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SLIDES SECTION

Advances in Fetal Neuroimaging

Recent development in neuroimaging of fetal brain have been remarkable. Following Chinese proverb, **one picture tells more than a thousand words**, we arranged for our readers three excellent contributions from Professors Toshiyuki Hata, Sonal Panchal and Radu Vlădăreanu. We are sure you will enjoy looking at them. Any one of you who can contribute is welcome to send his/her best photos to the office of editor-in-chief, email asim.kurjak@public.carnet.hr or jadranka.cerovec@yahoo.com

SECTION 1: FETAL NEUROIMAGING

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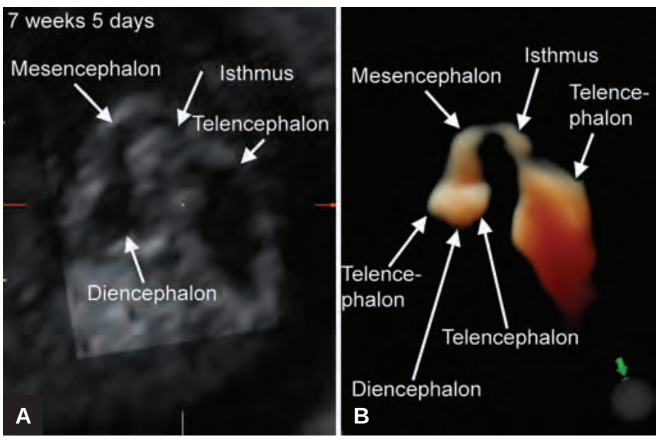
Conflict of interest: None

Embryonic Brain Vesicle



Figs 1A and B: Two-dimensional (2D) sonographic sagittal image (A) and HDlive image (B) of developing brain vesicles using the inversion mode in a normal embryo at 7 weeks and 5 days of gestation. As early as in the 7th week of gestation, 2D sonographic image shows that the brain vesicles are anechoic, irregular structures (A). The HDlive inversion mode can depict the tiny lobulated telencephalon, diencephalon, and mesencephalon, but the demarcation is not well defined, and the metencephalon appears as an elongated structure (B) (Courtesy: Reprinted with permission from Cajusay-Velasco and Hata[1])

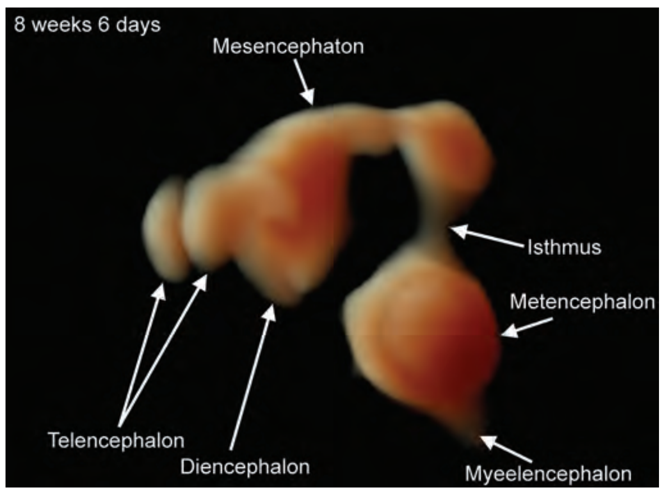


Fig. 2: HDlive image of developing brain vesicles using the inversion mode in a normal embryo at 8 weeks and 6 days of gestation. In the 8th week of gestation, brain vesicles are more discernible using HDlive. The telencephalon appears as a pair of rounded structures, the diencephalon and mesencephalon are still not well-differentiated, the isthmus is thin, metencephalon becomes rounded, and the myelencephalon appears as a small elongated structure (Courtesy: Reprinted with permission from Cajusay-Velasco and Hata[1])

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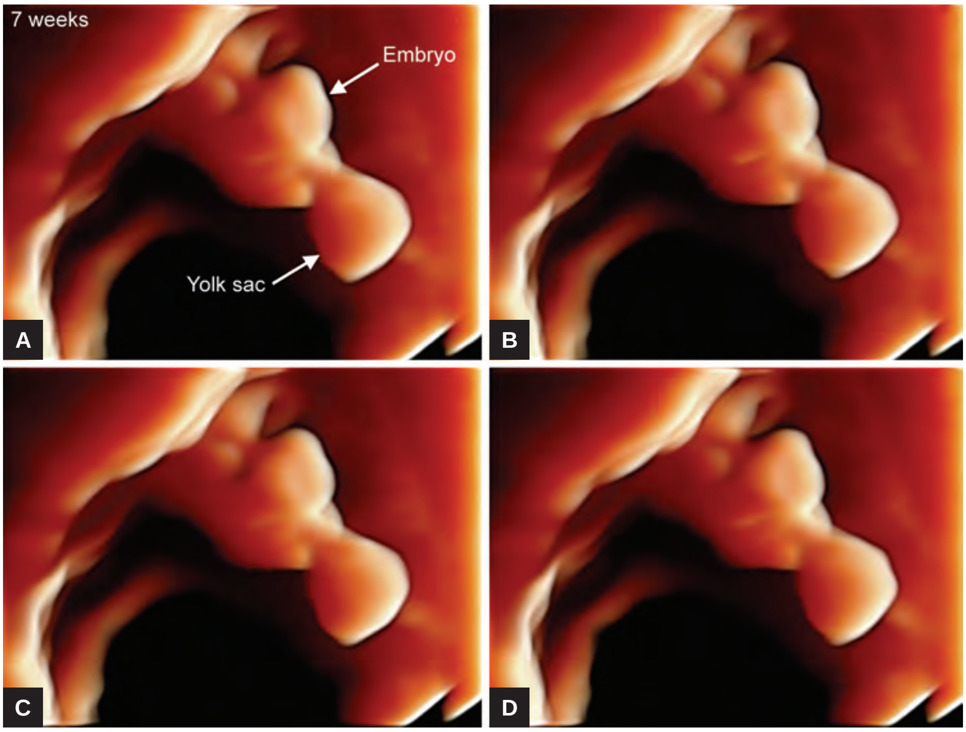
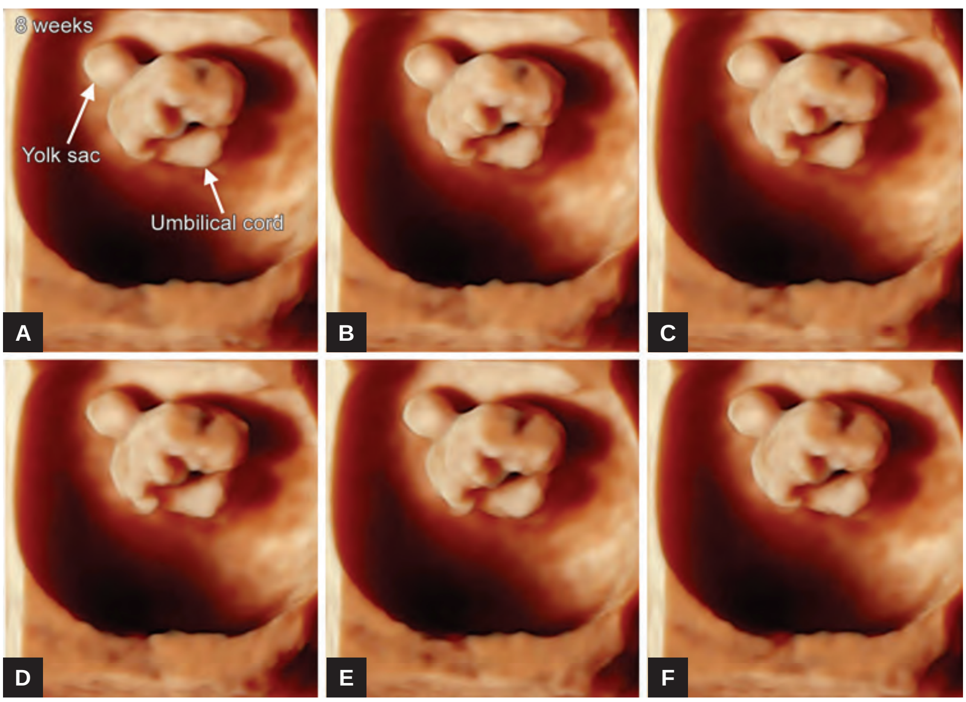
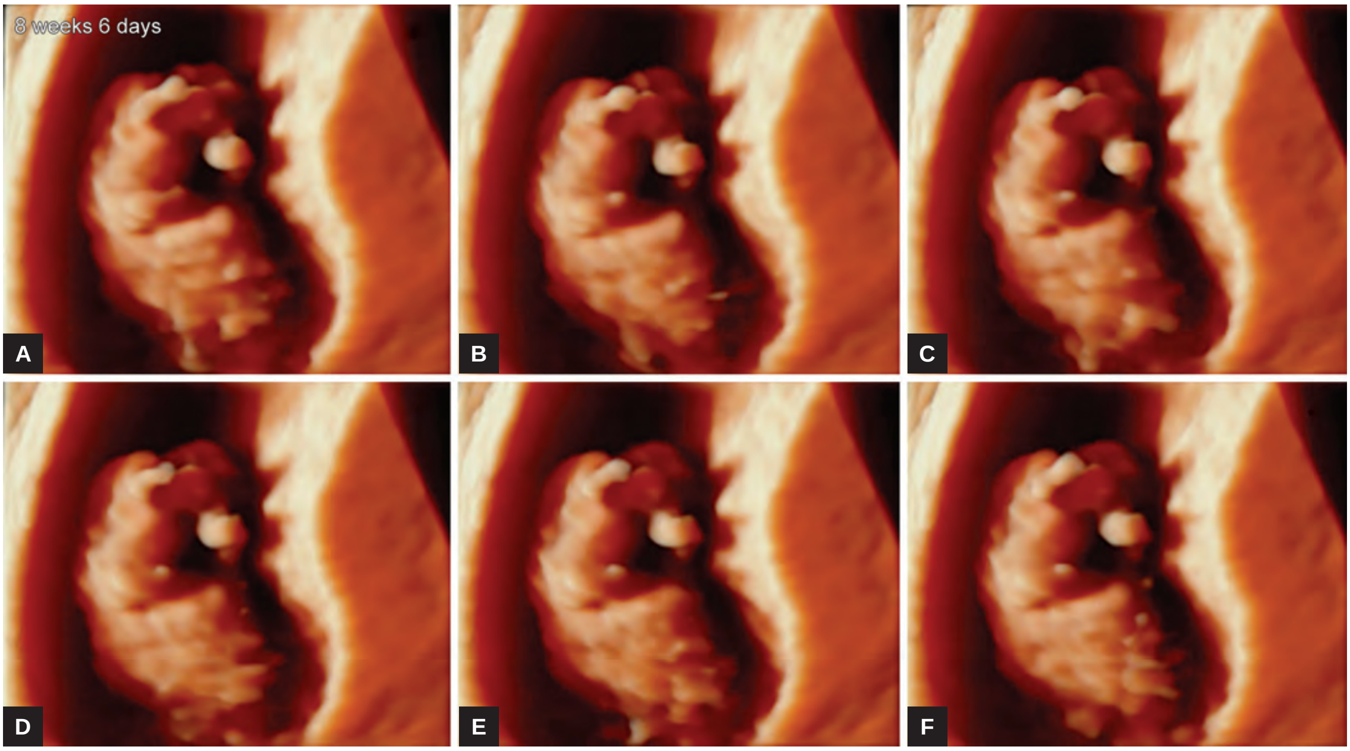
Fetal Movement in the First Trimester of Pregnancy



