REVIEW ARTICLE

3D and 4D US for Congenital Defects

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ABSTRACT

Invent of 3D and 4D ultrasound has made a dramatic improvement in fetal imaging. Various viewing directions and rendering modes help better demonstration of pathologies suspected on 2D US. Multiplanar mode is the key of the 3D US imaging. Software like magicut and TUI help to understand the anatomy better. Volume ultrasound is an excellent tool for diagnosis of facial defects, spinal abnormalities, limb abnormalities, etc. 4D US shows fetal movements and expressions that are basis for the neurodevelopment of the fetus. STIC and VCAD are the tools that have made detection of fetal cardiac anomalies more precise.

Keywords: Congenital defects, 3D and 4D ultrasound, Posterior urethral valves.

INTRODUCTION

Invent of 3D and 4D ultrasound has made a dramatic improvement in fetal imaging. On 3D ultrasound, multiple 2D ultrasound sections are taken they are all put together closely to construct 3D image. That means we have a whole block of tissues instead of just a thin slice of a 2D US. 4D US is a live 3D where 3D reconstruction is so fast, 16 to 32 frames/minute that it appears realtime. 3D, 4D US is, therefore, a volume ultrasound.

BASICS OF 3D IMAGING

The volume data can be viewed as a 3-dimensional object and in multiplanar mode in three orthogonal planes—sagittal, coronal and axial. All can be correlated to each other by the reference point, which is represented as a dot on all three images. This dot represents the same structure on all three planes. This dot is actually an intersecting point of lines seen on all three images (Fig. 1).

The volume can be seen as rendered image. Rendered image means watching the whole volume as a whole block of tissue. The rendering direction can also be selected. This means one can select to see the volume from above, below, right, left, front or back.

Various modes of rendering can be selected singularly or combined to optimize the visualization of soft tissues, bony structures or vessels. There are surface modes for seeing the surface, external features and transparent modes to see the bones, air, fluid, etc. Surface modes are smooth, texture, light and gradient light. Transparent modes are maximum for bones, minimum for air or fluid filled structures and X-ray mode (Fig. 2). There is an inversion mode that shows fluid filled structures or echolucent structures as solid structures making their definition very sharp.

This mode is useful for demonstration of septal defects in heart, defects of great vessels, posterior urethral valves, etc. and also for volume calculation of these fluid filled structures (Fig. 3).

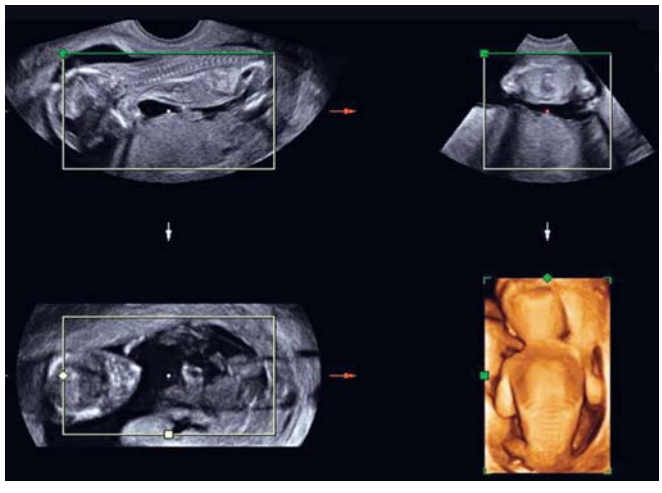


Fig. 1: Multiplanar and rendering mode of 13 weeks fetus on 3D USG

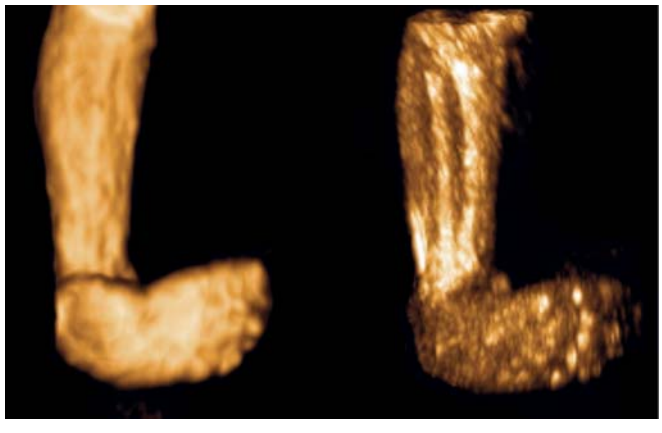


Fig. 2: Surface mode and transparent mode

Angiomode can be applied on a volume acquired with power/color Doppler that shows the vasculature in the given volume like angiography (Fig. 4). One can select to see the blood vessels in reference with the surrounding tissues by glass

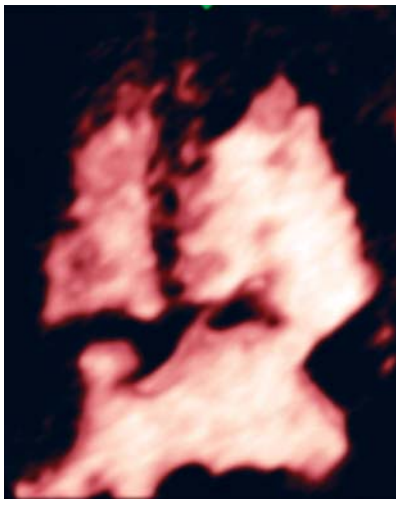


Fig. 3: Inversion mode: 4 chamber heart

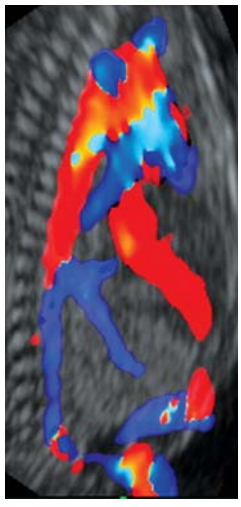


Fig. 4: Angiomode: fetal vasculature

body rendering or only the blood vessels by angiomode. This is like seeing an angiography. Here the advantage is no contrast or invasive procedure is required.

Additional Software Functions

Magicut is an electronic scalpel. This is used to cut off the extra tissue shadows from the rendered image. Tissues can be cut off in whole thickness or upto desired depth (Fig. 5).

TUI—tomographic ultrasound imaging allows simultaneous visualization of multiple parallel slices in all three orthogonal planes like CT or MRI (Fig. 6). This is very useful for the understanding of fetal anatomy and diagnosing abnormalities like tracheoesophageal fistula, diaphragmatic hernia, cleft palate, fetal mass lesions, cranial and spinal abnormalities, etc. TUI can be applied to both 3D as well as 4D modes.

