

For – 3D ultrasound in first and second trimester – hype or helpful?

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Hands Up!



Fig. 2: 3D surface image at 11+ weeks showing normal head, body limbs and cord.

Brief history

3D ultrasound has been the most rapidly evolving technique and technology in fetal ultrasound in the past few years. The technology began with “hand swept” slice acquisition using standard transducers followed by mechanically oscillating 3D transducers. This led to 4D (real-time 3D), and now the development of solid-state electronically oscillating transducers. Accompanying the hardware has been a similar explosion in software programming allowing complex manipulation and storage of the data. In fact, it is fair to say that at this time, the technology advances have been so profound that they have left the technique of most of us (human sonologists) way behind. My experience initially with manually swept 3D was that my personal enthusiasm did not translate widely



Fig. 1: VCI-C plane TV volume imaging showing a normal intrauterine gestation sac within the left horn of a bicornuate uterus.

to either my colleagues or to the public. However, with the advent of high quality real-time 4D scanners, which are easy to use and have a high rate of successful imaging, there is a sustained enthusiasm of use with colleagues and patients. This enthusiasm for 4D scanning should have the effect of improving our (operator) technique, and will also encourage the development of how we use 4D. Already, there is a proliferation of papers outlining the uses, a lot may stay as research or of academic interest only (hype), but some will translate to real advances in everyday practical fetal ultrasound (helpful).

I will outline some of the areas where I have found 3D helpful in my scanning (private practice).

Very early pregnancy

Endovaginal VCI-C plane 4D imaging, with the ability to view the endometrium coronally is extremely useful when trying to distinguish between an intrauterine cornual pregnancy versus an interstitial ectopic (Fig. 1). Volume contrast imaging (VCI) can also be used in second trimester scans to increase contrast and reduce noise when looking at subtle lung and liver lesions (e.g. CCAM and sequestrations).

Early anatomy

At the nuchal translucency (NT) scan, a brief 4D scan provides a unique opportunity to reassure parents. It is possible to view the entire fetus at once with a bouncing 11–14 week fetus showing a normal head, limbs and body (Fig. 2). While a careful 2D scan at 11–14 weeks will detect anencephaly, major limb and body abnormalities, certainly 3D imaging often better depicts these findings particularly to parents and clinicians¹. This is often useful when explaining findings to parents, who may have trouble understanding the 2D slices (Fig. 3).



Fig. 3: 3D surface image at 12wks demonstrates large omphalocele and shortish limbs. Trisomy 13.



Fig. 4: 3D surface image at anatomy scan showing persistent subtle overlapping fingers 2 and 3 right hand. Left hand and feet appeared normal. Trisomy 18.



Fig. 5: 3D skeletal image spine shows lower thoracic hemivertebra with rib disparity.



Fig. 6: 3D surface image face at anatomy scan showing descriptive facial and hand expressions.

Anatomy scan

Facial features, especially cleft lip and hard palate are well suited for 3D imaging, particularly when trying to depict these for the parents or clinicians. A well performed 2D anatomy scan should detect virtually all cleft lips, but sometimes cleft of the hard palate can only be found using volume imaging with either a reverse face 3D² or an extended mid-line sagittal image acquisition 3D¹.

Limbs

Hand, wrist and foot anomalies, including clubfoot, polydactyly and clenching, may be very difficult to depict in 2D imaging but are often well seen using 3D surface (Fig. 4).

Skeletal assessment

In particular, where spinal anomalies such as hemivertebra are detected, 3D imaging of the spine helps confirm the finding by depicting the hemivertebra, and also allows accurate counting of ribs on either side (Fig. 5). Spina bifida, skull and long bones can also be further demonstrated with 3D.

Heart

The Spatio-Temporal Image Correlation (STIC) volume acquisition, can allow rapid depiction of the cardiac anatomy, and with an enthusiastic sonographer can give a quick

and accurate depiction of the chambers and major vessels^{3,4,5,6}. STIC has many benefits both for screening in the routine anatomy scan, and for further evaluating the heart where an abnormality is suspected. It improves resolution, offers unlimited images in any plane, allows simultaneous correlation between image planes that are perpendicular to the acquisition plane and 3D rendered images can be reconstructed³. With an experienced sonologist, evaluation time may be shortened, especially with complex defects. It also allows all images in all planes to be reviewed in cine-loop, and the complete data volume can be stored, reviewed and manipulated later. This means the data can be assessed at a remote site by a more expert clinician who is not limited by the findings detected by the first examiner³. In conventional 2D ultrasound review of the examination is generally limited to the findings detected and documented by the sonologist.

Some 3D/4D imaging can be incorporated into the routine screening anatomy scan with not much effort or increase in scanning time in the majority of patients. Certainly, to look at the face and limbs only takes a few moments, and with enthusiasm and some practice, the heart and spine can often be shown in a more useful way. Just as the development of reasonable technique for things such as NT scanning, nasal bone, tricuspid and ductus, requires 50–100 or



so cases, similarly basic expertise in 3D scanning can be acquired and used during anatomy assessment⁶.

