xMatrix applications in **Obstetrics** and **Gynecology**

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Dr. Pramod Bapna is a consultant radiologist practicing for the past 15 years. He is FMF (UK) certified and also got certification from UCAM Spain for MSK ultrasound. Dr. Bapna has had advanced training from Mediscan center, Chennai and MSK ultrasound training from Prof Bouffard, Dr. Fernando, Dr. Peetrons, Dr. Ingrid Moller and Dr. Ayman Fahim. His special interest is in the field of ObGyn, fetal imaging and MSK ultrasound.

Abstract

Ultrasound imaging has undergone major technological improvements in the recent past, whereby the scope of imaging and the depth of clinical information now available through ultrasound has increased manifold. This article talks about the utility of the Philips xMATRIX transducer - which is the highly advanced ultrasound transducer presently available – in the Obstetrics and Gynecological examinations. The contemporary volume transducers have limitations such as poor resolution in coronal MPR, bulkiness of probe, constant change of probes for better gray scale examinations, etc... The X6-1 xMATRIX transducer not only overcomes these limitations but also provides ease of use and enhanced diagnostic confidence for the sonologist.

Utility of 'xMATRIX' transducer in clinical practice

The greatest thing in simple words I would say is it allows visualization in two planes without moving the transducer, thereby markedly reducing the possibility that you may miss out a very small lesion.

In my experience in abdominal imaging I find it useful in the visualization of calculi. A very large Stag horn calculus sometimes makes it impossible to judge whether you are dealing with a single large calculus or a cluster of calculi. The "X" plane allows differentiation convincingly.

The excellent fast volume data acquisition allows us to show the patient on bed the calculi in the GB or the urinary bladder with a single probe. (No need to change the probe).

Also, in the localization of small masses in the other organs especially small masses in the pancreatic head and in the liver, the diagnosis is improved with "X" plane imaging.

The xMATRIX X6-1 transducer is highly useful in evaluating Obstetrics and Gynecology ultrasound examinations as well.

I'm presenting a few cases in OB and Gynae and where I was assisted by this system.

Case Studies

Case Study 1 : Vein of Galen Malformation

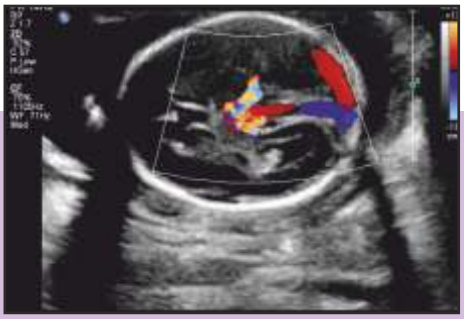
The Thalamic view of the head of the fetus shows e/o a clear fluid filled cystic area with a long tubular channel joining it on grey scale imaging. Color Doppler imaging shows dilated dural venous sinuses with a large cerebral vein and AV communication in the perithalamic area. This favors a diagnosis of vein of Galen malformation.

Color 3D and glass body rendered images were obtained after suppressing the grey scale image and showed the dilated aneurismal prosencephalic vein.

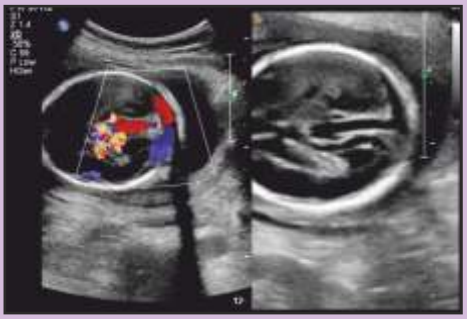
Clinical Note

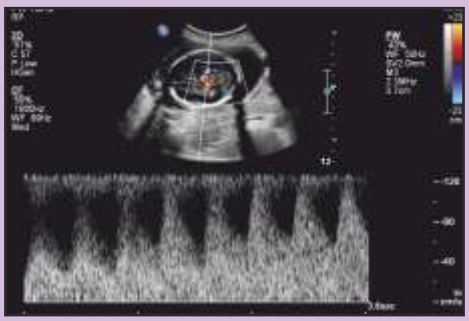
According to Lasjaunias classification and reference to Yasargil classification 4 Variants have been described. There may be a intermixing between types 1, 2 and 3. In type 1 there is a small pure cisternal fistula between the vein of Galen and either the pericallosal arteries (anterior or posterior) or the posterior cerebral arteries. In type 2 there is a Communication between vein of Galen and thalamoperforating vessels. There may be multiple channels. Our case is type 2. Type 3 is basically high flow mixed type 1 and 2. In Type 4 there is Parenchymal AVM with drainage in vein of Galen.

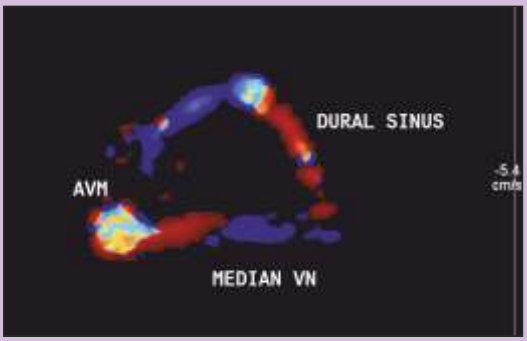
With the X matrix technology and the excellent 3D glass body rendering we could demonstrate type 2 Vein of Galen malformation.



Dilated Dural venous sinuses with a large cerebral vein and AV communication in the perithalamic area







3D glass body rendering shows dilated aneurismal prosencephalic vein.

