10.5005/jp-journals-10009-1170

REVIEW ARTICLE

Fetal and Gynecological 3D Ultrasound in Daily Practice

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ABSTRACT

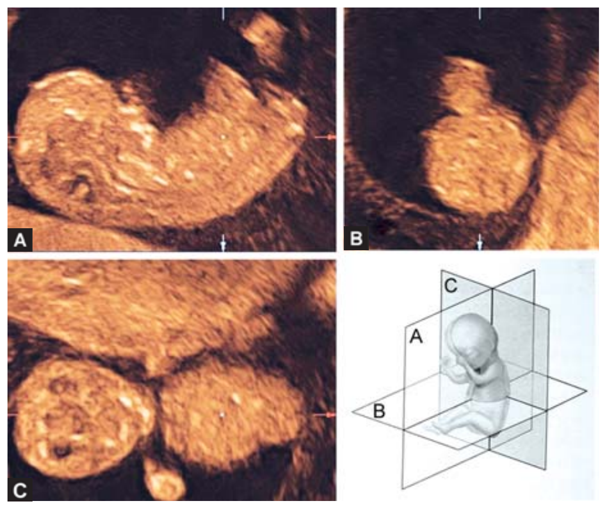
Three-dimensional ultrasound has many functions, and is a little complicated to use perfectly. But by starting from easy cases, objects and display modes in daily practice, 3D ultrasound would be a powerful diagnostic tool when and after some abnormalities are suspected with 2D ultrasound. Some tips to use 3D ultrasound easily and efficiently are demonstrated for those who are not familiar with 3D ultrasound.

Keywords: 3D ultrasound, Fetal biometry, Fetal abnormality, Uterine anomaly, Hydrosalpinx.

INTRODUCTION

Three-dimensional (3D) ultrasound has many functions[1-3] which conventional two-dimensional (2D) ultrasound has not. When one uses these functions perfectly, he/she can make sophisticated diagnoses. On the other hand, too many functions make 3D ultrasound a troublesome and even time consuming thing for daily practical use.

Three-dimensional ultrasound may be used easily and efficiently by most of the doctors and sonographers who do not use 3D ultrasound perfectly by selecting cases, objects and display modes. Here are shown some tips to use 3D ultrasound easily and efficiently in daily practice for those who are not familiar with 3D ultrasound.



Figs 1A to C: Three-orthogonal-plane display of a fetus at 10 weeks of gestation. Plane A (upper left) shows the median plane of the fetus

Fetal 3D Ultrasound

First Trimester

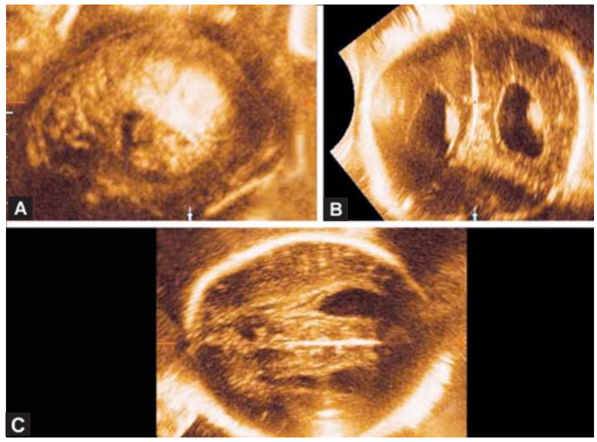
Three-dimensional ultrasound shows three sections, which are perpendicular to each other on a screen (three-orthogonal-plane display). By translating and rotating the 3D data set,[1-3] any arbitrary section including the exact median plane (midsagittal plane) can be easily obtained.

The measurement of crown-rump length (CRL) on the median plane is essential to determine the fetal age. The median plane of a fetus can be obtained easily by 3D ultrasound even when 2D ultrasound cannot depict the plane due to inappropriate fetal position (Figs 1A to C). The median plane is also important for nuchal translucency (NT) measurement. A 3D ultrasound scanner, which can depict the median plane of a fetus and measure NT from a 3D data set automatically, has been commercially available since 2010.