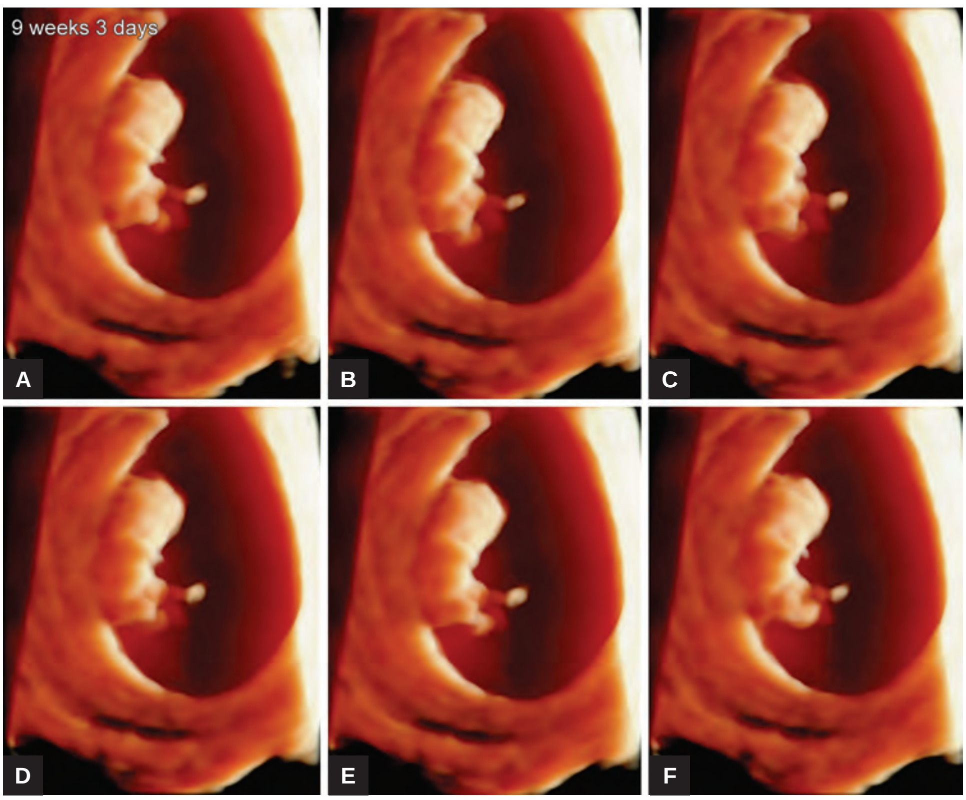
Figs 3A to D: Consecutive HDlive observations of a 7-week embryo (A to D). Only subtle limb movement can be noted (Courtesy: Reprinted with permission from Hata et al[2])



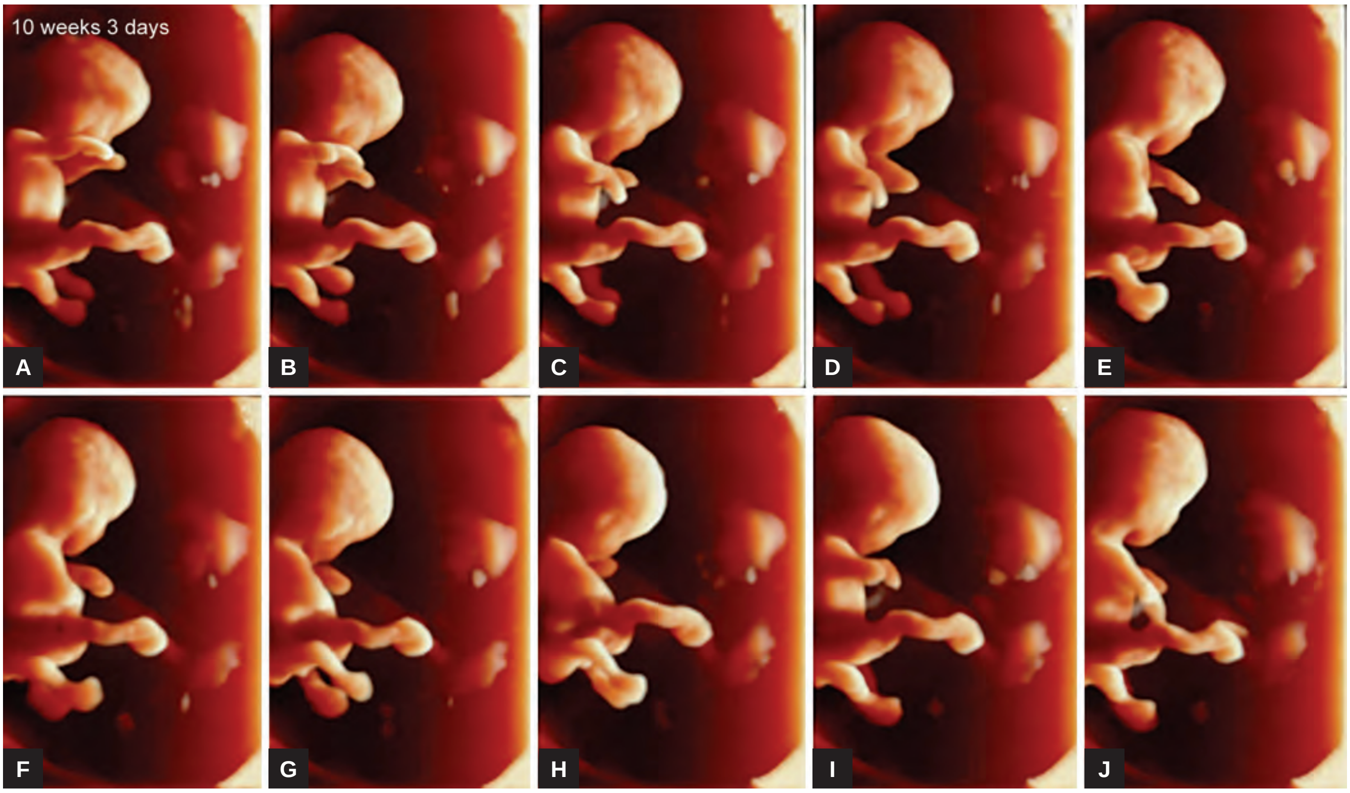
Figs 4A to F: Consecutive HDlive observations of an 8-week embryo (A to F). Embryonic limb movements can be clearly recognized at 8 weeks (Courtesy: Reprinted with permission from Hata et al[2])



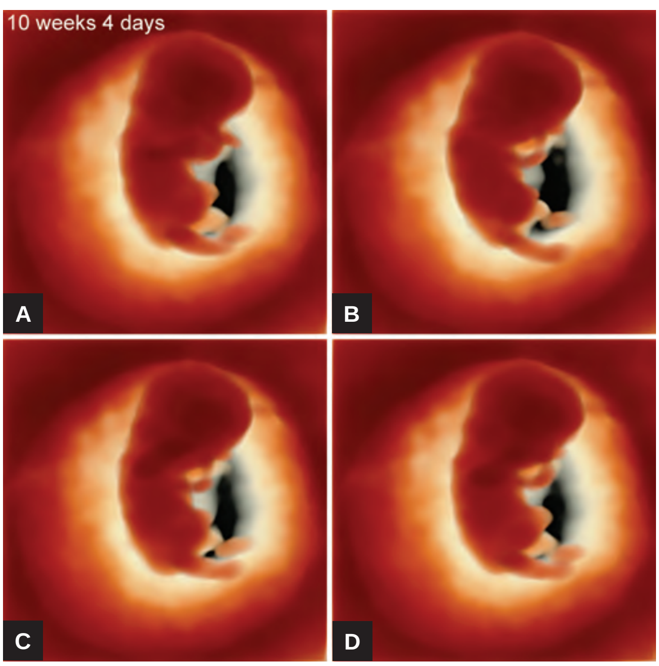
Figs 5A to F: Consecutive HDlive observations of an 8-week embryo (A to F). Embryonic limb movements can be clearly recognized at 8 weeks and 6 days (Courtesy: Reprinted with permission from Hata et al[2])