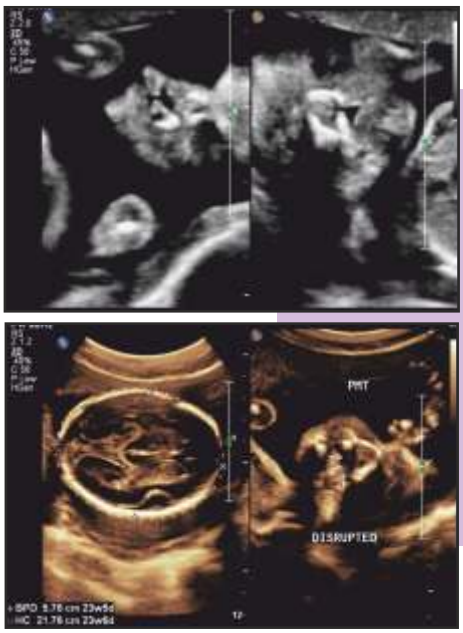
Case Studies

Case Study 2 : Cleft Lip and Palate

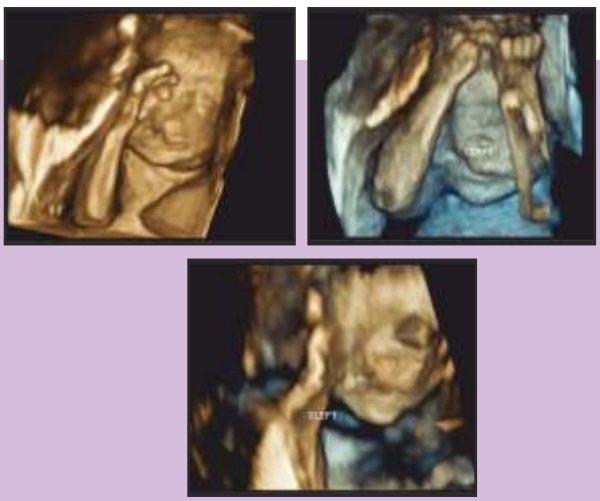
On a routine evaluation with Grey scale a disruption of the retro-nasal triangle was noted. There was a disruption of the maxillary bone with soft tissue herniation.

3D MPR of the area were obtained to show the defect.

Excellent 3D images with a fast rate of acquisition showed the defect clearly and convincingly.



Gray scale imaging shows disruption of the retro-nasal triangle and the maxillary bone



3D images depict the cleft lip and palate clearly and convincingly

Clinical Note

The condition results during the 4th to 6th weeks of gestation from a failure of fusion of one or both of the medial nasal prominences. These initially occur as paired medial nasal processes and failure of fusion with each other or with the maxillary processes will result in cleft lip with or without a cleft palate. As per the Nyberg 1995 antenatal ultrasound classification system, 5 types have been defined:

- Type I: isolated cleft lip alone
- Type II: unilateral cleft lip and palate
- Type III: bilateral cleft lip and palate
- Type IV: midline/median cleft lip and palate
- Type V: facial clefts associated with the amniotic band syndrome or the limb-body-wall complex

Incidence

Cleft lip and palate occurs in about 1 to 2 per 1000 births in the developed world. This can increase to 4% for a sibling of a previously affected fetus and up to 10% for a sibling of two previously affected infants. CL is about twice as common in males as females, while CP without CL is more common in females.

Causes

CDC has identified the following factors that increase the chances of developing orofacial defects in the fetus:

1) Smoking during pregnancy

2) Diabetes in pregnant women

3) Anti-epileptic treatment during pregnancy

US findings

Orofacial clefts, especially cleft lip with or without cleft palate, can be diagnosed during pregnancy by a routine ultrasound. In a bilateral cleft lip and palate, there is a pre-maxillary protrusion that is typically seen as a paranasal echogenic mass. However, sometimes certain types of cleft palate (for example, submucous cleft palate and bifid uvula) might not be diagnosed. 3D ultrasound improves the diagnostic accuracy in diagnosing these abnormalities.

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4. Diagnostic accuracy of transabdominal ultrasound in detecting prenatal cleft lip and palate: a systematic review. Ultrasound Obstet Gynecol. 2010 Apr; 35(4):495-502. doi: 10.1002/uog.7472, Maarse W1, Bergé SJ, Pistorius L, van Barneveld T, Kon M, Breugem C, Mink van der Molen AB.

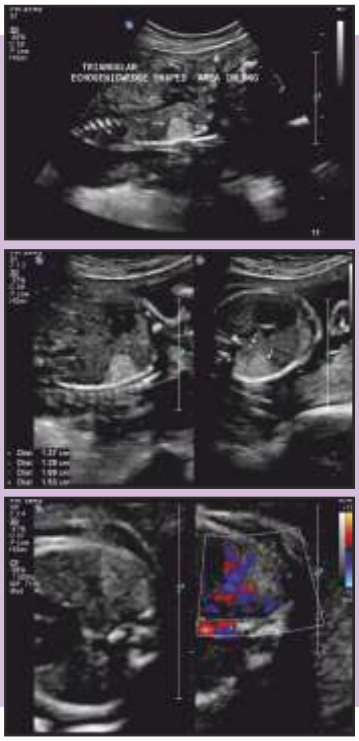
Case Studies

Case Study 3 : Pulmonary sequestration

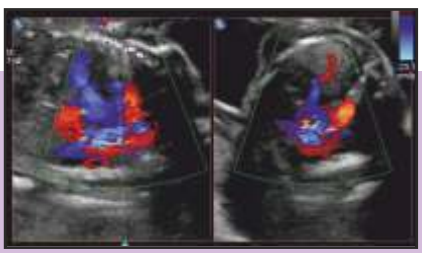
A Triangular wedge shaped echogenic area was visualized at the basal portion of the right fetal lung on grey scale imaging. This area measured about 1.7 x 1.5cms. This area was simultaneously accessed with "X" plane imaging to see its relationship with adjacent structures. Color Doppler in "x" plane imaging showed the relationship of this structure along with a feeding vessel from the aorta entering this lesion.

This helped us in making a diagnosis of sequestration against a d/d of:-

1) A small Cystic adenamatoid malformation (CCAM) and
2) Small mucus plug causing a basal atelectasis.



Gray scale imaging by C5-1 transducer showed a triangular wedge shaped echogenic area at the basal portion of the right lung



X-plane imaging helped in clearly demonstrating the feeder vessel from the abdominal aorta to this echogenic region, thereby confirming a diagnosis of Pulmonary Sequestration

Clinical Note

Pulmonary sequestration (also called accessory lung) refers to aberrant formation of segmental lung tissue that has no connection with the bronchial tree or pulmonary arteries. It is a bronchopulmonary foregut malformation (BPFM).