In the first trimester, 3D ultrasound depicts the whole body of a fetus three-dimensionally. 3D ultrasound makes complicated shape of conjoined twins understandable by

Fig. 2: A 3D surface image of conjoined twins at 12 weeks of gestation[7]

Fig. 3: A 3D surface image of a fetus with a bending left hand at 12 weeks of gestation[7]



Figs 4A to C: Three-orthogonal-plane display of a fetus with agenesis of the corpus callosum.[7] (A) Median plane (B) Coronal plane (C) Axial plane. Note: the corpus callosum is absent on the median plane (A)

showing its 3D surface image (Fig. 2). A fetal 3D surface image also shows limbs clearly at once. Abnormalities of fetal limbs can be found easily with 3D surface images (Fig. 3).

Second and Third Trimesters

Agenesis of the corpus callosum must be considered when mild ventriculomegaly is found. The most appropriate plane to diagnose agenesis of corpus callosum is the median plane of the fetal head. 3D ultrasound can easily show the plane and absence of the corpus callosum (Figs 4A to C).

One section alone cannot demonstrate how much amount of ascites accumulates in the abdominal cavity. Parallel-plane display by 3D ultrasound can demonstrate the amount of ascites exactly (Fig. 5).

The shape of a fetal face is much easier to understand with a 3D surface image than a 2D image. Cleft lip can be diagnosed with conventional 2D ultrasound, but it is hard to convey its exact appearance to the parents. A 3D surface image shows the face and the lesion clearly to the parents (Fig. 6).

Short-limbed dwarfism can be diagnosed by measuring long bones. But, it is also difficult to convey its exact appearance to the parents. A 3D surface image of the fetus shows it clearly (Fig. 7). The frontal bossing and depressed nasal bridge (Fig. 8) are clearly seen on a 3D surface image of a fetus with some kinds of short-limbed dwarfism, such as achondroplasia.

In a case of polyhydramnios, a clear 3D surface image can be obtained easily and sometimes some abnormalities, such as micrognathia (Fig. 9), a low set ear (Fig. 10), overlapping fingers (Fig. 11) and club foot (Fig. 12) are noticed.

Abnormality of external genitalia is sometimes difficult to diagnose with conventional 2D ultrasound. A 3D surface image demonstrates its clear shape (Fig. 13).

Maximum intensity projection[1-3] (so-called ‘maximum mode’) is mainly used for visualization of fetal skeleton. In some cases, a better 3D image can be obtained by mixing a 3D image by maximum intensity projection with a 3D image by so-called ‘X-ray mode’[1-3] or a 3D surface image with high threshold.[1-3] Scoliosis is diagnosed easily with 3D images (Fig. 14).

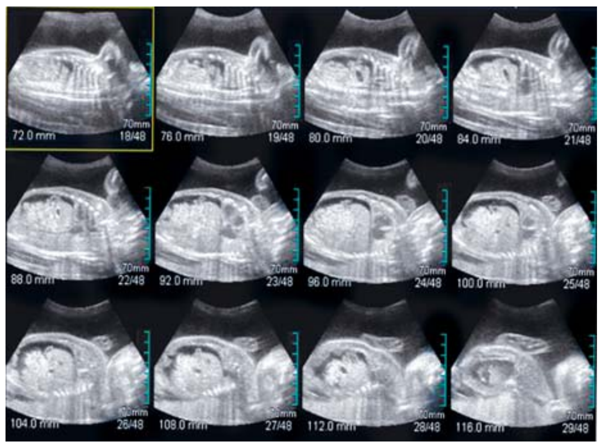


Fig. 5: Parallel-plane display of a fetal body with ascites[7]