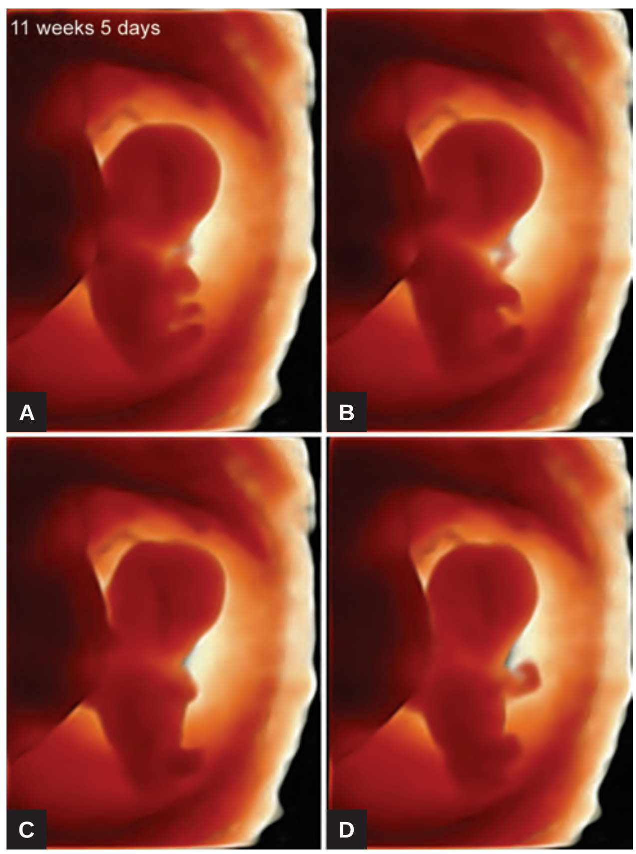
Figs 6A to F: Consecutive HDlive observations of a 9-week embryo (A to F). Simultaneous occurrence of hand, foot, and trunk movements can be noted at 9 weeks and 3 days (Courtesy: Reprinted with permission from Hata et al[2])



Figs 7A to J: Consecutive HDlive observations of a 10-week fetus (A to J). Smooth and fluid head and trunk movements involving complicated hand and leg movements can be clearly identified at 10 weeks and 3 days (Courtesy: Reprinted with permission from Hata et al[2])

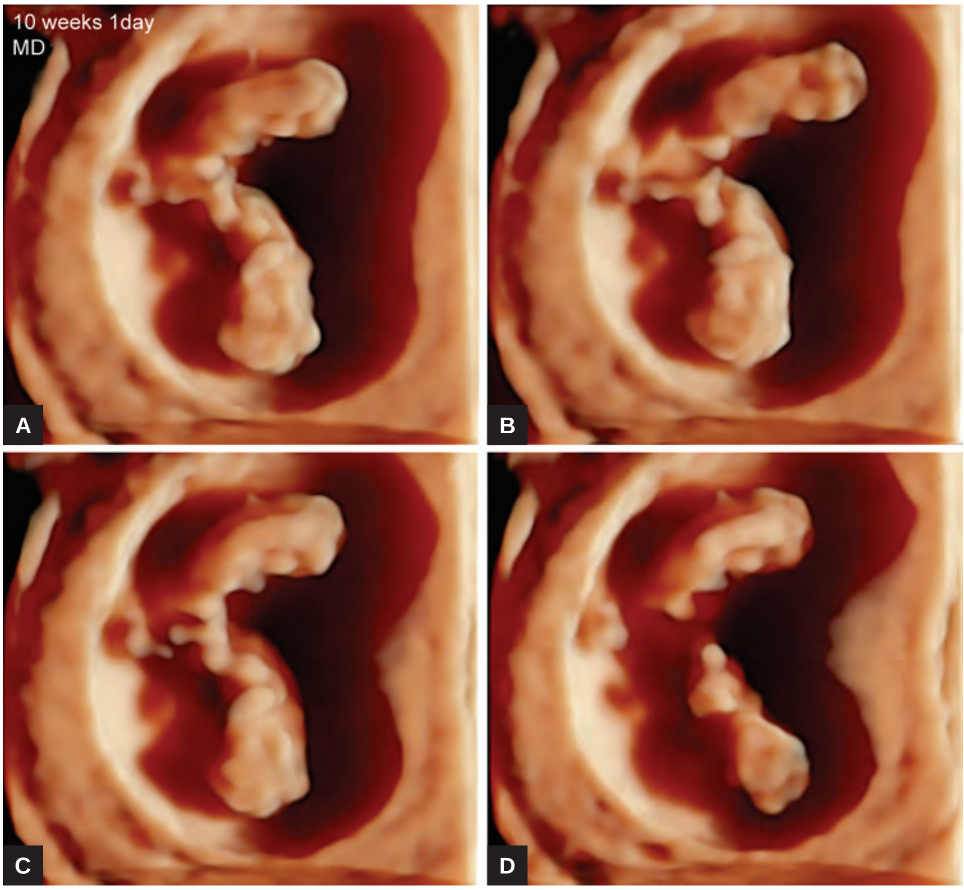


Figs 8A to D: Consecutive HDlive observations of a 10-week fetus (A to D). Simultaneous occurrence of hand, foot, and trunk movements can be noted at 10 weeks and 4 days (Courtesy: Reprinted with permission from Hata et al[2])

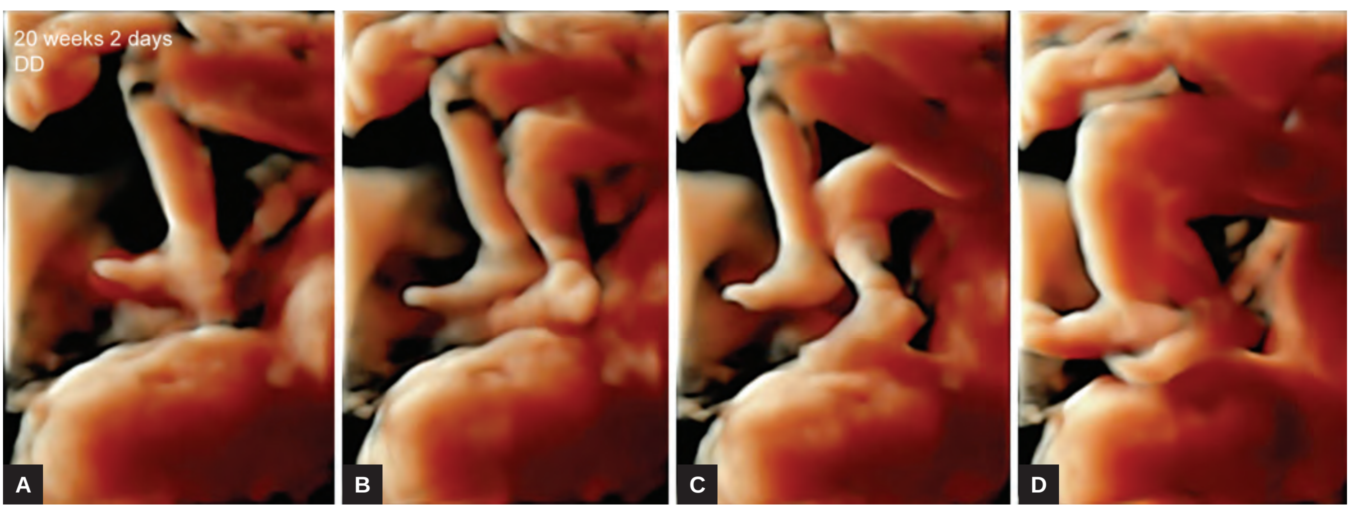


Figs 9A to D: Consecutive HDlive observations of an 11-week fetus (A to D). Smooth and fluid head and trunk movements involving complicated hand and leg movements can be clearly identified at 11 weeks and 5 days (Courtesy: Reprinted with permission from Hata et al[2])

Intertwin Contact

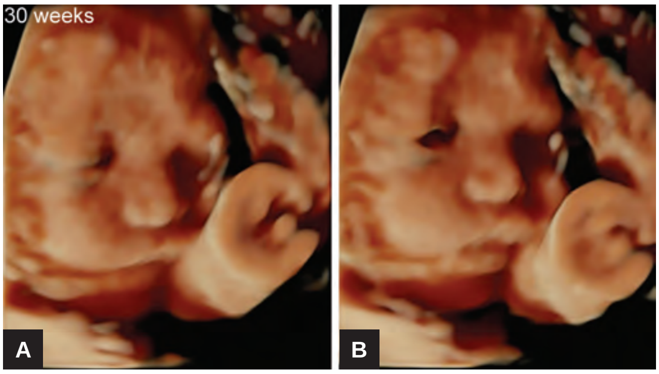


Figs 10A to D: Consecutive HDlive observations of monochorionic diamniotic (MD) twin fetuses at 10 weeks and 1 day of gestation (A to D). Leg-to-leg contact is clearly recognized (A), and there is a clear reaction of the cotwin (second) fetus (upper twin), who shows jumping movement (B). On the contrary, the second twin kicks the first twin's (lower twin) legs (C), and there is a clear reaction of the first twin fetus, who shows jumping movement (D) (Courtesy: Reprinted with permission from Hata et al[3])