The estimated incidence is 0.1%, with some authors proposing a greater male prevalence

Pathology

Pulmonary sequestration can be divided into intralobar and extralobar sequestration, based on the relationship of the aberrant segmental lung tissue to the pleura. The two types of sequestration are similar in their relationship to the bronchial tree and arterial supply but differ in their relationship to the pleura. In the vast majority of cases, the anomalous lung tissue has a systemic arterial supply which is usually a branch of the aorta. Overall, sequestration preferentially affects the lower lobes. 60% of intralobar sequestrations affect the left lower lobe, and 40% the right lower lobe. Extralobar sequestrations almost always affect the left lower lobe, however approximately 10% of extralobar sequestrations can be sub-diaphragmatic

Ultrasound findings

The typical sonographic appearance of pulmonary sequestration is an echogenic homogeneous mass that may be well defined or irregular. Some lesions have a cystic or more complex appearance. Doppler studies are helpful to identify the characteristic aberrant systemic artery that arises from the aorta and to delineate venous drainage. Other findings can include (unilateral) pleural effusion, mediastinal shift and fetal hydrops.

Pulmonary sequestration needs to be differentiated with Congenital Pulmonary Airways Malformation (CPAM), which is a multicystic mass of segmental lung tissue with abnormal bronchial proliferation, and can appear as a solid hyperechoic intrathoracic mass on ultrasound (Type III)

Most babies with pulmonary sequestration have a very good outcome.

References

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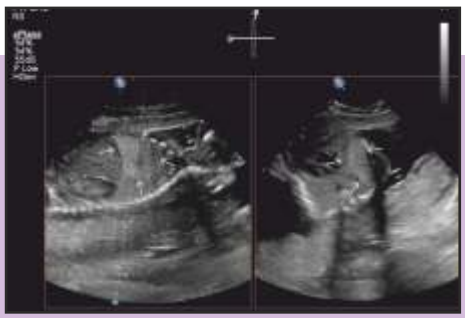
2. http://radiopaedia.org/articles/pulmonary-sequestration
3. Prenatal Sonography and MR Imaging of Pulmonary Sequestration Rajpal Dhingsa, Fergus V. Coakley, Craig T. Albanese, Roy A. Filly, Ruth Goldstein AJR:180, February 2003,

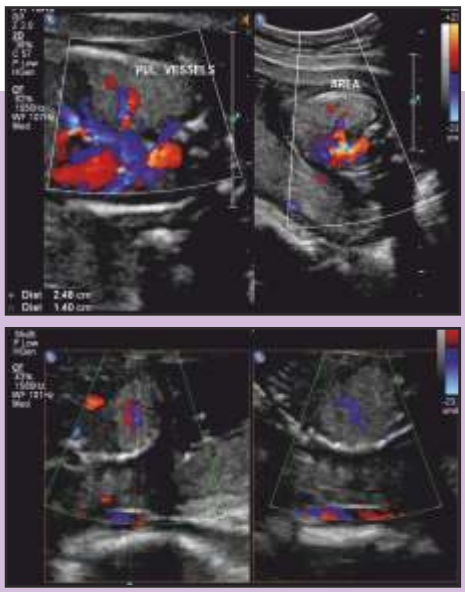
Case Studies

Case Study 4 : CCAM

USG of 20 week fetus shows an echogenic lesion in the right lung. Gray scale, color Doppler and x-MATRIX evaluation confirms the diagnosis of CCAM



Echogenic focus is seen at the right fetal lung. xMATRIX evaluation using live X-Plane shows the lesion in both orthogonal planes in real time



Pulmonary vessels are seen feeding the lesion, which are very well appreciated in the live X-Plane imaging

Clinical Note

Congenital cystic adenomatoid malformation (CCAM) is a pulmonary developmental anomaly arising from excessive overgrowth of the bronchioles, especially the terminal bronchioles, which causes the marked enlargement of the lobe, while the development of the alveoli is completely suppressed except at the periphery. The condition may be bilateral involving all lung tissue, but in the vast majority of cases it is confined to a single lung or lobe.

Classification

This lesion has been divided pathologically by Madewell and Stocker into three distinct types:

Type I which has single or multiple large cysts (> 2 cm. [usually 3 - 7 cm]) lined with pseudostratified columnar epithelium,

Type II, in which there are multiple small cysts (< 1.5 cm) lined by cuboidal to columnar epithelium and

Type III consisting of a mass of cuboidal-lined ciliated epithelium of alveolar like stuctures without macroscopic cysts

Ultrasound findings

CCAM appears as an isolated cystic or solid intrathoracic mass. A solid thoracic mass is usually indicative of a type III CCAM and is typically hyperechoic. There can be mass effect where the heart may appear displaced to the opposite side. Hydrops fetalis or polyhydramnios may develop and may be detected on ultrasound as ancillary sonographic features. Alternatively, the lesion may remain stable in size, or even regress.

Other associations include bilateral renal agenesis, renal dysplasia, cardiac abnormalities including tetralogy of Fallot, truncus arteriosus and ventricular septal defect, hydrocephalus, jejunal atresia, diaphragmatic hernia, enteric cyst, tracheoesophageal fistula, sirenomelia and vertebral and clavicular abnormalities

It is important to distinguish CCAM from broncho-pulmonary sequestration. In sequestration the sequestred segment gets a supply from the abdominal aorta. In CCAM the supply is through pulmonary artery branches.

The xMATRIX transducer helps in diagnosing both the abnormalities and also in differentiating one from another

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Case Studies

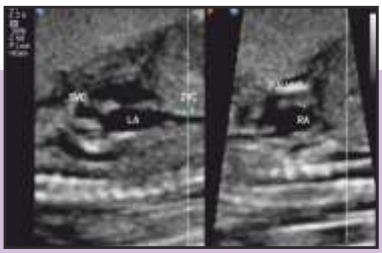
Case Study 5 : Complex Cardiac Anomalies

This 20 year primi-gravida came for a routine scan. The grey scale image revealed the fetal stomach on the right side. The Inter –ventricular septum appeared deficient near the crux. There appeared a large ASD. There was e/o anomalous veno-atrial connection and an abnormal atrio-ventricular connection. Both the Aorta and pulmonary artery are seen to arise from a common ventricle.