Volume Contrast Imaging

VCI allows thicker slices to be examined in real time. Thicker slice helps to increase the contrast, and therefore improves the definition of subtle lesions. The slice thickness can be adjusted from 2 mm to 10 mm and the distance between the slices can also be adjusted from 0.5 mm to any extent depending on the requirement. This slicing can be done in A plane—the plane of acquisition and in C plane—coronal plane. VCI in coronal plane is very useful for spine, corpus callosal defects and limb defects (Fig. 7).

Volume calculations by 3D using VOCAL II software are much more accurate than 2D volume calculations for lung, liver, cerebellum, ventricles, etc.

Spatial Temporal Imaging Correlation

STIC is offline 4D US and has proved to be extremely useful for evaluation of the heart. It is now also available for offline

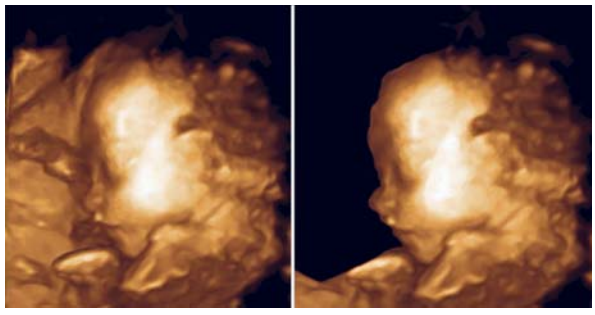


Fig. 5: Magicut: fetal face

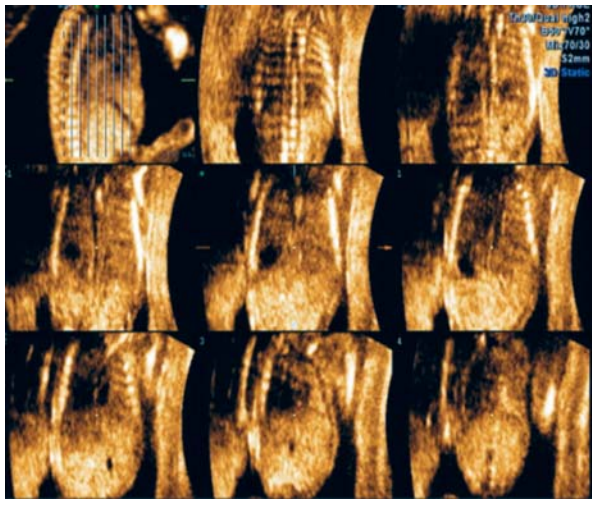


Fig. 6: TUI of fetal trunk in coronal plane

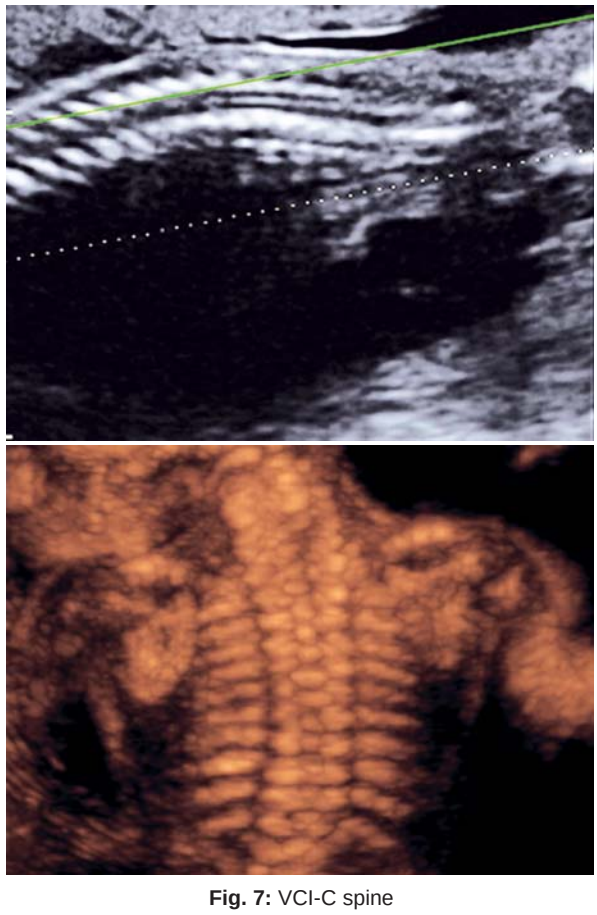


Fig. 7: VCI-C spine

vascular studies of other fetal or placental vessels also. VCAD is another tool to simplify fetal echocardiography.

All these together ultimately help to understand the complex fetal anatomy better with surface analysis of minor defects, volume measurements and vascular studies.

Applications for Detection of Congenital Defects in the Fetuses

3D US is superior to the standard 2D US for the assessment of first trimester of pregnancy. It has moved the embryology from postmortem studies to *in vivo*. Development of the embryo can be studied in detail by transvaginal 6 to 9 MHz volume probe. This is known as sonoembryology (Fig. 8).

Using 3D power Doppler, hemodynamic changes occuring during early placentation can be studied. Moreover, better accuracy can be achieved with a shorter examination time. 3D orientation and multiplanar imaging give unlimited tomograms with only limited probe manipulation and minimize the fetal exposure to ultrasound. Acquire a single sweep of the complete fetus in upto 5 seconds maximum and using surface rendering and maximum mode multiplanar mode and TUI complete detailed anatomy of the embryo at least till 12 weeks can be studied.

It is especially useful with unfavorable fetal position throughout the pregnancy. In second and third trimester, surface rendering demonstrates excellently the external fetal features and maximum mode demonstrates the fetal skeleton. Minimum mode and inversion modes are used to visualize the internal fetal anatomy. With this introduction of volume ultrasound applicability, we shall now discuss the applicability of volume ultrasound for diagnosis of congenital defects, system by system.

Nuchal Translucency Scan

Genetic scan or the Nuchal scan is done between 11 and 14 weeks of pregnancy to exclude chromosomal malformations. This includes measuring nuchal translucency, nasal bone, ductus venosus flow, looking for tricuspid regurge, measuring facial angle, looking for omphalocoele, renal pyelectasis, etc. Assessing for nuchal translucency, nasal bone and facial angle requires a true midsagittal section. This may always not be easy either by abdominal or vaginal route. A study by Kurjak et al has shown that using 3D US, midsagittal plane of the fetus can be visualized successfully 100% of the times versus 80% of times with 2D technique.[1] Either multiplanar mode or TUI may be used to get a true midsagittal section (Fig. 9). A study by Eppel et al shows that 3D transvaginal technique offers a shorter examination time and higher success rate for measuring nuchal translucency though it results in slight but significant underestimation of the measurement.[2] This probably may be due to the transvaginal approach instead of transabdominal.