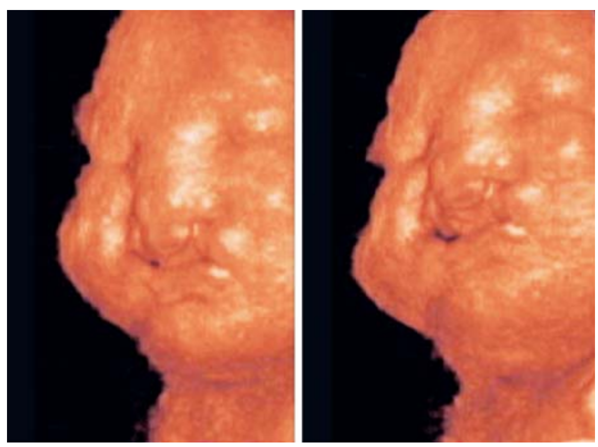


Fig. 6: A 3D surface image of a fetus with bilateral cleft lip[7]

Fig. 7: A 3D surface image of a fetus

Fig. 10: A 3D surface image of a fetus with trisomy 18 shows a low set ear

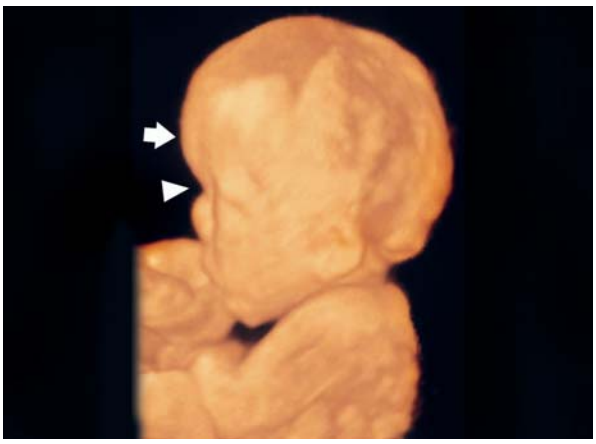


Fig. 8: A 3D surface image of a fetus with short-limbed dwarfism.[7] Note the frontal bossing (arrow) and depressed nasal bridge (arrow-head)

Fig. 11: A 3D surface image of a fetus with trisomy 18 shows overlapping fingers

Fig. 9: A 3D surface image of a fetus with micrognathia and polyhydramnios

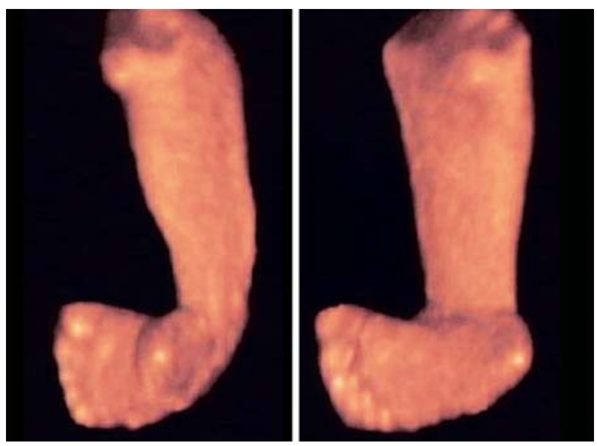


Fig. 12: A 3D surface image of a fetus with trisomy 18 shows a club foot.[7] Two images are of the same foot seen from different angles

Minimum intensity projection[1-3] (so-called 'minimum mode') is mainly used for visualization of cystic lesion. In some cases, a better 3D image can be obtained by mixing a 3D image by minimum intensity projection with a 3D image by X-ray mode. A 3D surface image of cystic parts (so-called 'inversion mode') is also used. A hydroureter often looks like a multicystic lesion by 2D ultrasound (Fig. 15A). A 3D surface image of cystic lesion shows luminal structures well (Fig. 15B).