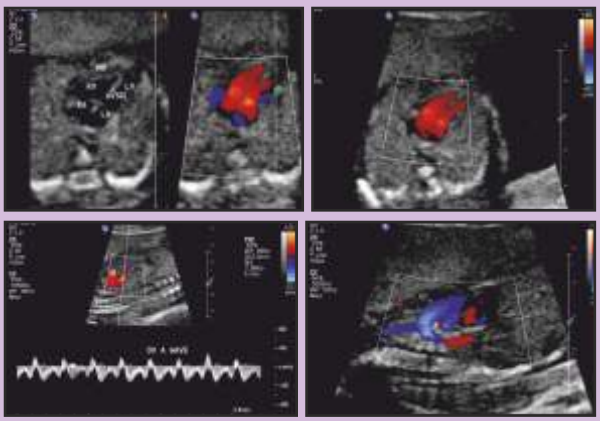
The fast data acquisition rate (< 3 secs) and excellent 3D acquisition property of the matrix probe helped us to get a good idea of the internal cardiac anatomy and the nature of the high VSD.

A similar case with an AVSD is also shown

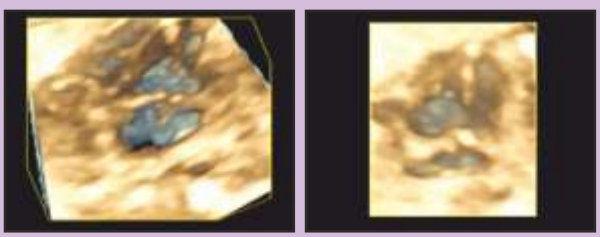
VSD



Gray scale imaging demonstrating an abnormal veno-atrial communication



Gray scale imaging demonstrating the ASD and the high-VSD. Color Doppler confirms the defect



3D surface rendered imaging helps to clearly identify the fetal cardiac defects, thanks to high quality and speed of acquisition

Clinical Note:

VSD represent one of the most common congenital cardiac anomalies and may be associated with up to 40% of such anomalies. The estimated incidence is at ~1 in 400 births.

Classification (according to location)

- Membranous/perimembranous (most common: 80-90%)
- Inlet/inflow
- Outlet/subarterial
- Muscular/trabecular

Associations

A VSD can occur on its own but frequently tends to occur with other cardiovascular associations such as tetralogy of Fallot, truncus arteriosus, double outlet right ventricle, aortic coarctation, tricuspid atresia, aortic regurgitation and pulmonary stenosis

Extra cardiac associations include - aneuploidic / chromosomal anomalies, trisomy 21, trisomy 18 and trisomy 13

Ultrasound findings

USG allows direct visualisation of the septal defect which can be easily seen in the four chamber view. A perimembranous VSD can seen as a septal dropout in the area adjacent to the tricuspid septal leaflet and below the right border of the aortic annulus. Small isolated VSD's can be difficult to detect prenatally.

Advanced ultrasound technology like STIC, used in tandem with color Doppler 3D and surface rendering provides additional information such as - measurement of the area of the defect, its spatial location in the septum and its temporal location in the cardiac cycle.

References

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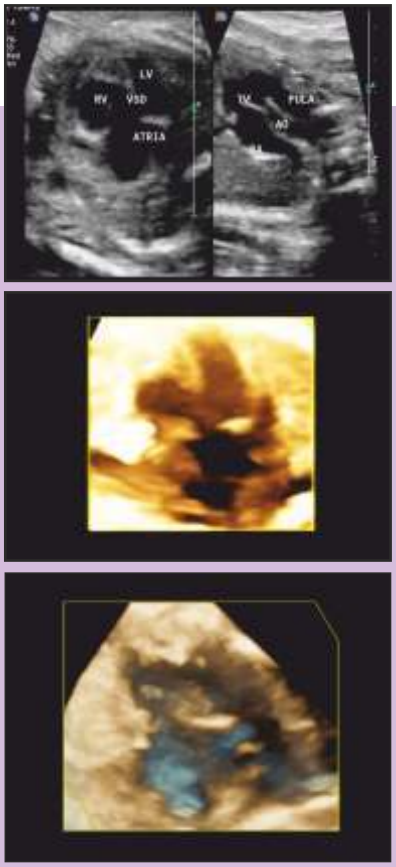
Case Studies

Case Study 5 : Complex Cardiac Anomalies

AVSD:



Another case of fetal complex cardiac anomaly – a case of AVSD with a clear demonstration of the defect at the crux that is confirmed on 3D imaging.

Atrioventricular septal defects (AVSDs) refer to a broad spectrum of malformations characterized by a deficiency of the atrioventricular septum and abnormalities of the atrioventricular valves. These malformations are presumed to result from abnormal or inadequate fusion of the superior and inferior endocardial cushions with the mid portion of the atrial septum and the muscular (trabecular) portion of the ventricular septum.

Classification

1. Partial or incomplete AVSD (also called partial common atrioventricular canal), characterised by an interatrial communication, without an interventricular communication. The most frequently encountered abnormality in patients with partial AVSD is the combination of primum ASD and cleft of the anterior mitral valve leaflet.

2. Complete AVSD (complete common atrioventricular canal defect –CAVC) is one in which there are defects in all structures formed by the endocardial cushions. It is characterised by an ostium primum ASD, perimembranous AV canal-type VSD and a common atrio-ventricular valve.

3. Intermediate AVSD (also called transitional common atrioventricular canal) is characterised by the combination of a partial AVSD with a small interventricular communication. A single vulvar annulus is usually present where the anterior and posterior bridging leaflets fuse overlying the ventricular septum.

Incidence

The estimated prevalence is at 3-4 in 10,000 births.

Ultrasound findings

It can be diagnosed easily in fetal echo cardiography by non-visualization of the 'crux' of the heart in a four-chamber view. An altered shape of the heart and observation of the abnormal atrioventricular valve (AV) motion in real-time provide further clues to this anomaly.