When the starting section of face is transverse or coronal, it is very difficult to find out nasal bone in midsagittal plane by 2D US. 3D US can be a useful tool to find out and measure the nasal bone. But if the angle between ultrasound transducer and imaginary line passing through fetal face profile is < 30° degree or > 60°, that is if fetal head is hyperextended or flexed, 3D can not help over 2D technique to see the nasal bone. Using multiplanar mode Peralta et al have described a gap between the nasal bones on axial plane in 20% of fetuses and in about 40% of these fetuses in midsagittal plane, nasal bone may be erroneously considered absent on 2D US.[3] So, 3D US can

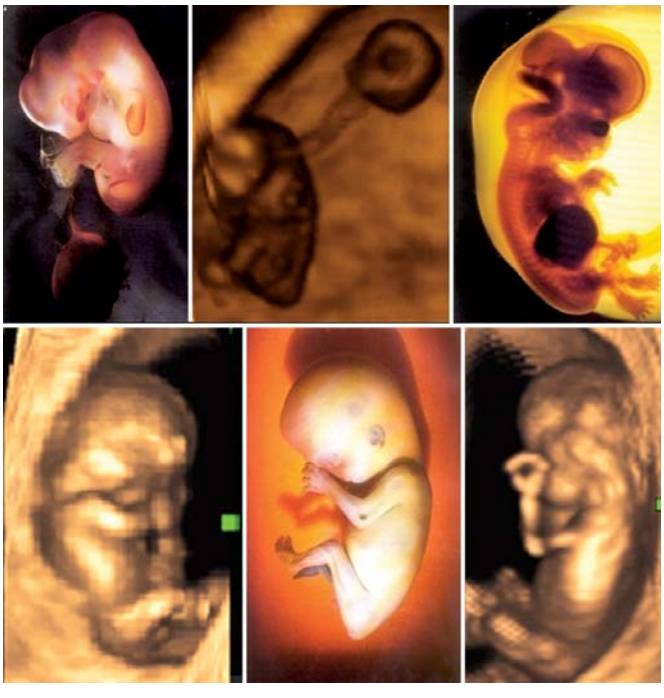


Fig. 8: 7, 11 and 13 weeks of gestation: embryological picture and volume sonography comparison

Fig. 9: Nuchal translucency seen multiplanar view and TUI

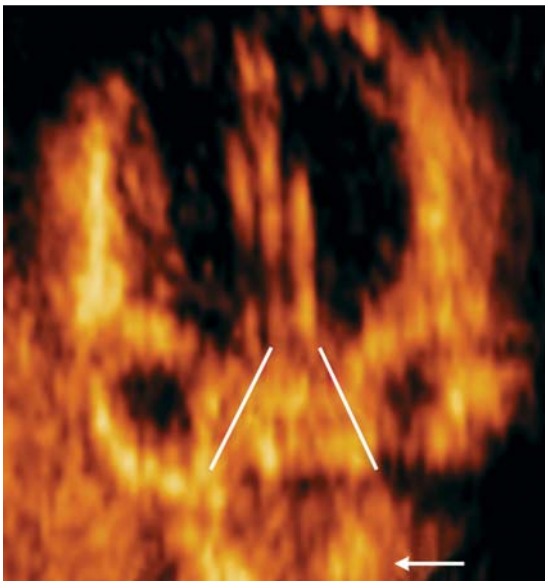


Fig. 10: Nasal bones on coronal section, maximum mode

Fig. 11: Rendered images of face

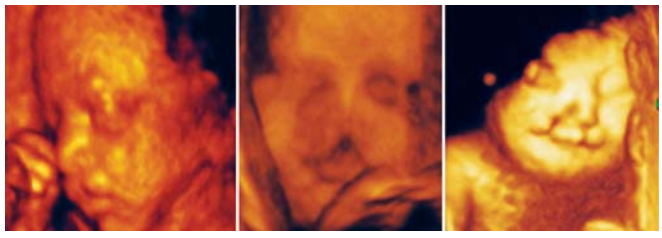


Fig. 12: Cleft lip and palate by rendering mode

demonstrate absent nasal bone in axial plane reducing the false positives (Fig. 10). In second trimester screening, maximum transparent mode is preferred to multiplanar to show unilateral or bilateral absence of nasal bone.

Facial Abnormalities

Volume ultrasound is the only modality that actually allows to study the fetal face. Surface smooth in a combination with gradient light is the rendering mode to be used to demonstrate the fetal face. Scanning the face profile and using updown viewing direction is the commonest way of demonstrating the fetal face (Fig. 11). Though fetus being actively moving in 2nd trimester, 4D instead of 3D is better used. Best time is between 23 and 30 weeks but proper fetal position is essential. To get a proper position, pressing mother's abdomen repeatedly, turning mother to one or another side or reexamining after a few minutes would help when fetus is not in a favorable position to see the face. In 90% of cases correct and reproducible face images can be produced in second trimester. Though, this reduces only 30% after 34 weeks due to the obligatory position that the fetus has to attain with its growing size.

3D US has an important role in diagnosis of facial cleft, micrognathia, nasal abnormalities and eye abnormalities. Merz et al have reported well-defined facial images as early as 9th week of pregnancy.[4] Defects of the orbits like hypertelorism, hypotelorism, single orbit, microophthalmia, commonly a part of genetic syndromes, may be suspected by 2D US but the confirmation and demonstration is not possible without the use of volume ultrasound.

Cleft lip can be demonstrated on surface rendering as a cut in the upper lip. It may be central, unilateral or bilateral. It may be associated with cleft palate. Though cleft lip is very well demonstrated on surface rendering, cleft palate needs studying the multiplanar planes (Fig. 12). Cleft palate can be diagnosed by TUI in axial plane, just caudal to the orbital plane (Fig. 13). TUI in coronal plane is also useful for demonstration of the connecting passage between the oral and nasal cavity in cleft palate (Fig. 14). Diagnosis of cleft lip and palate is almost 100% including the cleft of soft palate also.[5-7]

3D US can also pick up isolated soft palate defects as shown in studies by Pilu et al.[6] Another technique to detect the cleft palate is the 3D "reverse face" view (Figs 15A and B).[8] After acquiring the face volume the viewing direction is changed to back instead of front to see the facial bones from inside the skull. Maxilla and palate can be reliably studied as early as 11 weeks. Early diagnosis of median cleft syndrome is possible in which the frontal bones and nasal bones are largely separated with hypertelorism, flat nasal bridge, rudimentary nostrils and other facial abnormalities.[9] Generalized information of the facial bony defects helps to decide the surgical approach.

Micrognathia

3D US shows precise alignment of orthogonal planes in which accurate measurements can be made and allows the creation of rendered casts of the mandibular bone. Micrognathia is diagnosed subjectively by rendered 3D image of fetal face or objectively by measurement of inferior facial angle[10] and jaw index: AP diameter of mandible/BPD (< 0.23 is micrognathia).[11]

Ear Abnormalities

Size, morphology and placement of the ear are important for diagnosis of chromosomal abnormalities. 70% of trisomy 21 babies have helix-lobe lengths more than two standard deviation from mean. Detection of ear appendices may be a marker of renal malformation. Size and shape of the ear may sometimes be assessed on 2D US, but position of the ear can only be assessed by volume ultrasound (Figs 16A and B). Therefore, low placed ears, an important marker for trisomy 21 can only be demonstrated by volume ultrasound.