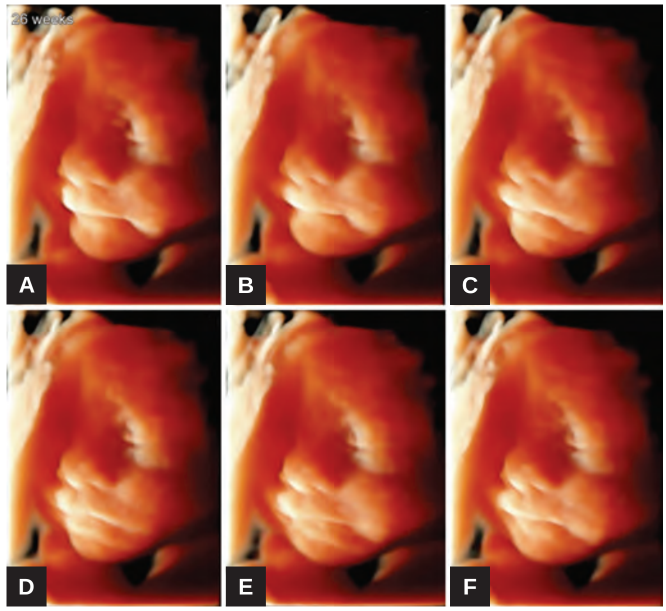


Figs 11A to D: Consecutive HDlive observations of dichorionic diamniotic (DD) twin fetuses at 20 weeks and 2 days of gestation (A to D). Leg-to-head contact (kick in the face) is clearly evident (Courtesy: Reprinted with permission from Hata et al[3])

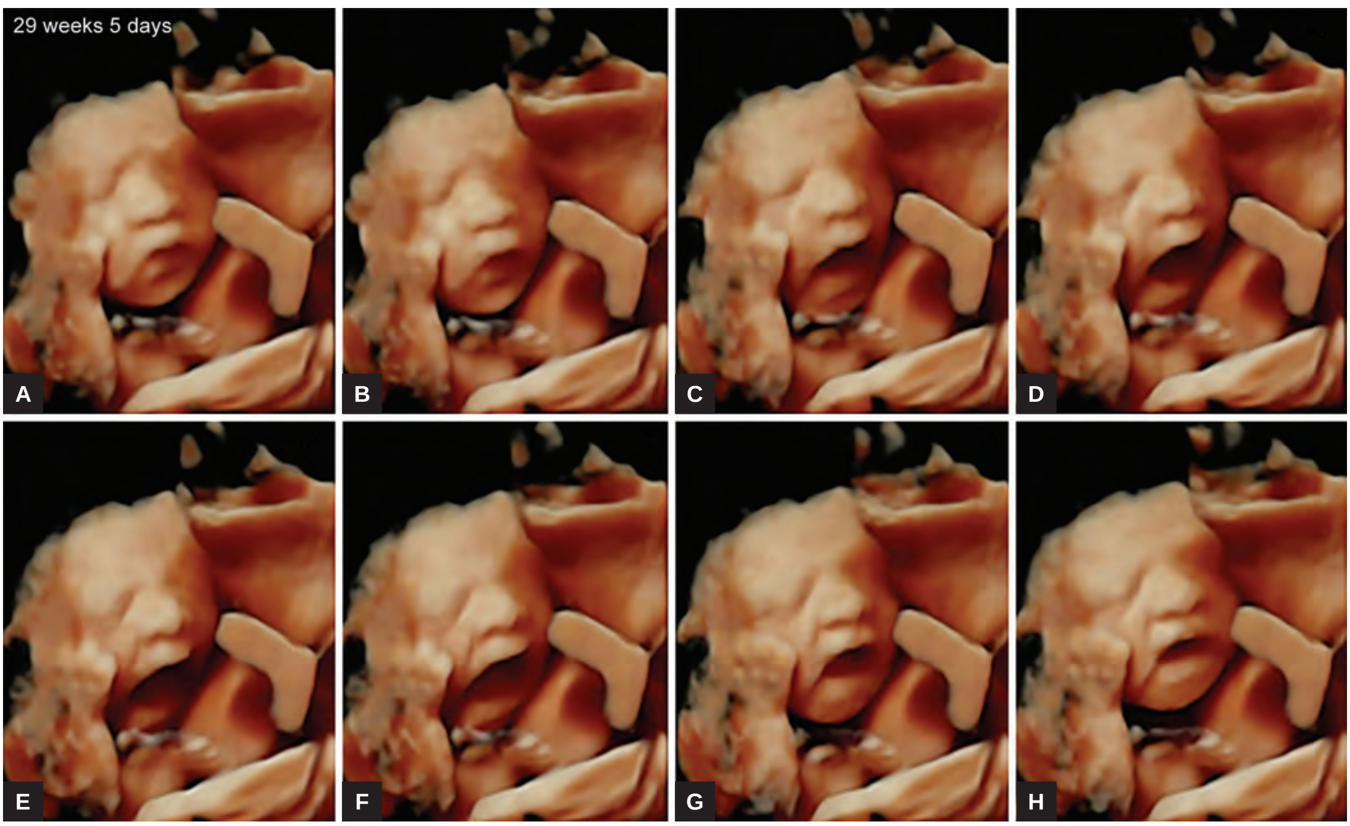
Fetal Facial Expression



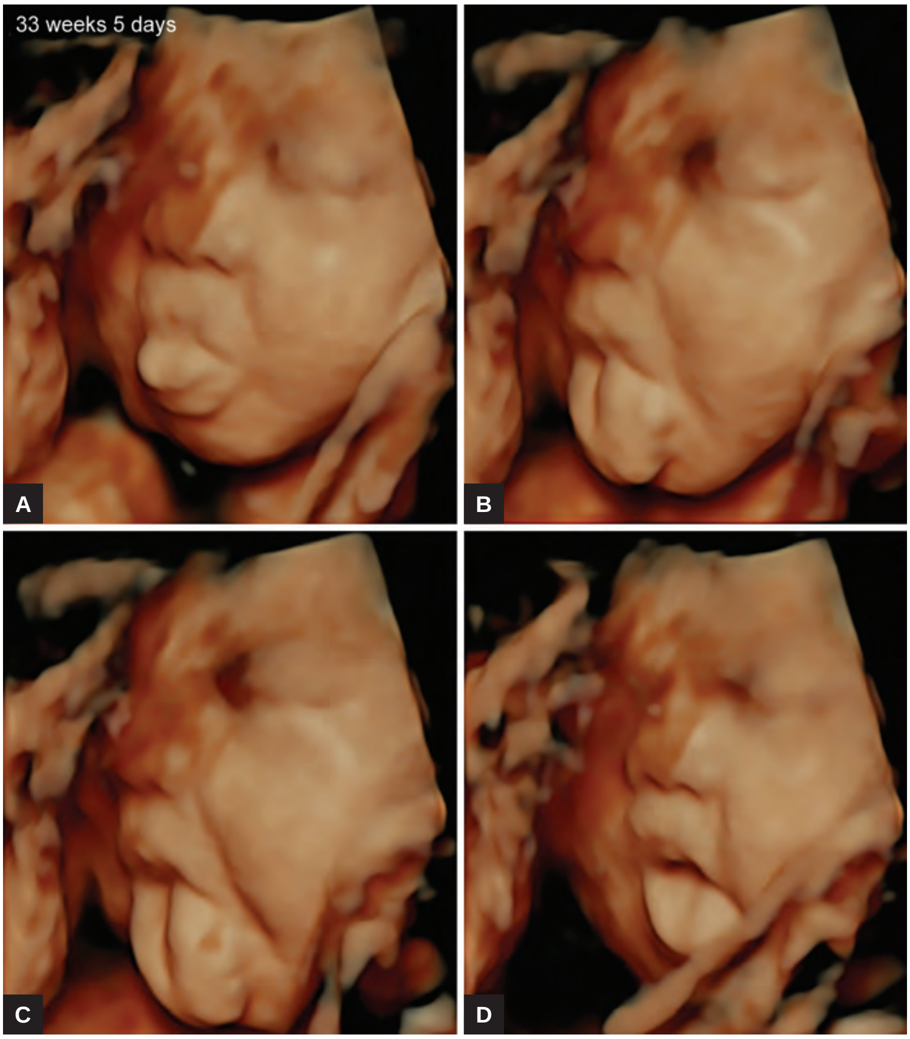
Figs 12A and B: Fetal blinking at 30 weeks of gestation. (A) Closed eyelid; (B) right open eyelid (Courtesy: Reprinted with permission from Hata et al[2])



Figs 13A to F: Consecutive observations of fetal mouthing at 26 weeks of gestation (A to F) (Courtesy: Reprinted with permission from Hata et al[2])



Figs 14A to H: Consecutive observations of fetal yawning at 29 weeks and 5 days of gestation (A to H) (Courtesy: Reprinted with permission from Hata et al[2])



Figs 15A to D: In the course of yawn-like opening of the mouth (A to D), tongue thrust can be clearly identified at 33 weeks and 5 days of gestation (Courtesy: Reprinted with permission from Hata et al[2])