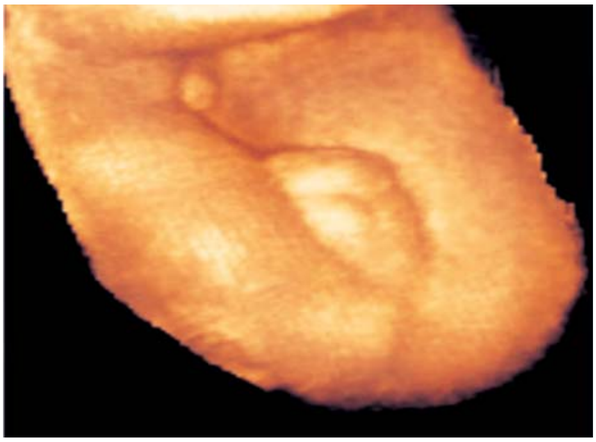


Fig. 13: A 3D surface image of hypospadias[7]

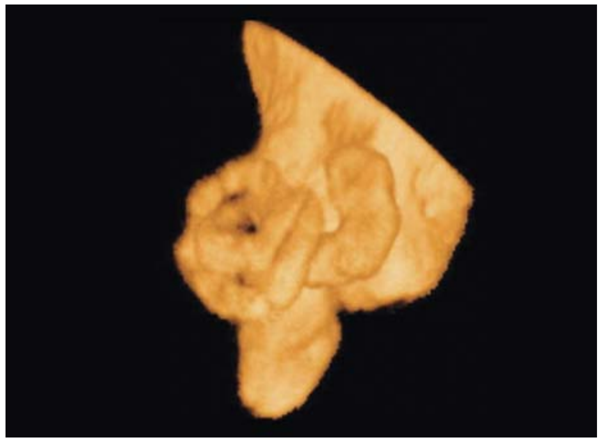


Fig. 15B: A 3D surface image of hydroureters and a megacystis by "inversion mode".[7] Note: the expanded and meandered ureters

Fig. 14: A 3D image of a fetus with body stalk anomaly.[7] Scoliosis (arrow) is easy to see

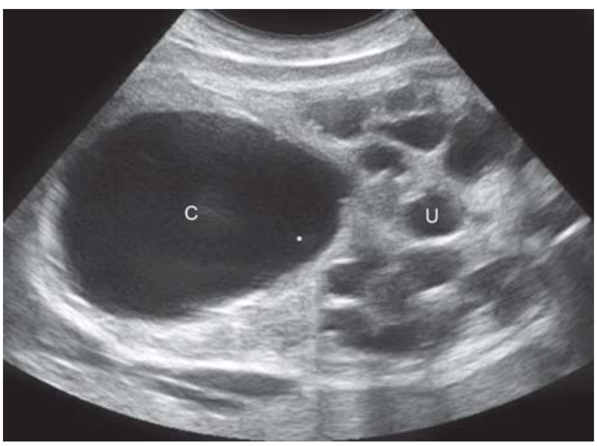


Fig. 15A: A 2D image of hydroureters (U) and a megacystis (C).[7] Hydroureters look like small multiple cysts

Gynecological 3D Ultrasound

Most gynecological abnormal findings are obtained by 2D ultrasound, and 3D ultrasound may not be attractive in gynecology as in obstetrics. Uterine tumors like a fibroma and ovarian tumors are diagnosed by using 2D ultrasound with or without Doppler. CT and MRI are also used for better diagnosis.

However, in some cases, 3D ultrasound gives better and more accurate information on the lesion easily than 2D ultrasound, CT or MRI.

Uterus

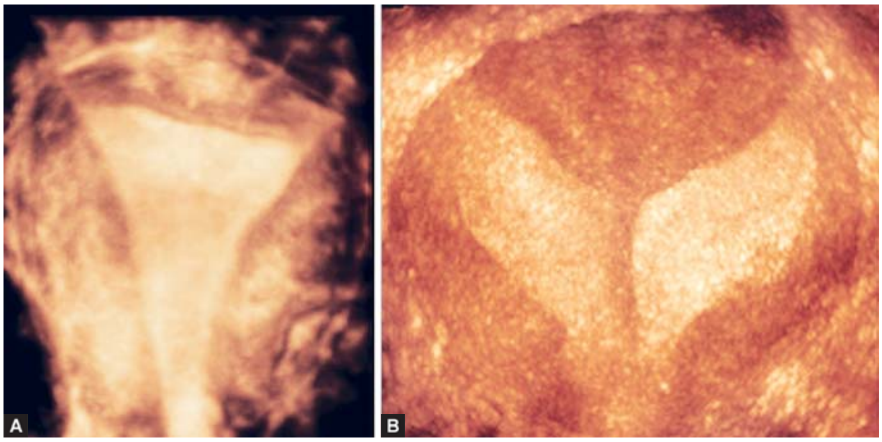
Endovaginal ultrasonography provides fine images of the uterus, when the probe is manipulated properly.[4] Conventional 2D ultrasound, however, cannot give a coronal view of the uterus.