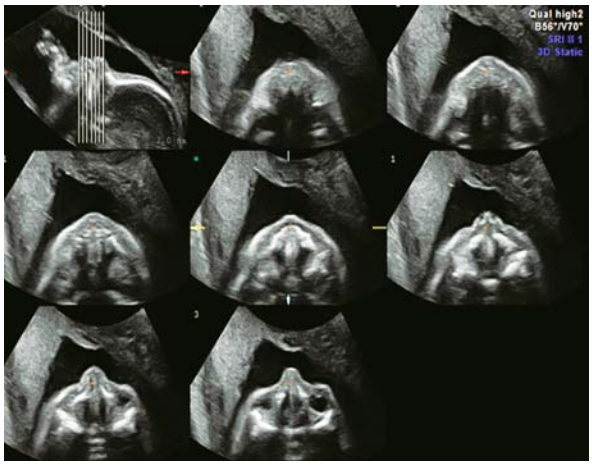


Fig. 13: Cleft palate seen by TUI axial plane

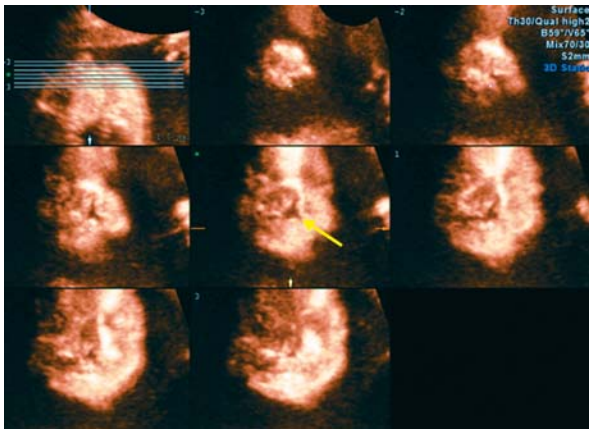


Fig. 14: TUI coronal plane: cleft palate

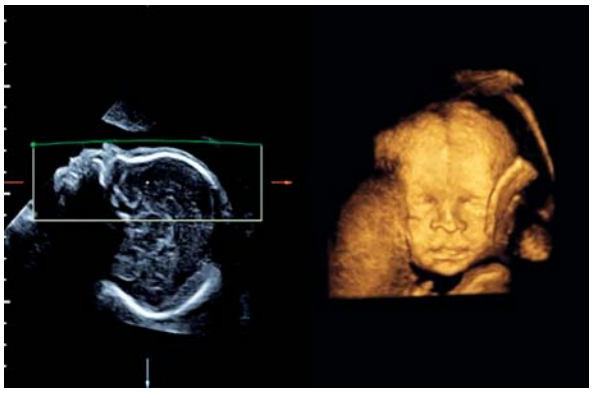


Fig. 15A: Front view of face

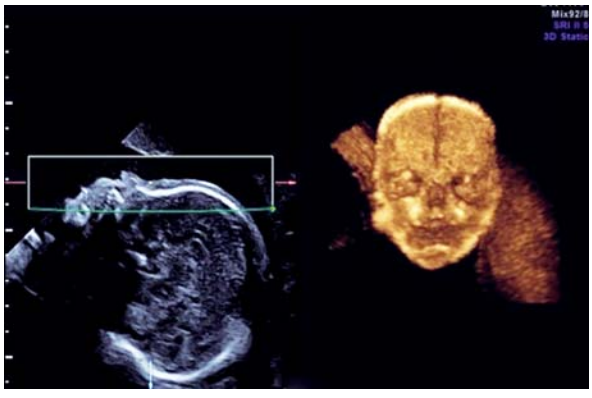
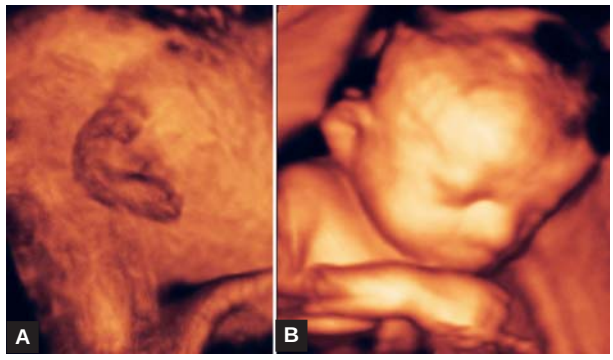


Fig. 15B: Reverse face view



Figs 16A and B: (A) Normal ear, (B) Low placed ear

Fig. 17: Various fetal face expressions: surface rendering

Apart from the defects or anatomical variations, only volume US can show the fetal expressions that represent the fetal behavior and neurological development of the fetus (Fig. 17).

The expressions recorded so far are:

- Yawning
- Smiling
- Swallowing
- Sucking
- Blinking
- Grimacing
- Mouthing
- Tongue expulsion.

Cranial Abnormalities

Skull bones and sutures can be identified by 3D US, which is difficult with 2D US due to natural curve of the skull. Maximum transparency mode is used for this. Excessive diastases of the sutures can be seen in cranium bifidum ocultum and premature closure can diagnose craniostenosis and microcephaly early.[12] By 3D multiplanar display, diagnosis of acrania (Fig. 18) and exencephaly can be rather easy depicting correct sagittal and coronal sections.

Volume US shows fontanelle very clearly. Features of fetal head dysmorphism like flattening or prominence of occipital

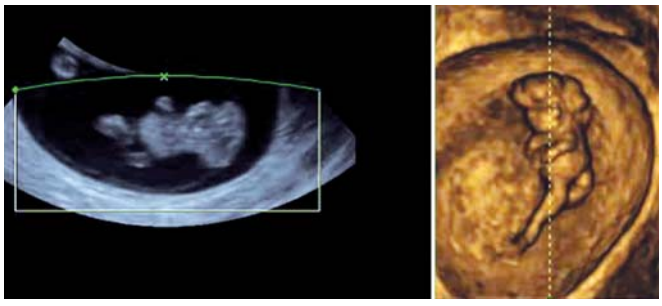


Fig. 18: Acrania: early pregnancy

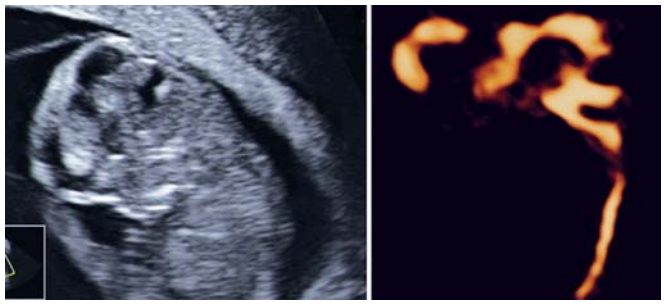


Fig. 19: Neural tube on 2D US and on inversion mode

bones or frontal bones, early closure of sutures and altered facial angles—superior or inferior can be diagnosed by volume ultrasound only. Small meningocoeles that are easily overlooked by 2D US, would be clearly demonstrated by volume ultrasound.