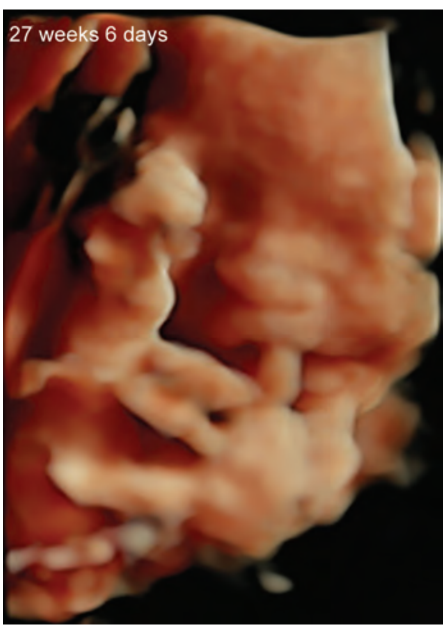
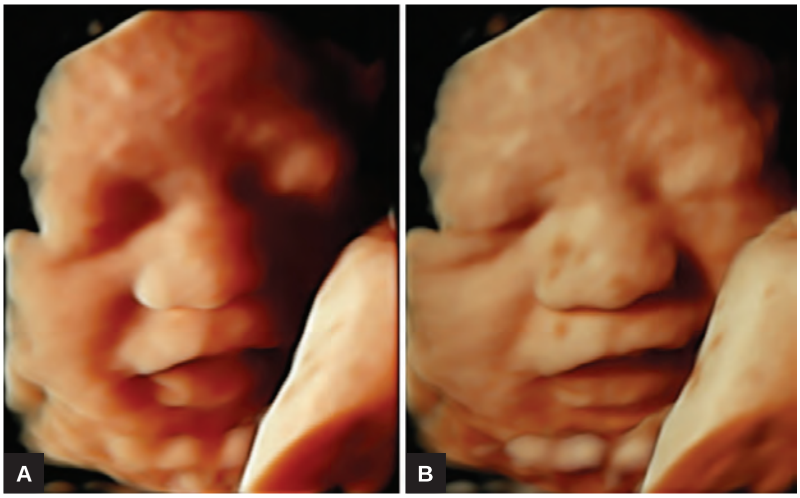
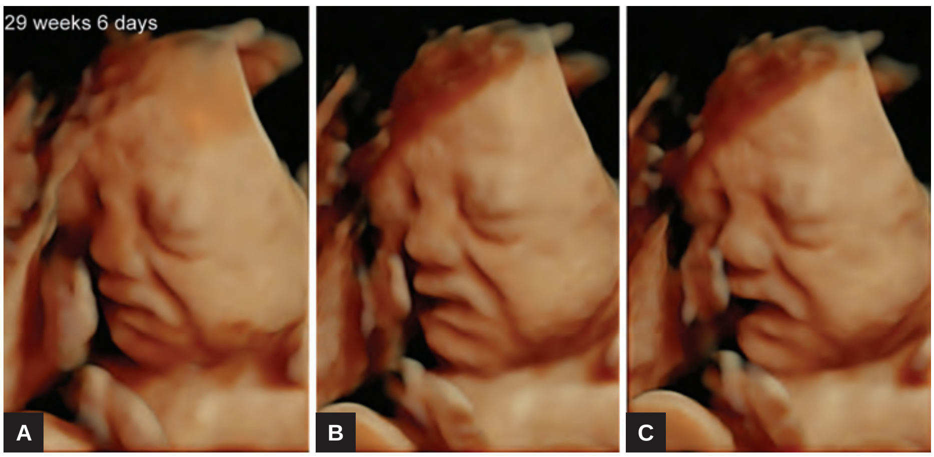


Fig. 16: Fetal sucking at 27 weeks and 6 days of gestation. The fetus sucks his/her fingers (Courtesy: Reprinted with permission from Hata et al[2])

Fig. 17: HDlive image of fetal smiling at 29 weeks and 1 day of gestation (Courtesy: Reprinted with permission from AboEllail and Hata[4])



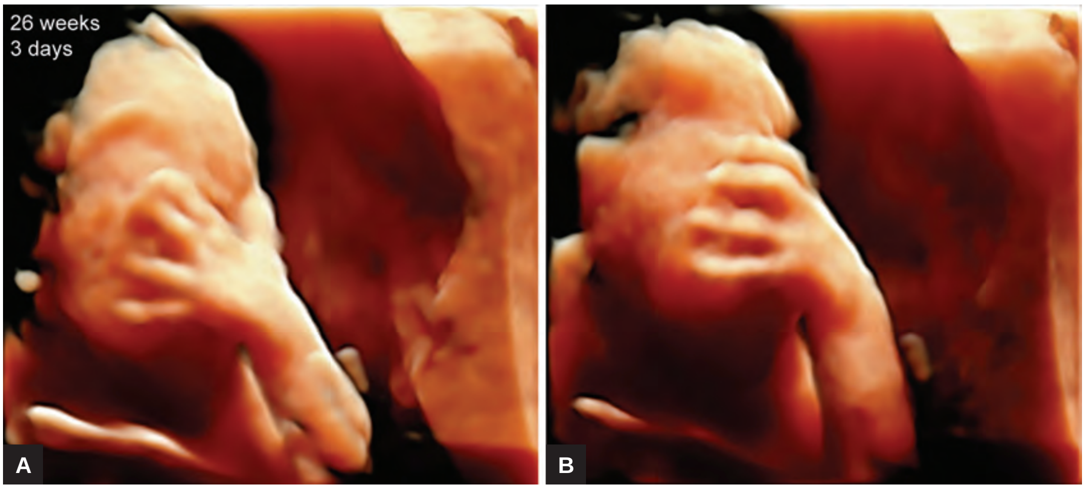
Figs 18A and B: Fetal smiling at 38 weeks and 4 days of gestation (Courtesy: Reprinted with permission from Hata et al[2])



Figs 19A to C: Consecutive observations of fetal crying-like movement at 26 weeks of gestation (A to C) (Courtesy: Reprinted with permission from Hata et al[2])

Fetal Emotion-like Behavior

Fig. 20: Fetal emotion-like behavior using hand-to-face movement, such as the "joy" pose at 18 weeks and 6 days of gestation (Courtesy: Reprinted with permission from Hata et al[2])



Figs 21A and B: Consecutive HDlive observations of fetal emotion-like behavior using hand-to-face movement, such as the "embarrassed" pose at 26 weeks and 3 days of gestation (A and B) (Courtesy: Reprinted with permission from Hata et al[2])

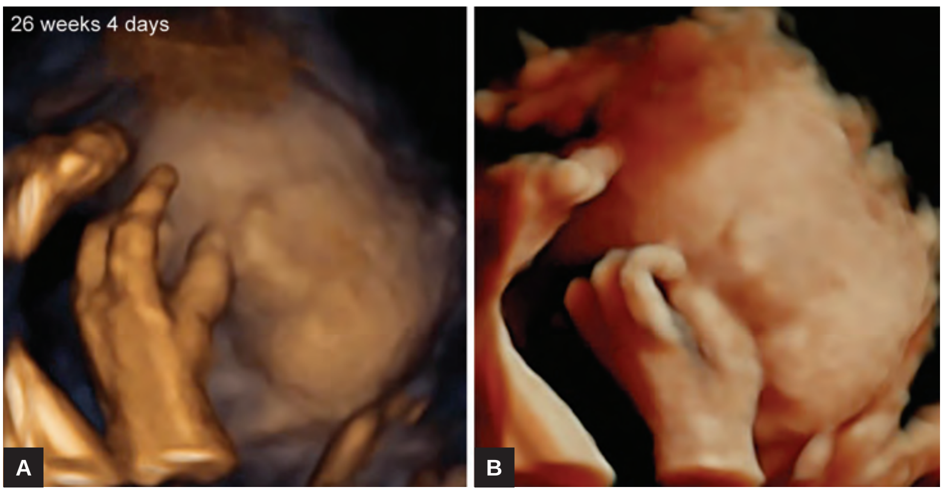


Fig. 22: Sorrow-like movement at 26 weeks and 4 days of gestation demonstrated by four-dimensional ultrasound (A) and HDlive (B). Does the fetus show emotions? (Courtesy: Reprinted with permission from AboEllail and Hata[4])

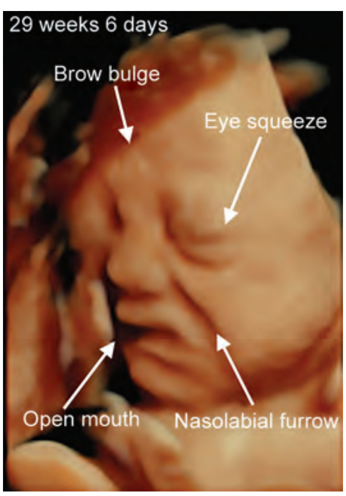
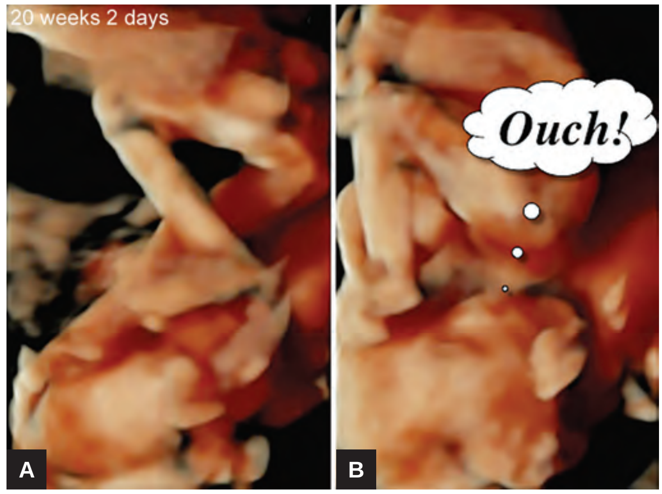


