3D AND 4D ULTRASOUND IN OBSTETRICS

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Major advances in ultrasound technology have historically been self fulfilling prophecies with respect to the research and development of their clinical applications. The progression from static to real time B mode imaging, and the introduction of colour and power doppler are classic examples of how rapidly new technology moves from the design phase to the research arena and then seamlessly into everyday obstetric ultrasound practice. Nowadays, for example, even the lower cost portable machines have doppler capability as a standard feature. The same paradigm applies to the current wave of 3D/4D ultrasound technological advancement sweeping the obstetrical and gynaecological ultrasound world. This new application has also been driven by patient or consumer demand fueled by the popular press which is a new dynamic for the obstetric ultrasound specialist.

The development of three dimensional ultrasound from static 3D to real time 4D and beyond has been rapid. The new concepts required to use these tools require a great deal of hands on training not least because of the inherent spatial thinking required. The purpose of this portion of the workshop is to provide the participant with a necessarily brief but global snapshot of the new technological aspects and potential clinical applications of 3D/4D ultrasound.

As mentioned above consumer interest and demand has provided a not completely unexpected catalyst for the development of 3D/4D ultrasound. Ironically the attractive surface rendered 3D images that allow us to observe fetal behaviour represent only the tip of the iceberg when it comes to the range of 3D/4D applications currently available. The list of applications is extensive and includes multiplanar imaging, volume contrast imaging, spatial-temporal image correlation, volume calculation, tomographic ultrasound imaging and multiple render modes.

3D imaging is limited by the same physics that governs 2D image quality. A welcome byproduct of the drive for better 3D/4D ultrasound systems has therefore been parallel improvements to the native 2D imaging resolution such as harmonic, compound resolution and speckle reduction imaging. That said the crux of successful 3D/4D systems that allows real time 4D display and immediate volume dataset analysis involves short acquisition times from fully automatic swept probes and high speed computing capability to ensure the geometrical accuracy of the sampled volume data.

Multiplanar imaging encompasses the important advantage that 3D ultrasound has over 2D ultrasound. This application has the ability to reconstruct and display any chosen 2D sectional image from within the sampled volume. Many of these sections would not be available using conventional 2D imaging because of the natural limitations to probe movement. The volume dataset can also be examined as a rendered 3D image. Furthermore, once saved the volume datasets can be reviewed at a later time or even at a different site i.e. off line analysis.

Clinical applications in both obstetrics and gynaecology for these 3D/4D ultrasound systems are still rapidly being developed by workers worldwide as evidenced by the strong representation of 3D related articles published over the last few years. Reports so far suggest that 3D ultrasound is useful in the second and third trimesters for examining fetuses at risk for anomalies. Two of the largest series concur that 3D ultrasound was advantageous over using 2D only in demonstrating fetal defects in over half of the cases of fetal anomaly examined [1, 2]. These anomalies that were visualized better using 3D ultrasound when compared to 2D ultrasound only included facial defects, cleft lip and palate and talipes. 3D ultrasound can also assist in demonstrating the extent of neural tube defects [3]. Spinal curvature anomalies such as scoliosis can also be displayed using 3D/4D rendered imaging.

Off line analysis allows re-examination of the 3D volume dataset in any chosen sectional planes or rendered image after the original examination has been performed. Multiplanar reconstruction can display multiple sectional planes not appreciated at the initial scan although the native image resolution can be a limiting factor here. The sampled volumes representative of the suspected anomaly or anatomical region of interest can be sent to specialists not available on site for further opinion once these volumes have been re-examined. New diagnostic information may be obtained and this would in some cases obviate the need for patient travel. 3D/4D technology has potential therefore to ease the burden of long distances carried by the Australian obstetric population where the imaging specialist expertise is concentrated in the metropolitan population centers.

References:

1. Merz E, Bahlmann F, Weber G. Volume scanning in the evaluation of fetal malformations: A new dimension in prenatal diagnosis. Ultrasound Obstet Gynecol 5: 222, 1995.
2. Pretorious DH, Richards RD, Budorick NE, et al. Three dimensional ultrasound in the evaluation of fetal anomalies. Radiology 205 (P)(Suppl): 245, 1997.
3. Mueller GM, Weiner CP, Yankowitz J. Three dimensional ultrasound in the evaluation of fetal head and spine anomalies. Obstet Gynecol 88(3): 372, 1996