Congenital uterine anomalies are easy to diagnose with a coronal view of the uterus,[5] which can be obtained easily by 3D ultrasound (Figs 16A and B). Foreign bodies, such as an intrauterine contraceptive device can be identified and located in the uterine cavity by seeing a coronal view of the uterus.[5] The tip of a catheter can be monitored and located in the uterine cavity by using a 3D ultrasound scanner transabdominally, when an embryo is transferred into the uterine cavity through the ET catheter.[6]

Sonohysterography or saline infusion sonography is used to diagnose abnormalities in the uterine cavity accurately. Three-dimensional ultrasound with sonohysterography can demonstrate lesions in the uterine cavity clearly and three-dimensionally. By translating each image on three-orthogonal-plane display, lesions in the endometrial cavity can be searched by millimeter (Fig. 17). By setting ROI (region of interest),[1-3] to remove the anterior wall of the uterus, endometrial polyps in the uterine cavity can be seen three-dimensionally (Figs 18 and 19).

Uterine Tubes

Hydrosalpinx is often misdiagnosed as an ovarian cyst with 2D ultrasound. Its luminal structure can be easily seen on a



Figs 16A and B: Coronal views of uteruses. (A) A normal uterus (B) A septate uterus

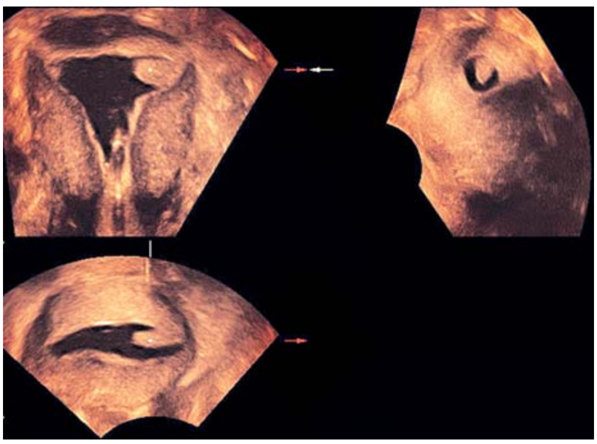


Fig. 17: Three-orthogonal-plane display of the uterus after infusion of saline into the uterine cavity. Note that an endometrial polyp is depicted on the three planes

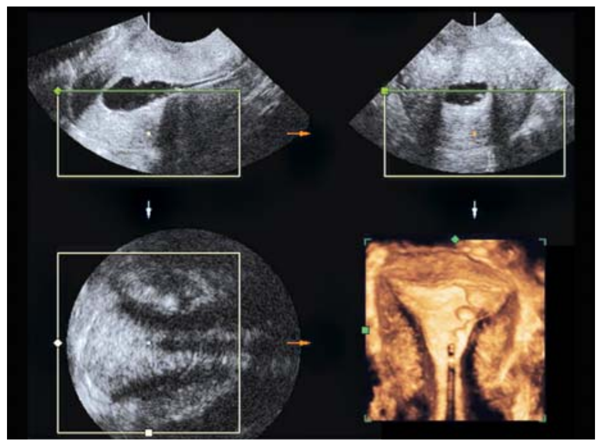


Fig. 18: Three-orthogonal-plane and a 3D surface image of endometrial polyps. Same case as in figure 17