Fig. 23: HDlive image of fetal pain at 29 weeks and 6 days of gestation. Facial expressions as important indicators of fetal pain may include several features, such as brow bulge, eye squeeze, nasolabial furrow, and open mouth (Courtesy: Reprinted with permission from Hata et al[5])

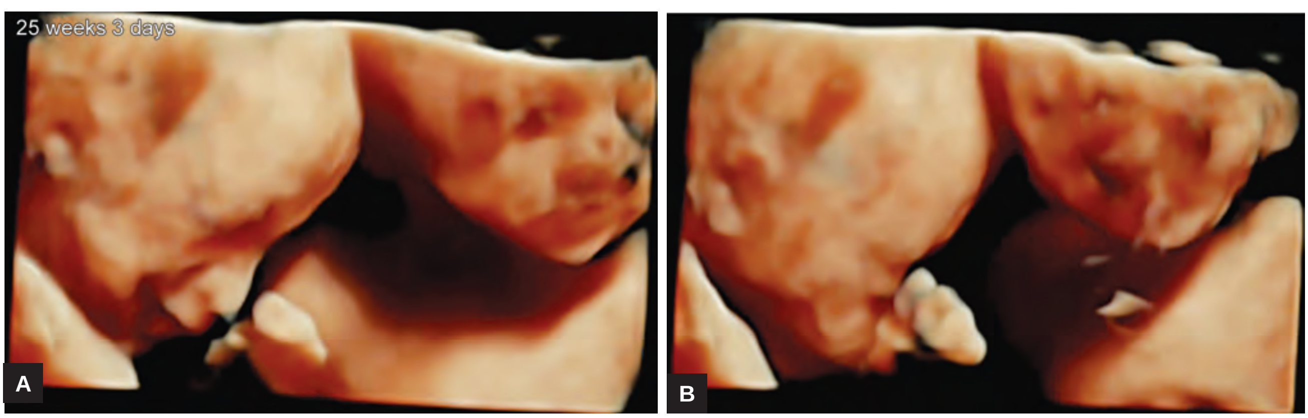
Fig. 24: HDlive image of a healthy fetus at 30 weeks and 1 day of gestation. This fetus is showing a peace sign using his/her fingers (Courtesy: Reprinted with permission from Hata et al[5])

Fig. 25: HDlive image of a healthy fetus at 28 weeks of gestation. This fetus is picking his/her nose (Courtesy: Reprinted with permission from Hata et al[5])



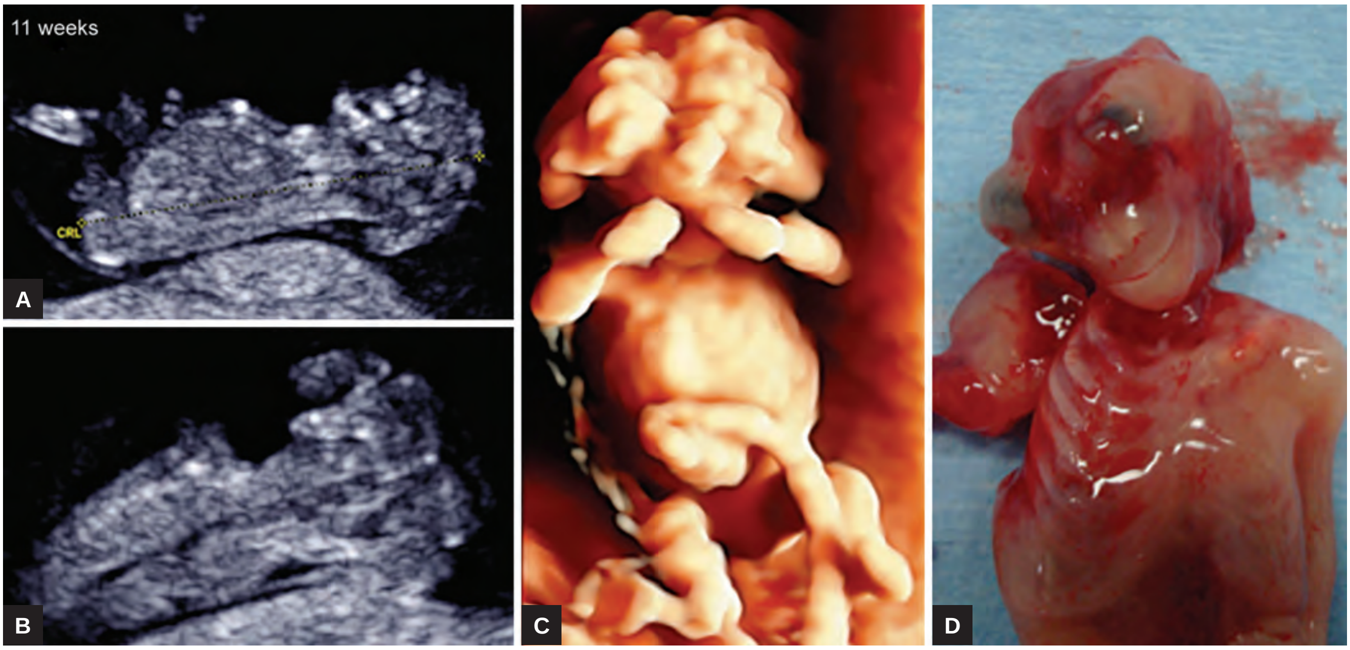
Figs 26A and B: HDlive presents the facial expression of a fetus after being kicked in the face by its cotwin at 20 weeks and 2 days of gestation (A and B). How does this fetus feel? It seems to be painful (Courtesy: Reprinted with permission from Hata et al[6])

Fig. 27: HDlive image of monochorionic diamniotic twins at 17 weeks and 6 days of gestation. One twin fetus looks like he/she is whispering to the cotwin fetus. Is there communication between them? Is this a fetal conversation between twins? (Courtesy: Reprinted with permission from Hata et al[6])



Figs 28A and B: HDlive shows fetal twin behaviors at 25 weeks and 3 days of gestation (A and B). One twin fetus (left) seems to be sad, and the cotwin fetus (right) turns his/her face to the left twin (Courtesy: Reprinted with permission from Hata et al[6])

Fetal Anomaly



Figs 29A to D: HDlive image of a fetus with acrania/exencephaly at 11 weeks of gestation. (A and B) Two-dimensional sonographic images; (C) HDlive image; (D) photograph of the abortus (Courtesy: Reprinted with permission from Cajusay-Velasco and Hata[1])

Fig. 30: HDlive image of amniotic band syndrome at 13 weeks and 3 days of gestation. Multiple amniotic bands, a deformed brain, absence of a right finger, and amputation of a right toe are evident (Courtesy: Reprinted with permission from Hata et al[7])

Fig. 31: HDlive images at 15 weeks and 4 days of gestation. A string-like amniotic band, fetal acrania, and cleft lip can be identified. The amniotic band is attached to the fetal brain (Courtesy: Reprinted with permission from Hata et al[7])

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SECTION 2: FETAL NEUROIMAGING

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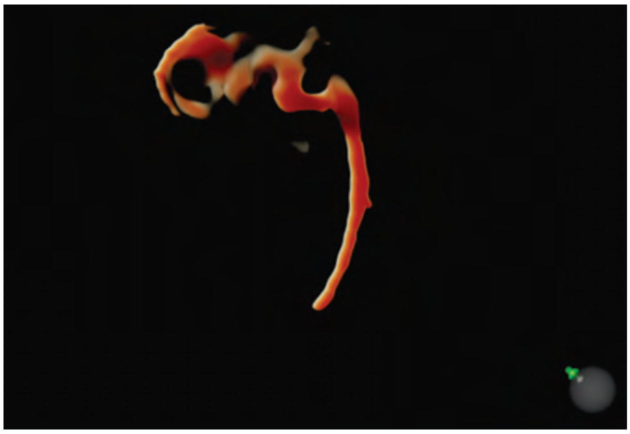
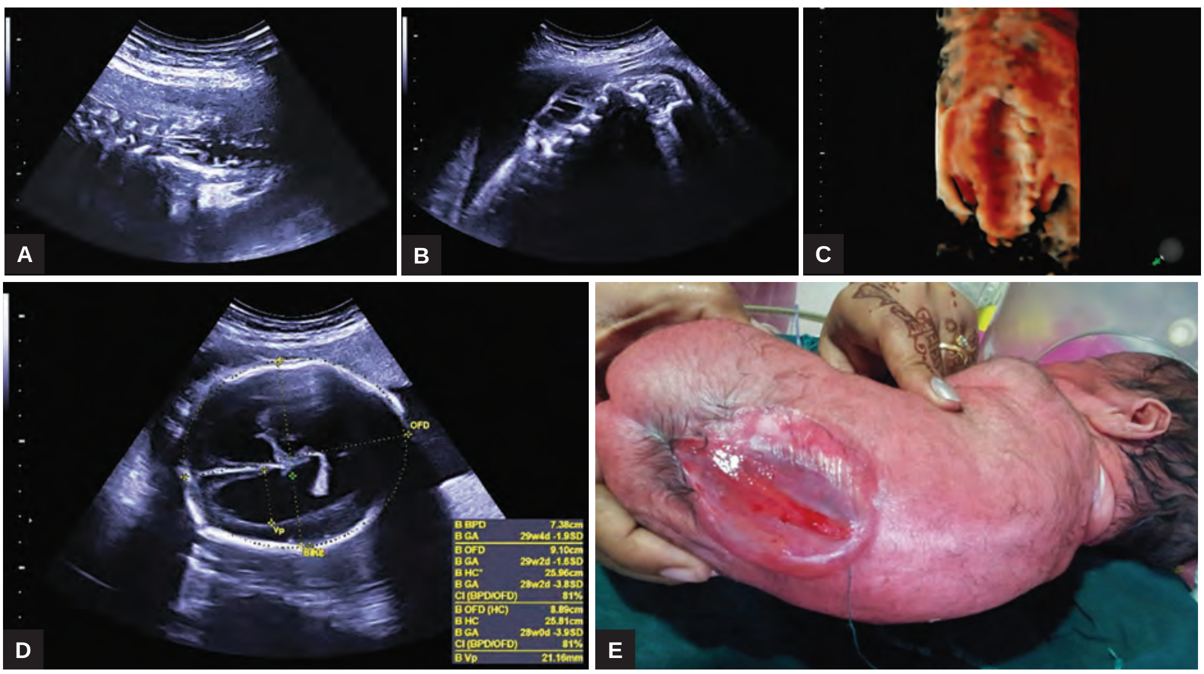