Other cardiac abnormalities associated with AVSD include outflow tract lesions, cardiac arrhythmias, ventriculomegaly and single umbilical artery. Non-cardiac systemic abnormalities associated with AVSD include those of MSK, CNS, GI and Genitourinary. 40-60% of AVSD cases may be associated with chromosomal anomalies, especially trisomy 21. An early diagnosis of AVSD, with determination of its severity, presence of cardiac, other systemic chromosomal anomalies plays a crucial role in prenatal decision-making

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Case Studies

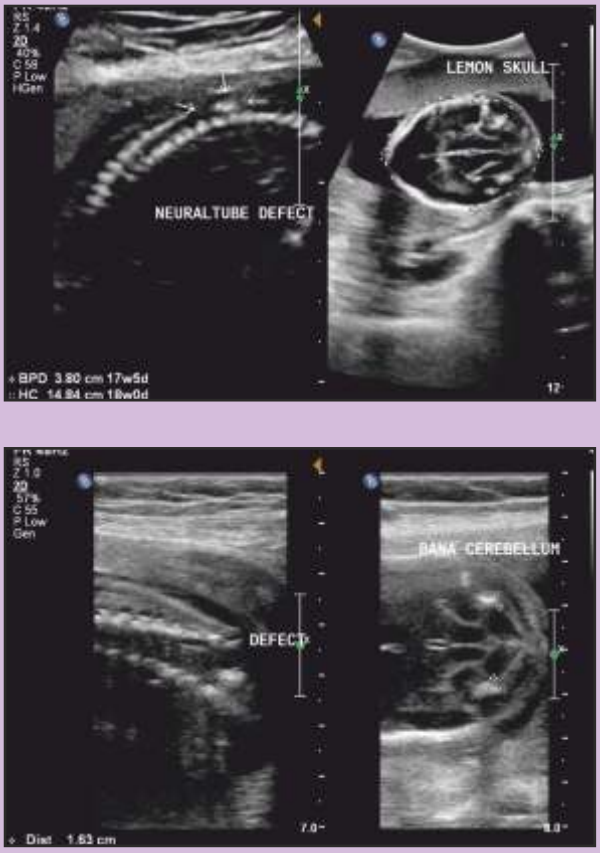
Case Study 6 : Spina Bifida

The Feature of “X” plane imaging provides excellent tool for the visualization of the spine in the sagittal as well as the short axis. With this feature we are unlikely to miss a defect which is small.

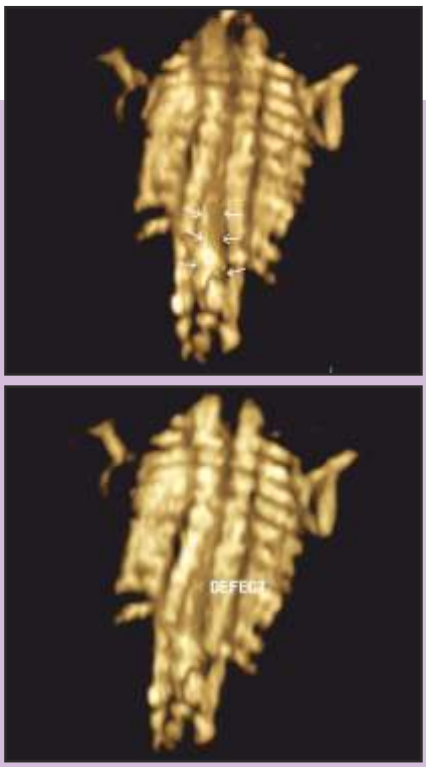
The feature of Q-lab provides a dynamic tool to view the structure in three MPR planes and their corresponding 3D reconstruction.

In the second trimester the spine in the sagittal section the lowest visualized segment is S4 and in the third trimester S5. Counting from this upwards tells us the exact location of the spinal defect.

A problem comes when the fetus is in breech presentation with spine towards maternal back. The feature of “X” plane imaging helps in such cases.



Gray scale imaging in this 18 week gestation showing the spina-bifida. The lemon sign and the banana sign (cerebellum) are seen as well



3D image reconstruction with skeletal mode clearly demonstrates the spina-finda at the lumbar region

Clinical Note

Spina bifida can be defined as a midline vertebral defect, resulting in exposure of neural contents to the amniotic fluid. In majority of cases, the defect is located on the posterior vertebral arches. In rare cases, the defect is caused by division of the vertebral body.

Classification

Spina bifida can also be subtyped as:

a) **open:** (80-90%) especially if detected antenatally, and include - myeloschisis and myelomeningocoele (mostly open, associated with Chiari II malformation)

b) **closed:** covering skin present and can include - meningocoele (may be open), lipomyelomeningocoele, myelocystocoele, tethered cord, diastomyelia and syringomyelia

The estimated incidence is at 1:1000-2000 live births

Continued on page no. 10 ➔

Case Studies

Case Study 6 : Spina Bifida

Continued from page no. 9 ➔

Eitiology

The aetiology is often multi-factorial with both genetic and environmental factors considered to play a role. Intake of adequate amounts of folic acid plays a protective role.

Ultrasound findings

Ultrasonographic examination should be conducted in standardized planes: coronal plane, transverse plane or sagittal plane.

In coronal sections, spina bifida may be recognized by splaying of the vertebral lateral pedicles. In axial or transverse sections, separation of the posterior ossification centers is observed, along with a skin defect and exposure of neural contents to the amniotic fluid. In most cases, a myelomeningocele sac can be seen. Longitudinal sections are used to determine the extension of the anomaly once it is diagnosed.

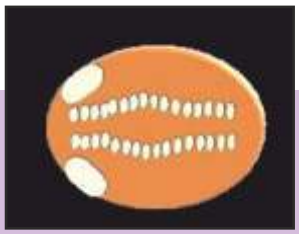


Fig 1: Coronal Section

Fig 2: Axial Section

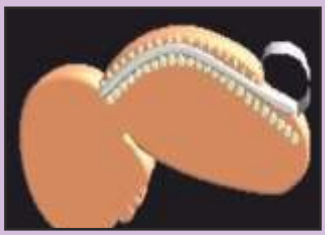


Fig 3: Longitudinal Section

In addition to the above, two indirect signs of spina bifida could be seen:

a) The "lemon sign": characterized by a more or less pronounced depression at the level of the metopic suture, giving to the calvarium the shape of a lemon.

b) The “banana sign”: characterized by herniation of the cerebellar vermis through the foramen magnum, giving the cerebellum the aspect of a banana. Both signs are the consequence of the Arnold-Chiari Malformation type II, commonly associated with spina bifida.