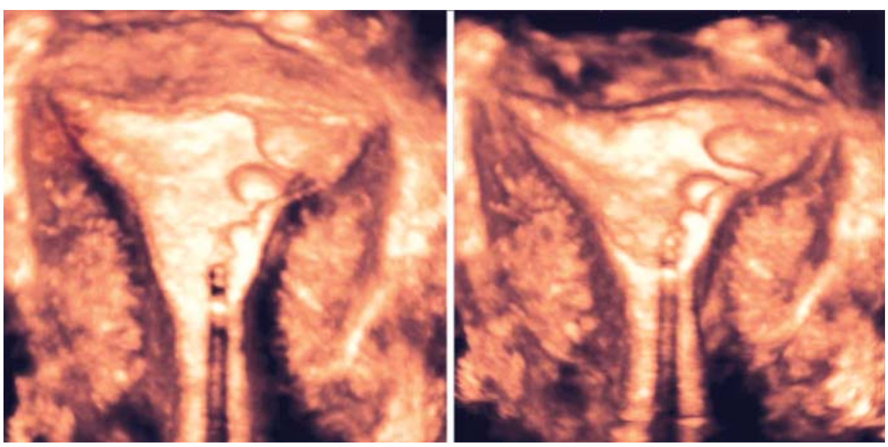
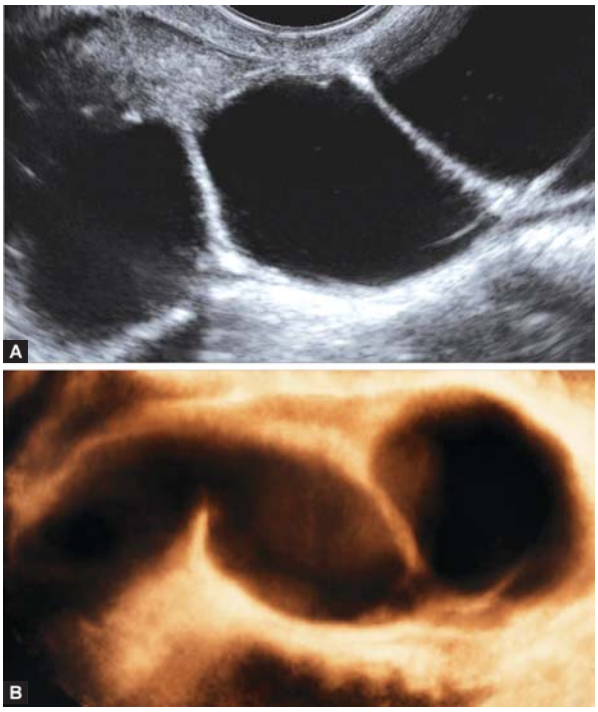


Fig. 19: Three-dimensional surface images of endometrial polyps from different angles. Same case as in figure 17

3D image by minimum intensity projection (Figs 20A and B). A 3D image by minimum intensity projection is sometimes mixed with a 3D image by X-ray mode for better imaging.

CONCLUSIONS

Three-dimensional ultrasound has been used in many hospitals and clinics in Japan. However, most scans are performed not for diagnoses but for showing 3D surface images of fetuses to



Figs 20A and B: (A) An image of hydrosalpinx obtained by 2D ultrasound. It looks like a multiple cysts of an ovary. (B) A 3D image by minimum intensity projection of the same hydrosalpinx seen from the transducer. Luminal structure can be easily seen

their parents, in other word, for 'entertainment'. One reason for this situation might be that most users think that 3D ultrasound is too complicated to use perfectly, and it is time consuming to use it for detailed diagnoses.

Three-dimensional ultrasound, however, is not so difficult to use when cases, objects and display modes are selected properly. Conventional 2D ultrasound is primary tool for diagnosis, and most experts on 3D ultrasound use 2D ultrasound first. Three-dimensional ultrasound might be used when and after some abnormalities are suspected with 2D ultrasound.

By starting from easy cases, objects and display modes and increasing the indications and display modes gradually in daily practice, 3D ultrasound would be a more powerful diagnostic tool for every user.

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