Fig. 1: Three-dimensional ultrasound image of the neural canal of a fetus of 9 weeks, rendered in inversion and HDlive mode. The image demonstrates the prosencephalon, mesencephalon, and rhombencephalon with (1) mesencephalic flexure at the midbrain level; (2) cervical flexure at the junction between rhombencephalon and spinal cord; (3) pontine flexure in the hindbrain



Figs 2A to E: (A) Coronal view of the lower fetal spine seen on B-mode ultrasound. There is asymmetrical absence of ossification centers of the transverse process of lumbosacral vertebral bodies. There is disruption of the spinal cord showing a central anechoic cliff. Suggestive of major spinal canal defect; (B) sagittal section of the same fetal spine shows nonparallelism of the ossification centers of the vertebral bodies. These are malaligned and are deviating posteriorly, with absence of overlying skin over the most posterior point. Above and below this point a skin raphe is seen. Findings indicate that this major spinal canal defect is open also; (C) three-dimensional ultrasound image of the same fetal spine typically demonstrates the above described abnormality; (D) a B-mode image of the head of the same fetus shows grossly dilated ventricles with dangling choroid plexuses and flattening of frontal bones (lemon skull); and (E) postbirth image of the same fetus as shown in the previous images

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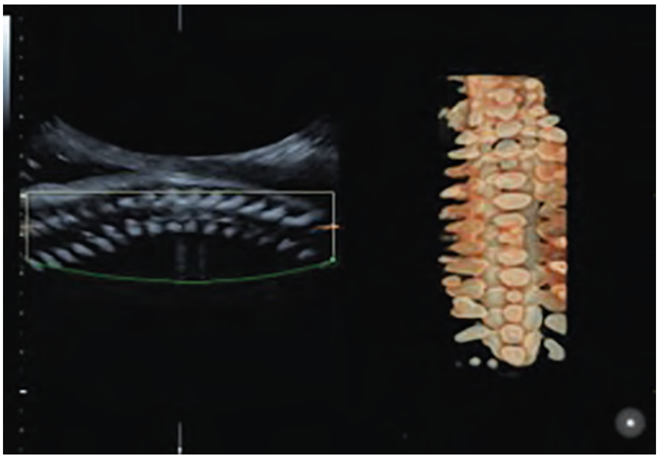
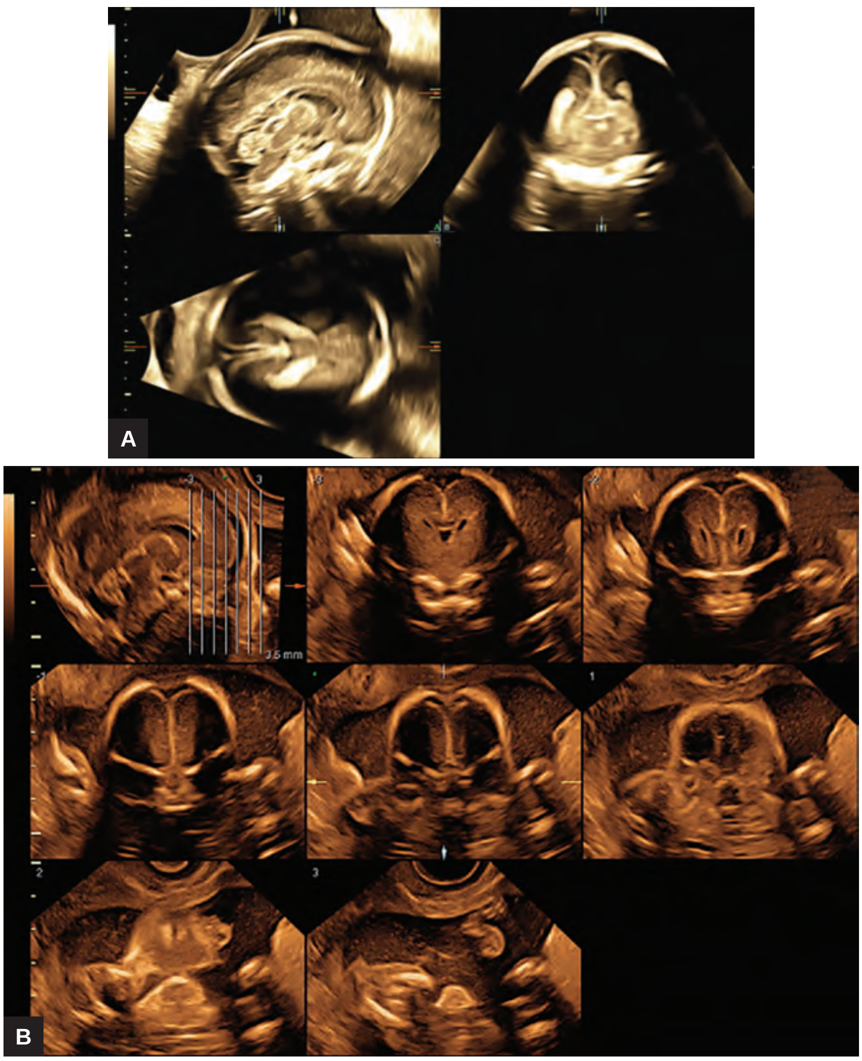


Fig. 3: Three-dimensional ultrasound image of the fetal spine, rendered in coronal plane on HDlive render mode of a 29-week-old fetus, showing the detailed anatomy of the bony spine from anterior aspects, with costovertebral joints

Fig. 4: Three-dimensional ultrasound image of the 14-week fetal face profile rendered on surface mode shows abnormal facial profile with deep flat nasal bridge, low-set ears, and a comparatively large head. Anterior fontanelle and lambdoid sutures are very clearly seen. This patient had previous two fetuses with hydrocephalus. In view of this, it may be considered the earliest manifestation of the same



Figs 5A and B: (A) Maturity. Image a demonstrates a para-midsagittal section of the fetal head, clearly demonstrating the corpus callosum, and the entire paramedian anatomy of the brain, including the cerebellum. The image clearly demonstrates the sulci-gyri pattern of the cerebellum. Image b shows the coronal plane of the same and image c is the axial section; (B) tomographic ultrasound image of the same fetal head showing serial coronal sections from the tip of the nose to the splenium of the corpus callosum. The different sections show tip of the nose, bony orbits, maxillary plate and frontal processes of nasal bones, anterior horns of lateral ventricles, and corpus callosum in coronal section

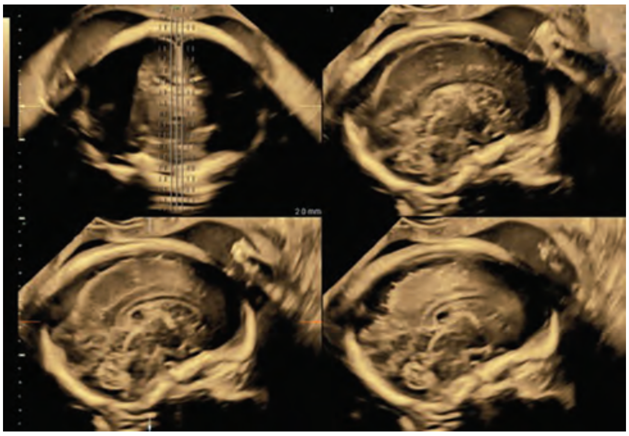
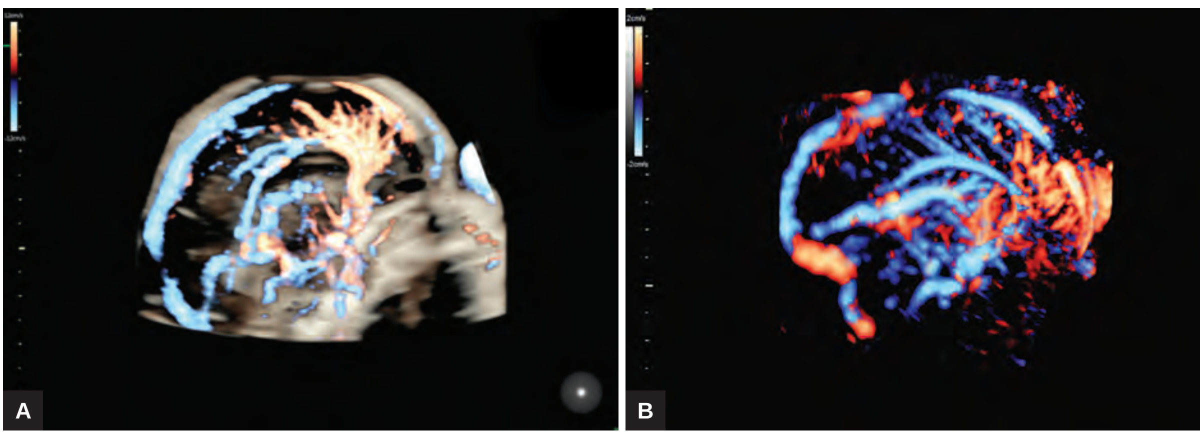
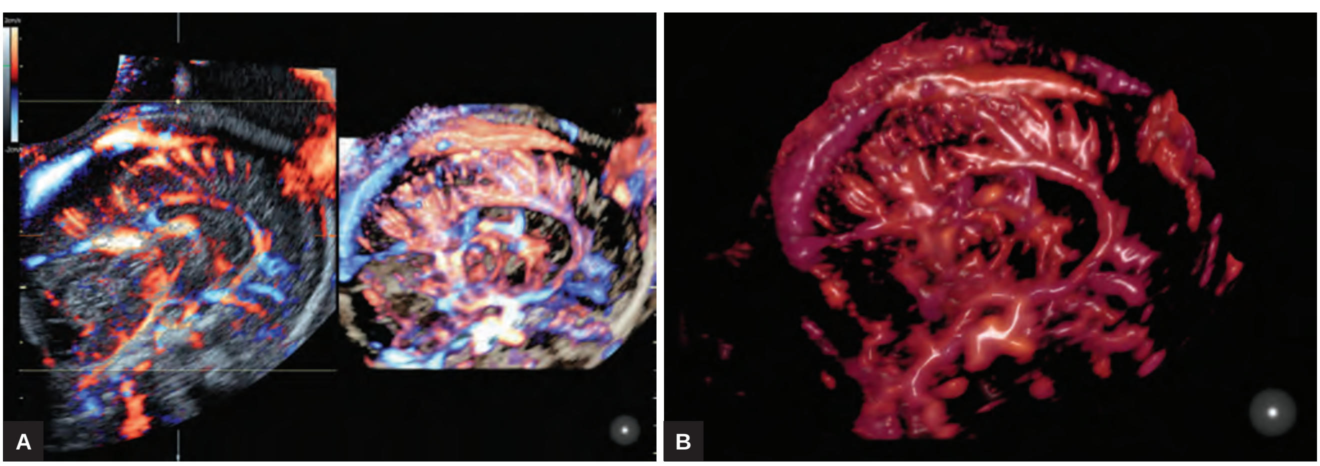