Central Nervous System

Development of diencephalon, mesencephalon and rhombencephalon can be studied from 9 weeks of gestation, even on a good 2D US. Diagnosis of alobar holoprosencephaly is possible as early as 10 weeks by absence of central cleft.[13] Volume ultrasound allows visualization of the whole neural tube in inversion mode from 8 weeks onwards and thus helps to understand the neural tube development of the fetus (Fig. 19).

In late 2nd and 3rd trimester, if fetus is in cephalic presentation, transvaginal approach can be a better approach to study fetal brain. Placenta and thick skull bones may be obstructing the vision on transabdominal approach. Once the fetal brain has been scanned, it is then possible to navigate in the stored volume. By multiplanar display, the brain anatomy can be studied in detail.

Using TUI in all three orthogonal planes all the coronal, sagittal and axial sections required for a detailed neurosonogram can be achieved by one single sweep of the fetal head (Fig. 20).

Development of brain in second trimester has three developmental landmarks:

1. Development of lateral ventricle into frontal, occipital and temporal horns.
2. Development of corpus callosum (Fig. 21).
3. Development of cerebellar vermis.

VOCAL may be used for volume calculation of cerebellar hemispheres, vermis and intracranial lesions. VCI in coronal plane depicts the midline structures like corpus callosum, optic chiasma and cerebellar vermis.

Agenesis of corpus callosum and cerebellar vermian hypoplasias—Dandy-Walker syndrome can be diagnosed using VCI C. Normal corpus callosum and cerebellar vermis with ventriculomegaly is most likely due to aqueduct stenosis. Ventriculomegaly can be quantitatively evaluated and clearly delineated using inversion mode for rendering.

Paladini and Volpe[14] have suggested measuring tentoro vermian angle, tentoroclivus angle, clivovermian angle, etc to diagnose vermian abnormalities. Skull base development can be assessed by measurement of anterior skull base length and posterior cranial fossa length and skull base angle. Brain growth leads to higher increment in posterior cranial fossa length leading to 6° flexion in the skull base angle.[15] Craniofacial variability index (CVI) can assist in fetal facial anatomy to study craniofacial development.[16] Sections of the skull required for all these measurements can be all achieved and measured by TUI and multiplanar mode. This technique has proved to be almost as sensitive as CT scan or MRI for the study of expansive brain lesions. 3D US may be applied to every CNS abnormality diagnosed with traditional 2D technique and may offer further information useful for correct diagnosis. It can delineate the exact nature and anatomic level of anomaly (Figs 22 to 24).

3D power Doppler also delineates the cerebral vasculature and its abnormalities (Fig. 25).

Study of fetal motorial and behavioral pattern is essential for complete evaluation or functional integrity of fetal central nervous system (Figs 26 and 27). Only 4D US allows the evaluation of fetal motorial and behavioral patterns. With 4D US, it is possible to better define the degree of normality and pathology of fetal neurological functions *in utero* and to find out which fetuses are at risk of bad neurological outcome. Kurjak et al have described patterns of neurodevelopmental behavior during the three trimesters of pregnancy using 4D US.[17] The changes in the motorial pattern express the evolution of the maturative process of central nervous system during intrauterine life. These fetal behaviors and movements can help diagnosis of motoric development failure at the end of the first trimester. Delayed motoric development is seen in fetuses of diabeteic mothers. Infolding of the thumb in the fist of the fetus is typically described as neurological thumb being a sign of some neurological deficit. Fetuses with arthrogryposis show early disturbances in motoric development with absent limb movement and joint contractures.

Spinal Abnormalities

Evaluation of the central nervous system cannot be called complete without the evaluation of spine. Evaluation of spine in sagittal, coronal and axial all three planes is essential to diagnose spinal abnormalities correctly. All three views can not be achieved in one fetal position on 2D US. 3D US saves examination time and clearly can show all three views at a time on multiplanar mode along with the overlying skin surface by

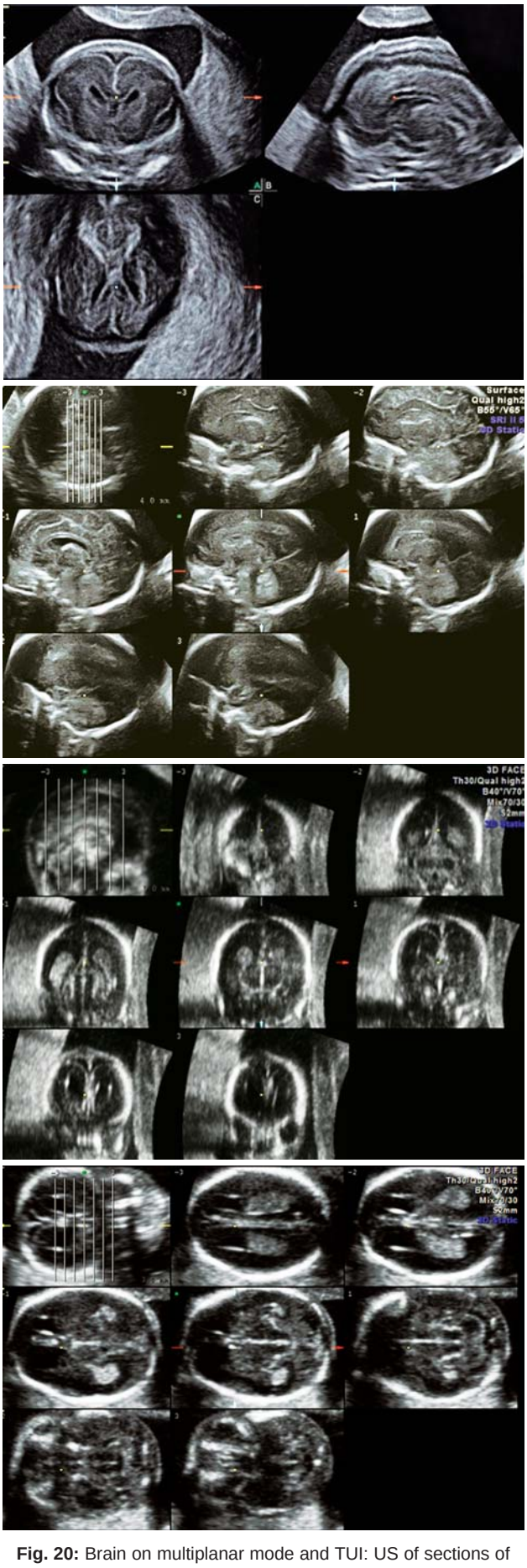


Fig. 20: Brain on multiplanar mode and TUI: US of sections of detailed neurosonogram