3-D ultrasound improves the characterization of spina bifida by adding further information, especially the multiplanar views

Clinical significance

Neonatal morbidity and mortality rate is estimated as 25%. Survival rate of those treated in the immediate neonatal period approaches 40% at seven years. 25% of these children are almost totally paralyzed, 25% require intense rehabilitation and 25% do not have a significant lower extremity dysfunction. Hence, a confident diagnosis of spina bifida is vital for parental counselling and further management, which would involve either termination of pregnancy or delivering the fetus at a well-equipped tertiary care center. Also, the presence of a spina bifida would be a major indication to rule out the same abnormality in subsequent pregnancies (risk of recurrence is 03 – 5%)

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Case Studies

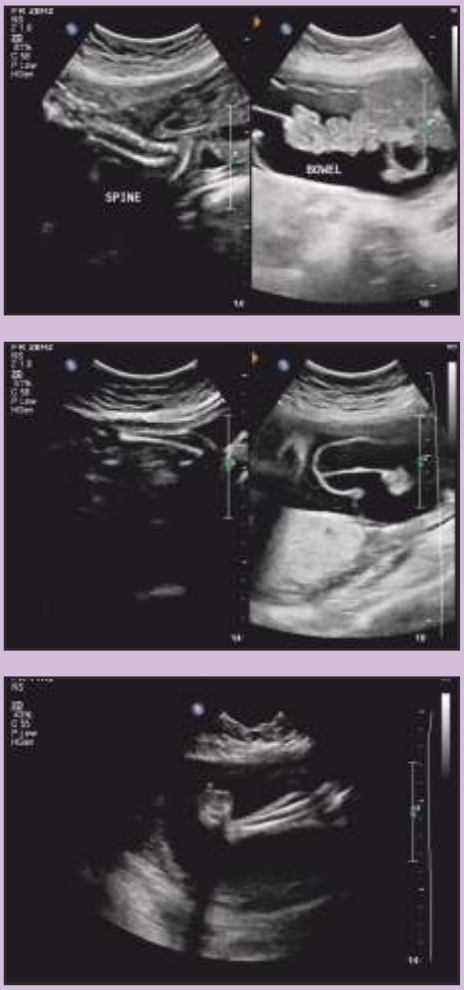
Case Study 7 : Limb body wall complex

A 24 – 25 weeks pregnancy presenting with multiple congenital abnormalities involving the fetal abdomen, limbs and spine

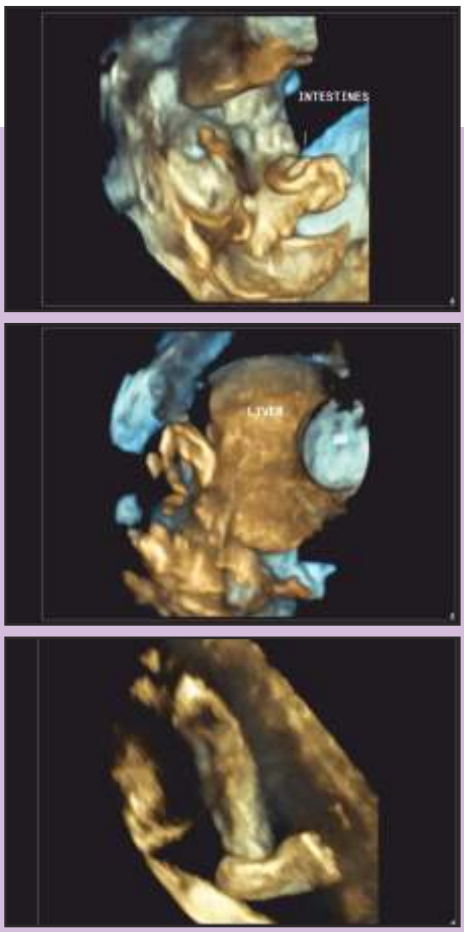
Grey scale imaging reveals a “lemon shaped skull” with infratentoral herniation of contents, spinal defect, herniation of bowel, herniation of abdominal viscera (large abdominal wall defect), multiple septae.

A single limb is visualized with a Talipes deformity. The Bone window setting demonstrated the limb defect very clearly.

The “x” matrix proved helpful in spinal and abdominal imaging.



Gay scale examination reveals spinal deformity, herniation of bowel loops, and limb abnormality



3D imaging provides detail evaluation of the abnormalities detected on gray scale. These images demonstrate the herniation of the abdominal contents as well as clearly depict the talipes deformity of the lower limb

Clinical Note

The limb body wall complex (LBWC) is a rare variable group of congenital limb and body wall defects (involving mainly the chest and abdomen). LBWC is considered a component of the fetal midline disruption syndrome, which also consists of body stalk anomaly and Pentalogy of Cantrell.

LBWC can include abdominoschisis, thoracic wall defect / thoracoschisis, anomalies of the lower limbs – clubfoot/ brachydactyly/ polydactyly/ syndactyly/ oligodactyly/ absent limbs, scoliosis (often profound), exencephaly

Other associated defects can include cardiac and diaphragmatic defects, bowel atresia, renal agenesis, hydronephrosis, neural tube defects, facial defects, caudal regression syndrome, and single umbilical artery

Continued on page no. 12 ➔

Case Studies

Case Study 7 : Limb body wall complex

Continued from page no. 11 ➔

The estimated incidence is at around 1 in 10-14,000 live births.

Pathology

The proposed mechanisms leading to LBWC include

- Early amnion rupture
- Early vascular disruption
- Embryologic malformation with abnormal development of the body folds

Ultrasound features

May show a large abdominal wall defect with the fetus being adherent to the placenta. The umbilical cord insertion site is very difficult to find or is absent and there is direct apposition of the membranous sac to the amniochorionic membrane. An accompanying kyphoscoliosis / scoliosis may also be detected on ultrasound. Early first trimester scanning may also show an increased nuchal translucency.

3D ultrasound is very useful in the investigation of limb-body wall complex, particularly when making a detailed assessment of fetal structural defects and of any amniotic bands. By identifying LBWC more clearly and completely, 3D USG makes the information easily understandable for parents and thereby aiding in the decision making.

Treatment and prognosis

The condition carries an extremely poor prognosis and is invariably fatal. Management is often supportive. Future pregnancies are however not thought to carry an increased risk of redeveloping the condition.

