FGR or IUGR by using various modes of 3D ultrasound.

In 1992, Kuo and coworkers [9] first reported the primary application of 3D ultrasonography in obstetrics. Later on, Chang et al. [10] first used 3D-ultrasound-assessed fetal thigh volumetry in predicting birth weight. Moreover, Liang et al. [11] reported predicting birth weight by fetal upper-arm volume with use of 3D ultrasonography. Subsequently, using fetal limbs volume to predict fetal weight has further validated the application of 3D ultrasound worldwide [12,13]. Moreover, Chang and colleagues have reported a series of studies of prenatal diagnosis of FGR by fetal organ volumetry using 3D ultrasound, including fetal upper arm volume [14], humerus volume [15], femur volume [16], and soft tissue volume of the upper arm [17]. They achieved better results for prenatal detection of FGR by 3D ultrasound than by 2D ultrasound [14–17].

After a thorough review of the recent literature, Lee and coworkers [8] have concluded that 3D ultrasound has the potential to provide improved visualization of fetal anatomical morphology compared with conventional 2D ultrasound imaging. However, they have also pointed out that, although no preferred method for the 3D ultrasound estimation of fetal weight has emerged for prenatal diagnosis of FGR [8], the advent of 3D ultrasound imaging has allowed the accurate and reliable calculation of fetal organ and soft tissue volumes.

Of interest, two additional original articles of prenatal diagnosis of fetal anomalies using 3D ultrasound are published in this special issue, one on cystic hygroma [18] and the other on fetal encephalocele [19]. Tsai and coworkers [18] have reviewed a computer database of prenatal diagnosis of cystic hygroma in 2000–2011. In total, 85 cases of fetal cystic hygroma were diagnosed in utero. Perhaps, their report is one of the largest series of prenatal diagnosis of fetal cystic hygroma worldwide. The range of gestational age at prenatal diagnosis by 3D ultrasound was between 9 and 27 weeks (mean: 14.1 weeks), and 65% cases of cystic hygroma were diagnosed at the first trimester [18]. Compared with their previous works on prenatal diagnosis of cystic hygroma in 1995–2000 [20], they found significantly earlier gestational age at prenatal diagnosis of cystic hygroma than a decade ago; only 13% of cases of cystic hygroma were detected at the first trimester in the last century [20]. Tsai et al. [18] have attributed the reasons for improvement in prenatal diagnosis of cystic hygroma to at least three possible factors: (1) improved resolution and imaging of 3D ultrasound machines; (2) improved techniques and increased awareness of physicians; and (3) prenatal measurement of fetal nuchal translucency at the first trimester [21]. It remains to be resolved whether their findings of earlier detection of congenital anomalies can be applied to other types of fetal anomalies, such as multicystic dysplastic kidneys [22] or encephaloceles. Yet, at least their studies on prenatal diagnosis of cystic hygroma have confirmed the clinical use of 3D ultrasound in earlier detection of fetal anomalies.

In addition to their previous case report of fetal encephalocele detected in utero [23], Liao and coworkers have retrospectively reviewed their databank of prenatal diagnosis of fetal encephalocele using 3D ultrasound. They have concluded that 3D ultrasound can detect fetal encephalocele early and provide additional vivid illustration after various modes of reconstruction. They have suggested that 3D ultrasound may contribute to early detection of fetal encephalocele and provide visual imaging, and thus substantially assist prenatal diagnosis as well as genetic consultation.

Given the above evidence in at least four articles in the current special issue of J Med Ultrasound, we are convinced that 3D ultrasound is of great help in clinical practice in obstetrics and gynecology. We expect that further studies and reports will emerge to confirm and justify the clinical application of 3D ultrasound in fetal and reproductive medicine. The reports in this current issue are just the beginning.

References


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