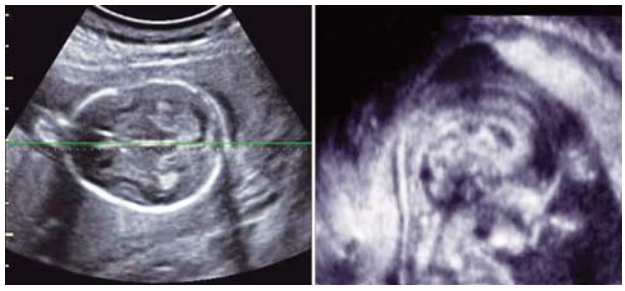


Fig. 21: Corpus callosum as seen by VCI-C

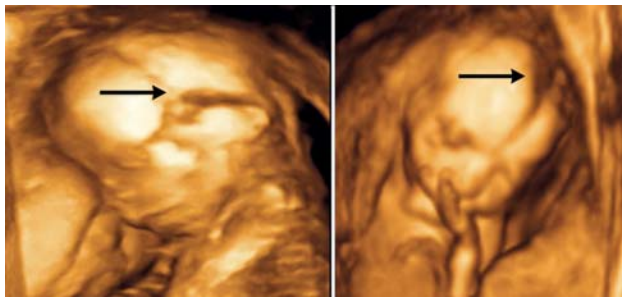


Fig. 22: Sutures and anterior fontanelle

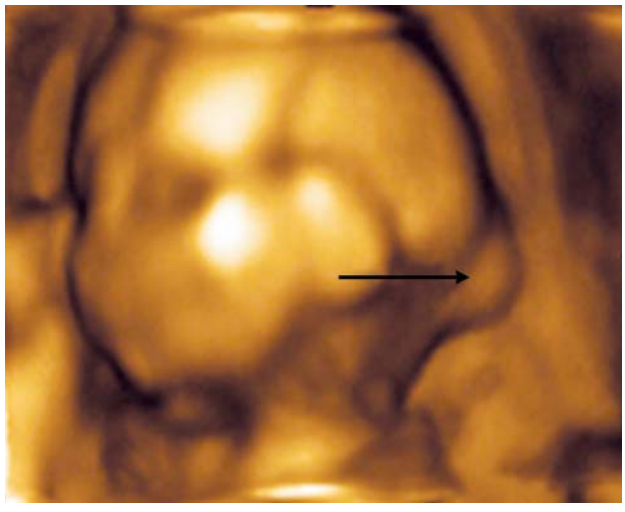


Fig. 23: Small occipital meningocele

Fig. 24: Inversion mode ventricle

Fig. 25: Cerebral vasculature

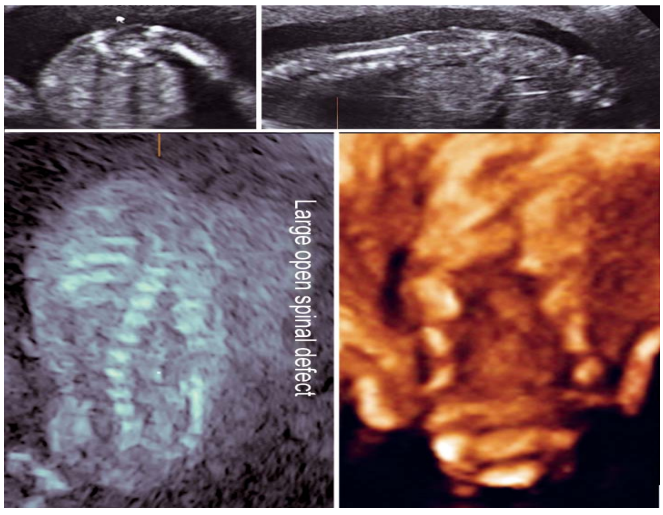
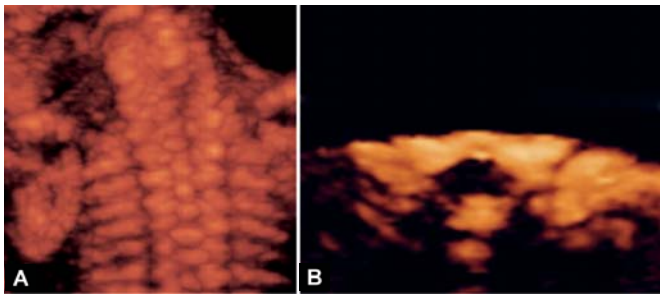


Fig. 29: Open spinal canal defect on 2D US transverse and sagittal sections and on 3D in coronal view

Fig. 26: Movements of hand



Figs 30A and B: (A) Spine (B) Vertebra-transverse

Fig. 27: Fetus scratching the ear

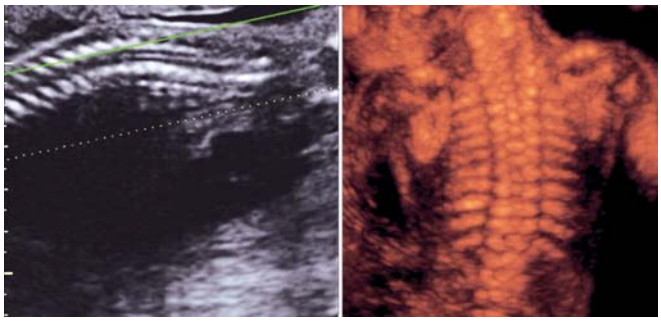


Fig. 28: Normal spine: VCI-C

using maximum mode transparent rendering and surface rendering. Using 4D VCI C can also show coronal view even when on 2D US only axial section is seen (Figs 28 and 29).

Using magicut and 3D rotation, it is also possible to see each vertebrae separately on transverse section and to define the extent of lesion especially in cases of open spinal canal defects (Figs 30A and B). Volume US has almost 100% sensitivity and very high specificity for diagnosis of spinal abnormalities. Longitudinal scan of the fetus is used with maximum mode to evaluate the thoracic cage, clavicle and scapulae. Absent 12th rib is a marker for trisomy 21.

Chest

Multiplanar mode and TUI allow to study the spatial relationship between lungs, heart, esophagus and diaphragm (Fig. 31).[18] Trachea and esophagus morphology can be studied, thus helping to diagnose tracheoesophageal fistulae early and decide the type *in utero*. VOCAL and 3D-4D multiplanar mode is useful for the assessment of fetal lung volume in cases of diaphragmatic hernia and pulmonary hypoplasia. Diaphragmatic hernia can be easily diagnosed by 2D USG also but the role of 3D USG here is to assess the amount of lung compression and calculate the exact lung volume, which is very important for deciding the prognosis.