Differential diagnosis includes gastroschisis, omphalocoele, pentalogy of Cantrell, amniotic band syndrome, OEIS complex. It is very important to differentiate LBWC complex from these entities as body stalk complex is invariably fatal whereas the other conditions, such as an isolated omphalocoele carries good prognosis.

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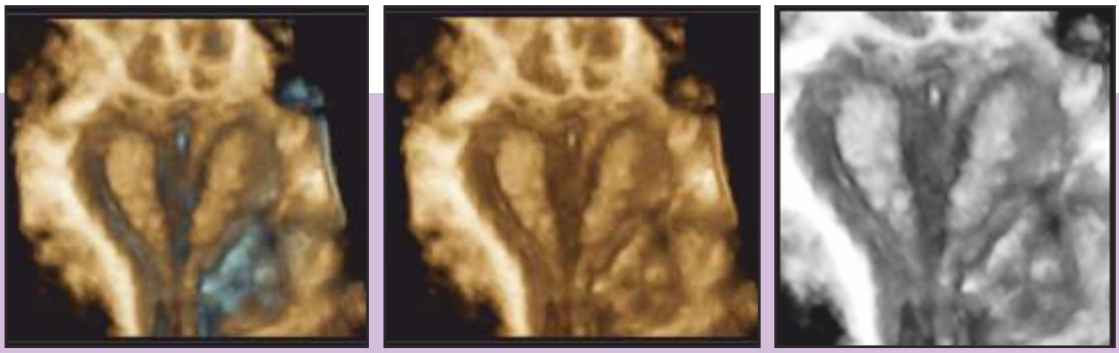
   Keerthi Kocherla, Vasantha Kumari, Prasada Rao Kocherla; Indian Journal of Radiology and Imaging / February 2015 / Vol 25 / Issue 1

Case Study 8 : Complete uterine cervical septation



3D reconstruction with the matrix probe depicting two uterine cavities and two cervices.

Continued on page no. 13 ➔

Case Studies

Case Study 8 : Complete uterine cervical septation

Continued from page no. 12 ➔

Grey scale imaging in this 17yrs Female who came with the c/o irregular menstrual bleeding, lower abdominal pain showed two uterine cavities. There was no myometrial dipping.

The greatest power which “x” matrix offered was that we did a 3D reconstruction with the matrix probe and got excellent images depicting two uterine cavities and two cervices.

Without this technique it would not have been possible to elicit it. The only tool left would have been a pelvic MRI.

Clinical Note

A septate uterus is considered the commonest uterine anomaly (accounts for 55% of such anomalies). It is classified as a class V Mullerian duct anomaly and results from partial or complete failure of resorption of the uterovaginal septum after fusion of the para-mesonephric ducts. The septum is usually fibrous but can also have varying muscular components. Septate uterus is the most common anomaly associated with reproductive failure (67%).

As with other uterine anomalies, concurrent renal anomalies may be associated

Subtypes

- A partial septum (sub-septate uterus) involves the endometrial canal but not the cervix
- A septum is considered "complete" if it extends to either the internal or external cervical os
- Septate uterus and vagina – where septum extends into the vagina:

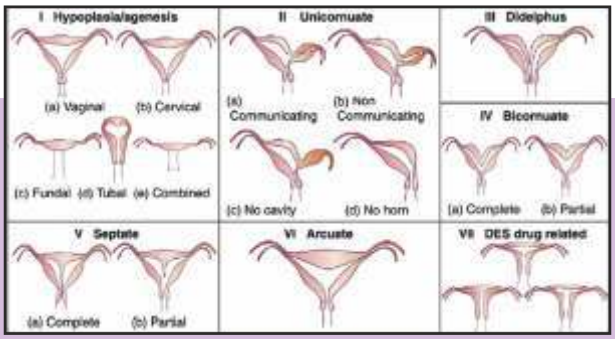


Fig: American fertility society classification of uterine malformations

Ultrasound

The echogenic endometrial stripe is separated at the fundus by the intermediate echogenicity of the septum. The septum extends to the cervix in a complete septate uterus. The external uterine contour must demonstrate a convex, flat, or mildly concave (ideally <1cm) configuration and may best be appreciated on coronal images of the uterus.

Colour Doppler may show vascularity in the septum in 70% of cases; and if present may be associated with a higher rate of obstetric complications. An angle of less than 75° between the uterine horns is suggestive of a septate uterus, and an angle of more than 105° is more consistent with bicornuate uteri

3D ultrasound can help in differentiating a septate from a unicornuate uterus. This differentiation is important as the septate uterus can be treated by excising the septum by hysteroscopic metroplasty, thereby creating a singly uterine cavity and improving the reproductive outcome (spontaneous abortion rate can be reduced from 88% to 5.9% after hysteroscopic metroplasty.)

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C. BERMEJO*, P. MART´INEZ TEN†, R. CANTARERO*, D. DIAZ*, J. P ´ EREZ PEDREGOSA‡, E. BARRO´ N†, E. LABRADOR§ and L. RUIZ LO´ PEZ¶

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Khaled Abd AlWahab Abo Dewan a, Mohamed Mohamed Hefeda, Dina Gamal ElDein ElKholy

The Egyptian Journal of Radiology and Nuclear Medicine (2014) 45, 987–995

xMATRIX – A Revolutionary Change in Ultrasound Imaging!

xMATRIX technology combines the proprietary PureWave crystal technology and the Acoustic Amplifier Technology to provide a sensor with high sensitivity and bandwidth, resulting in outstanding penetration and resolution. Incorporating the transmit and receive microbeamforming in the transducer handle provides complete flexibility in electronic beam positioning, focusing, and imaging formats. The thin-slice imaging of X6-1 reduces the volume averaging in elevation, enhances the inter-costal imaging, and increases the spatial resolution in all 3D multi-planar reconstructed (MPR) views.

What makes Philips xMATRIX technology different?

The so-called 1.XD/ Matrix Array Transducers presently available with some of the vendors may provide a limited improvement over the conventional 1D arrays by dividing the elevation aperture into a small number of rows, providing multiple elevation foci and may increase depth of field (Figure 1) However, the enhancement is modest and limited by the small number of rows. Furthermore, the elements are too large in elevation to allow significant steering in elevation, so imaging is still limited to a single lateral plane. While it may be technically accurate to describe such an array as a "2D matrix of elements," it is really a minor extension of conventional technology and falls far short of xMATRIX capability.