So far, we are only really scratching at the surface with 3D. It has opened up the possibilities of what we can do with ultrasound, and its beneficial uses will increase with people's imagination.

Indirect benefits

There are numerous indirect ways in which 3D ultrasound helps in first and second trimester ultrasound. Although some of these are debatable, and also unscientific, they still are real, and for me they have been a giant leap forward in the use of ultrasound.

3D ultrasound further "humanises" the fetus in the eyes of the parents and sonographers. Perhaps this will help clarify the rights of the fetus/unborn child, and may also help with ethical considerations. 3D will enable a better understanding of fetal behaviour. At the moment our focus on fetal wellbeing ("happiness") is largely confined to third trimester biophysical profile and Doppler. With 4D ultrasound we can see the "happy" 12-week fetus, not only jumping around, but break-dancing, kickboxing, waving and exploring its world. The happy second trimester fetus can be seen making facial expressions, tongue-poking, exploring its body with hands, and even giving the hippy peace sign or other "gangsta" hand signals (Fig. 6). The reaction of parents and sonographers upon seeing this is special.

Parental and family bonding is enhanced. Is this just some psycho mumbo-jumbo? No, I think it's real, and comes at a time when sometimes there may be extra strains within a relationship, or within a family. Mum knows she is pregnant and feels the babe, but now Dad can really see the cutie causing the havoc, and big brother or sister can better understand Mum's distraction^{7,8}.

What about the enjoyment and attentiveness of the sonographer? Within my practice I have seen a newfound staff enthusiasm with the use of 4D. It has added a spring in their step and put a smile on their face, to the extent that my policy now is that the brief use of 4D is encouraged as part of the routine obstetric scan. Why? Well I believe this makes us better sonographers. Why is it that even now, there are some cases of spina bifida, cleft lip, club-foot, hand anomalies etc. that are not detected at the routine anatomy scan? Why are we not better at detecting major heart abnormalities. We all know we should do better. My belief is that some of the "missed" diagnoses arise because of complacency, or boredom. Most anatomy scans are "normal". For those of us doing routine scans, the incidence of most anomalies means we can do hundreds of anatomy scans without seeing a major abnormality. To find the "wolf in sheep's clothing" requires a constant vigilance in the face of endless normals. It is harder to stay "switched on" when there is no variation, so the cerebellum is overlooked, the top lip not viewed, or both hands not checked. 4D provides the variation, the spark or stimulus to keep us alert for every scan. The vitality of 3D is also seen adding enthusiasm to non-clinical reception and office staff.

Another indirect benefit of 4D is it encourages the sonographer to obtain a nice midline sagittal view of the face in 2D, this being the position to obtain a frontal face 3D. It also happens to be an important position to assess the nasal bone, the hard palate, the mandible for micrognathia, the



Babe with attitude.

frontal bone and the premaxillary soft tissue, amongst other things. That's useful.

The advent of 4D is forcing private practices and hospital departments to upgrade, so we have the latest hardware and software benefits these machines bring, rather than making do with an older machine and a fuzzier image. Further to this, 4D is generally only available on the higher end machines, which tend to have a clearer image and better user characteristics. Again this helps by, not only the clearer image assisting diagnosis, but it also enthruses the operator and enhances performance.

Conclusions

Even setting narrow parameters on how we judge the helpfulness of 3D in first and second trimester ultrasound (versus conventional 2D), we can see it clearly makes a difference in areas such as anatomic anomalies (cleft lip, clubfoot etc.), in better assessment of the heart, and by giving a reassuring overview of limbs, face and body surface.

With wider parameters and by assessing indirect benefits of 3D, the helpfulness of this imaging modality is even more compelling. So much so that, at the current point in time, it would be very hard to argue against replacing any outdated US machine with anything but a 4D capable unit.

Then there's the future. I have never been great at crystal ball gazing, but we can look at how history treats significant technological advances. In 15 years we have gone from being amazed at a brick we could use as a mobile phone, to now being complacent about a thing the size of a pack of cards which is not only a phone, but a great camera, computer, GPS navigation system and portable stereo all in one! To me the future uses of 4D ultrasound will expand greatly, making our assessment of the fetus in the first and second trimesters, not only a more complete, but also a more enjoyable experience.

Yes there are problems, and probably the biggest problem is to actually recognise what is just hype, and what is really useful with 4D. While the real uses, the things we can really use 4D for in our everyday scanning, are plentiful and compelling enough that we all need to utilise it, the hype will be even more plentiful. The reality of academia, the business world, and human inquisitiveness means that already there are huge amounts of hype about obscure and difficult uses for 4D. Articles need publishing, and the "volumes"

(no pun intended) are expanding. We will all need to navigate this “hype”, and to help with this I thank my “opponent” in this debate, Assoc Prof Janet Vaughan, who is actually an “ally”.

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