Studies have evaluated the potential of three-dimensional power Doppler to predict neonatal outcome and pulmonary arterial hypertension in fetuses with congenital diaphragmatic hernia and have found that severity of pulmonary arterial hypertension was associated with progressive reduction in prenatal vascular indices.

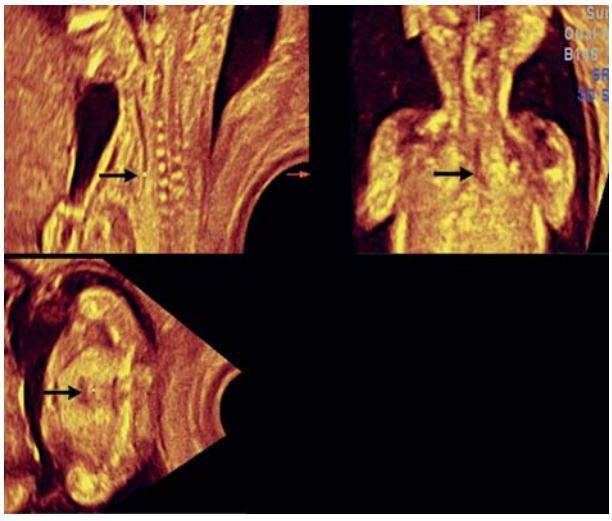


Fig. 31: Chest—Multiplanar mode: tracheal bifurcation

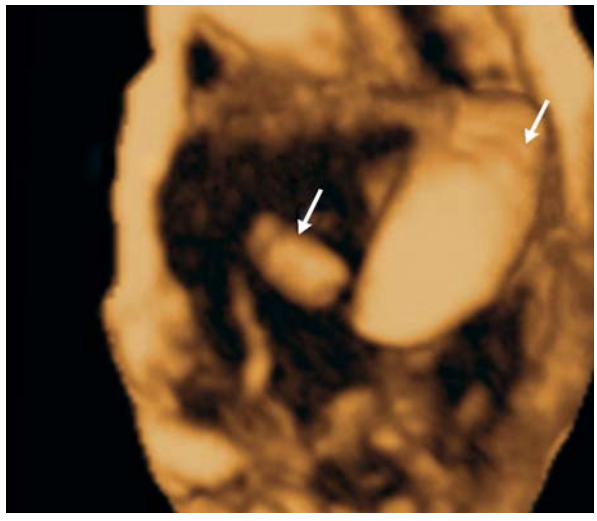


Fig. 32: Inversion mode: duodenal atresia

Abdomen

Using transparent mode and multiplanar mode, the abdominal organs can be very well-defined with definition of all tissue planes. 3D US is an effective tool for diagnosis of gastrointestinal malformations and gives additional information over 2D US for pediatric surgeons for surgical planning and counseling with parents. All abdominal masses may be better evaluated by multiplanar mode for their origin and extension. Inversion mode helps to define cystic lesions and can be best used to confirm the diagnosis of pyloric stenosis, duodenal atresia, posterior urethral valves, obstructive uropathy, etc (Figs 32 and 33).

Surface rendering allows clear visualization of genitals. Hypospadias is seen as 'Tulip sign'[19] and clitoral hypertrophy can be diagnosed in third trimester.

Anterior abdominal wall defects are well-demonstrated on volume USG. 3D with power doppler is very useful to differentiate the bowel containing from the liver containing omphalocoele. Use of 3D multiplanar display is more accurate than the use of 2D US for measuring the size of omphalocele. Congenital anomalies of the abdomen like omphalocele and gastroschisis can be confidently differentiated through 3D US (Fig. 34).

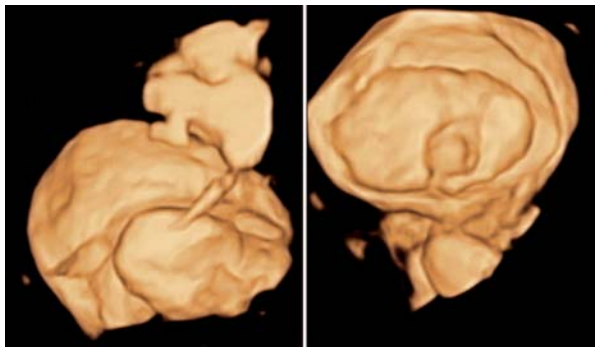


Fig. 33: Inversion of hydronephrosis and ureterocele inside the bladder

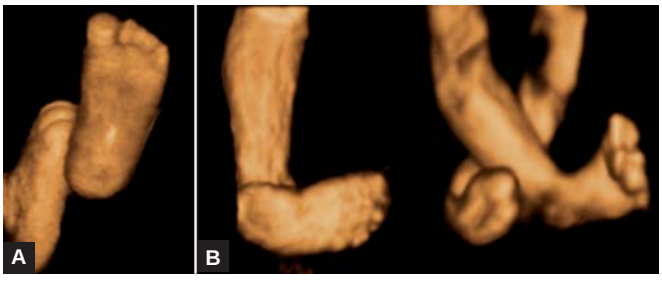
Fig. 34: Omphalocele

Limb Abnormalities

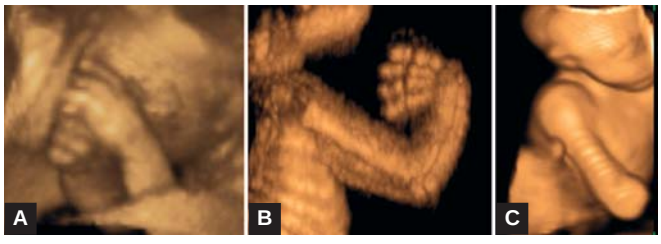
Accurate analysis of majority of bony structures can be done by using maximum mode rendering of 3D US. Phocomelia and Sirenomelia like abnormalities can be diagnosed as early as 11 to 12 weeks. 3D-4D US enables detailed examination of fingers and toes with almost 100% certainty of detecting agenesis and extradigits. Motor abnormalities and abnormal attitude of fingers, toes or hands and legs like club feet (Figs 35A and B), overriding of fingers or thumb in the fist may be manifestations of chromosomal or neurological abnormality (Figs 36A to C).

Placenta

It is known that pregnancy induced hypertension occurs only after atleast 70% of the placental vasculature is obliterated. 3D power Doppler with angiomode of the placental vasculature may show obliteration of the placental vessels and pruning effect and help to predict pregnancy induced hypertension much earlier (Fig. 37).