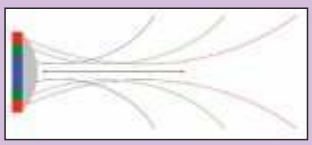


Fig 1 : *1.XD arrays with a few elevation rows provide multiple elevation foci and extended depth of field, but no elevation steering so the field of view is still limited to a single plane.*

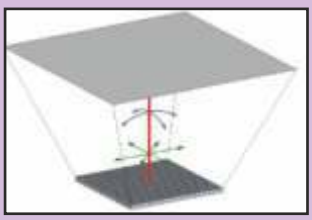


Fig 2 : *2D array provides electronic control of acoustic beam for translation (green), steering (blue), and focusing (red) anywhere within a 3D field of view (shown here as a truncated pyramid).*

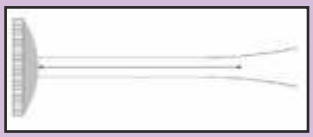


Fig 3 : *xMATRIX array with many rows in elevation, providing more precise control of slice thickness and therefore greatly improved depth of field.*

xMATRIX transducers have many rows of elements in elevation, resulting in thousands of elements overall. This provides steering and focusing in any direction within a 3D field of view (Figure 3), which enables modes such as xPlane, with two planes displayed simultaneously in real time, as well as 3D, both real-time and retrospective. Having many rows also allows much more precise control of the size and focus of the elevation aperture, resulting in increased depth of field and good slice thickness.

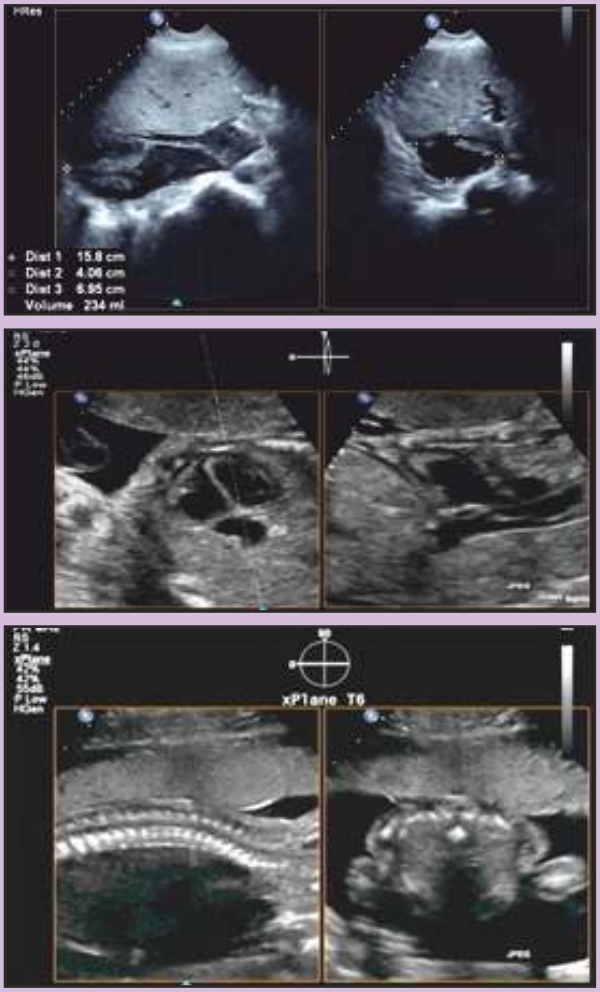
The xMATRIX, X6-1 transducer comprises of a phenomenal - 9212 active elements arranged in a 2D array (Fig 4). Located directly beneath the array are the microbeamformer electronics, with 9212 microchannels comprising over 8 million electronic devices (Fig 5)

Fig 4: *View of X6-1 transducer, looking at the face of the transducer with the lens removed. The 2D array with 9212 active elements is visible.*

Fig 5 : *Beneath the sensor elements are the microbeamformer circuits, comprising over 8 million electronic devices.*

xMATRIX – A Revolutionary Change in Ultrasound Imaging!

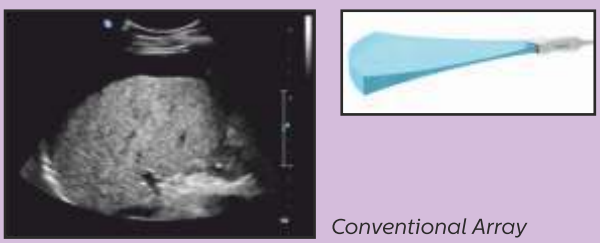
X6-1 xMATRIX Clinical Applications



Live xPlane imaging

- Instant visualization of spatial anatomy in two live planes.
- Quick 3-diameter ellipsoid volume.
- Improved ergonomics with reduction in wrist strain by up to 70%.

Ultra-thin slice imaging

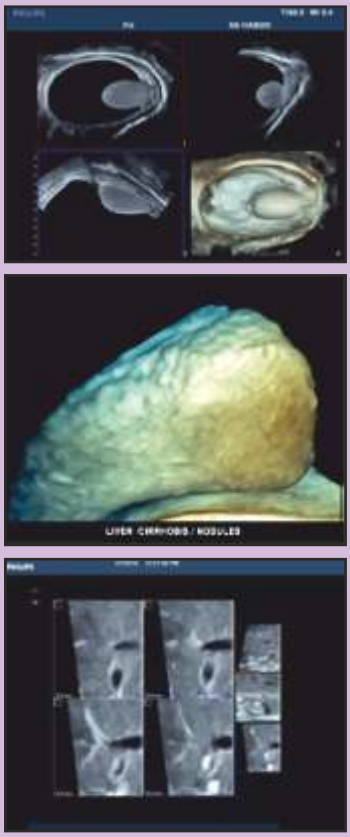


Conventional Array

Ultra- thin slice imaging

- Exceptional tissue uniformity and detail throughout depth of field.
- Superb discrimination of vascular anatomy.
- Enhanced intercostal imaging

Volume imaging



- Streamlines workflow and allows managing ultrasound exams just like CT/MR.
- Assessment of lesions using MPR views and advanced quantification tools possible.
- Enhances diagnostic confidence by providing ultrasound imaging in unique new ways.

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