Figs 35A and B: (A) Feet, (B) club feet



Figs 36A to C: (A) Hands, (B) clubbed hand, (C) absent forearm

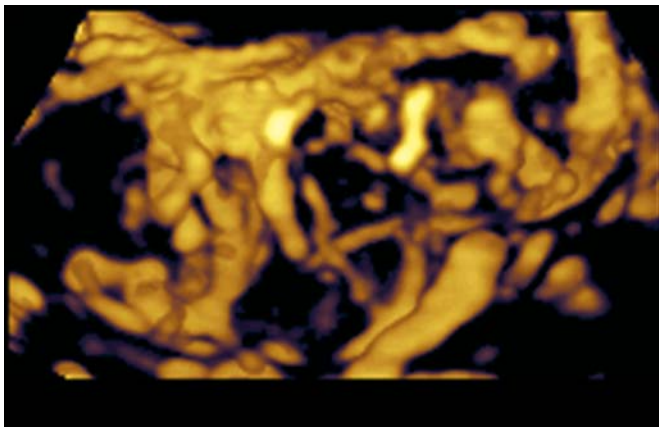


Fig. 37: Placental vasculature

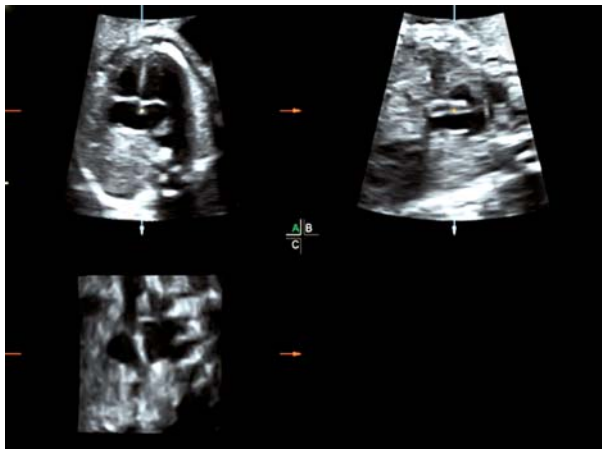
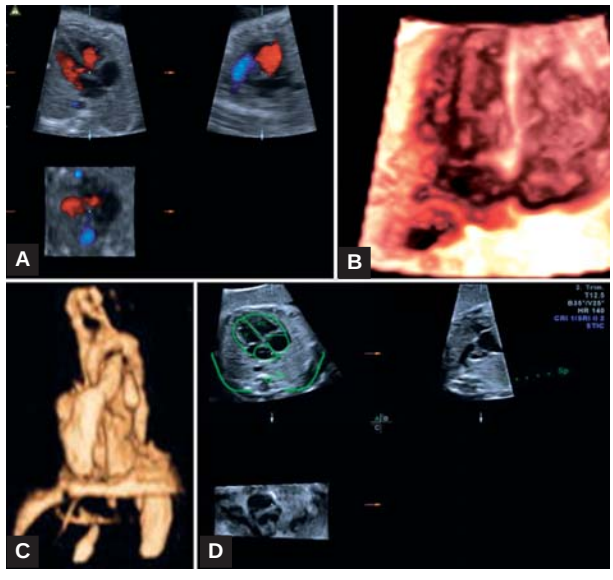


Fig. 38: Fetal heart with STIC



Figs 39A to D: (A) Multiplanar image of heart by STIC with color Doppler (B) rendered image of 4 chamber heart, (C) inversion view of crossing over of outflow tracts, (D) STIC with VCAD

Benacerraff et al[20] have described a novel use of 3D US in offline fetal evaluation. According to their study, five volume sweeps should be taken of every fetus, and they are examined offline. This method has proved to be successful in detailed evaluation of fetal anatomy and very sensitive for diagnosing fetal anomalies. These sweeps are axial section of fetal head, axial section of fetal thorax, axial section of fetal abdomen, longitudinal sweep of lower limbs and longitudinal section of head.

3D-4D for Fetal Echocardiography

Cardiac evaluations have been made less time consuming and much easier with advancing technology. New 4D US technology with STIC (Spatial temporal imaging correlation) can be used for offline 4D cardiac evaluation. After optimizing the 2D image a single sweep is taken from the upper abdomen to the upper chest in 7.5 to 15 seconds. Multiple images of the heart during different phases of cardiac cycle are captured and stored as a volume. This can be seen in all three planes—X, Y, Z (sagittal, axial and coronal) and can be run as a continuous cardiac cycle (Fig. 38). This acquisition can also be done with color or power Doppler (Fig. 39A).

Walking through these sections give all the planes required for complete cardiac evaluation like four chamber view, left ventricular outflow tract view, right ventricular outflow tract view, three vessel view, short axis view, aortic arch view, ductus arch view, etc. The image can also be seen as live 3D by various rendering modes (Fig. 39B). Inversion mode of rendering can be an excellent tool to demonstrate septal defects, outflow tracts and great vessels (Fig. 39C). Rendering from different directions can give all those views of the heart that were never possible by any other modality. For example, basic view or surgical view of the heart, which shows relationship of all the four valves that is very informative for outflow tract relationship, inflow tract

abnormalities and important for surgeons. Using tomographic ultrasound imaging may also help looking at the heart in different sections. The new GE machines (VolusonE8) have now come up with a still easier and more standardized technique of storage and evaluation of fetal cardiac volumes. This software is known as **VCAD**. When working with this, the essential views of the heart are only a button touch away. No manual rotations or walking through are necessary. A predrawn diagram is placed on the acquired volume of the heart and then various sections required are automatically achieved by only a button touch. This makes cardiac evaluation much quicker both online and offline (Fig. 39D). Though detailed fetal echocardiography by STIC or VCAD is beyond the scope of this chapter, there are certain novel applications worth mentioning. Using rendering, the heart is reconstructed in four chamber view and then is cut by a line from apex to base, closely placed near the septum and then rotating, it shows the interventricular septum en face. This view is excellent for demonstration of location and extent of VSD (Ventricular septal defect).

Conjoined Twins

In conjoined twins, practicability and the consequent morbidity of the fetuses after separation depend on the degree of codivision of organs and vascular structures. Therefore, detailed and accurate anatomic and vascular map is fundamental for evaluation of joined organs in conjoined fetuses, and is of fundamental importance to decide the line of treatment. Moreover defects like orofacial cleft, diaphragmatic hernia, imperforate anus and neural tube defects are also common. Bega et al have reported that combining multiplanar display and surface rendering can assess these fetuses fairly reliably, as early as 10 weeks.[21] 3D US can be of great help in classifying more accurately the type of conjoined twins and color Doppler may be of further help (Fig. 40).

Fig. 40: Conjoined twins

Limitations of 3D-4D US

As for 2D US maternal obesity, maternal scar, maternal movements, excessive fetal movements, and air, calcifications or bones that come in way of sound propogation are obstacles for 3D US also. Oligohydramnios does not permit sufficient fluid interface that is an absolute essential for surface rendering and so is not a favorable factor for reconstruction and surface rendering.

Volume ultrasound is a valuable tool for diagnosis and demonstration of fetal abnormalities inspite of these limitations.

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