Fig. 6: Tomographic ultrasound image of the fetal plane showing midsagittal and parasagittal sections of a 24-week-old fetal brain. The first image in coronal section is a reference images and the image below that is a midsagittal image with the other two on the right side showing parasagittal sections. The midsagittal sections show the corpus callosum and all the midline brain structures, whereas the parasagittal images prove to be excellent sections for demonstration of the cerebral cortex and subarachnoid space

Fig. 7: Midsagittal plane-rendered image of a 31-week-old fetal brain showing the detailed anatomy of the midline structures of the brain, including the detailed sulci-gyri pattern of the cortex



Figs 8A and B: Midsagittal section of the fetal brain acquired three-dimensionally with high-definition power Doppler flow. (A) A glass body rendered image; and (B) the angiography mode rendered image of 20-week-old fetal brain. The images show the entire detailed cerebral vascular anatomy: internal carotid artery; anterior, middle, and posterior cerebral arteries; pericallosal artery, all with their major branches; superior and inferior sagittal sinuses; and vein of Galen



Figs 9A and B: Cerebral vascular anatomy of the same fetus at 30 weeks of gestation rendered on glass body rendered mode (A) and monocolor HDlive angiomode; (B) an important point to be brought to notice is the visualization of the full length of the pericallosal artery, which indicates a normal complete corpus callosum

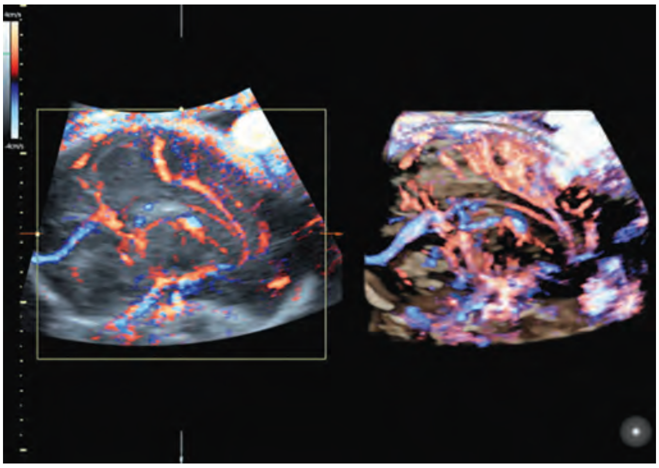


Fig. 10: Three-dimensional high-definition flow-acquired volume of the fetal head rendered on glass body mode. This plane though appears same as Figure 9A, rendered image shows evident upward deviation of the pericallosal artery, suggesting a partial agenesis of corpus callosum. But close look at the sectional plane on the left shows thalamus indicating a parasagittal plane indicating that the vessel progressing toward the cortex might not be the main pericallosal artery, but its branch. Close observation shows continuation of the normal pericallosal artery, though it appears thinner than the main vessel. Before confirming the diagnosis of partial agenesis of corpus callosum, a true midsagittal section must be confirmed

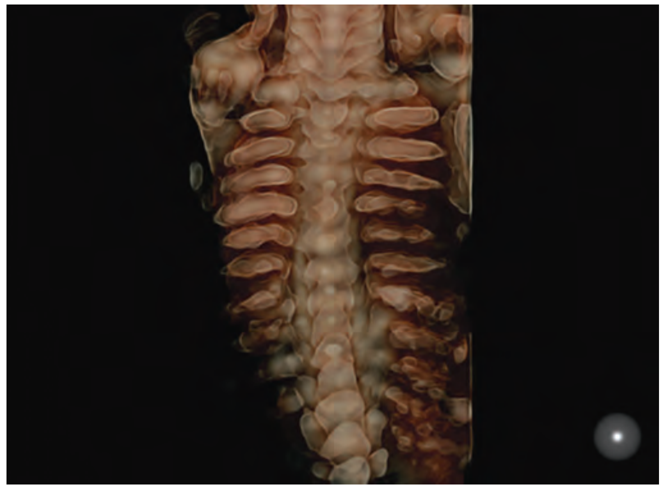
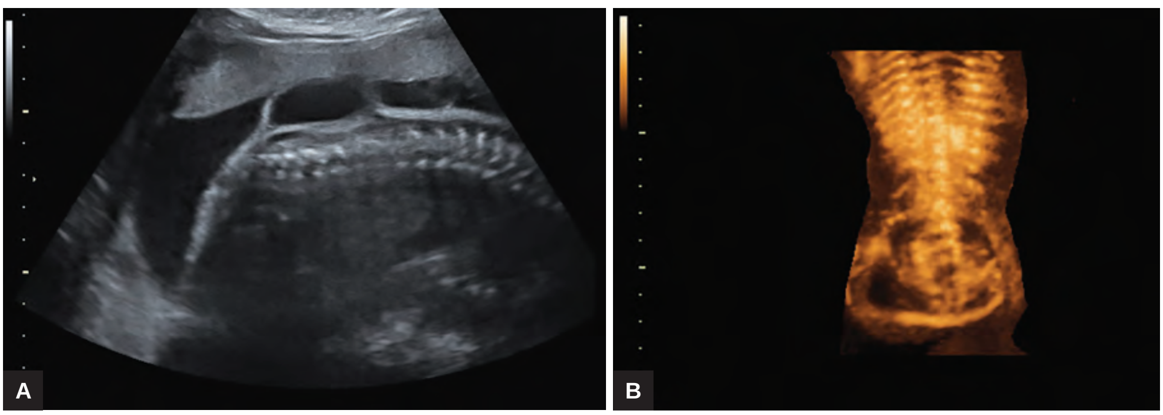
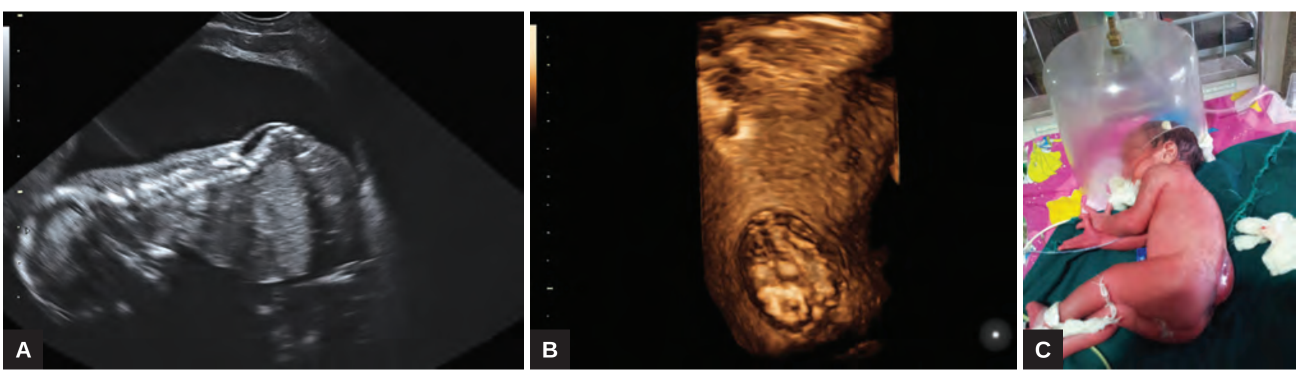


Fig. 11: Three-dimensional ultrasound acquired, HDlive silhouette mode rendered image of the spine of 27-week-old fetus, showing the detailed anatomy of the vertebral column as well as the posterior end of the ribs



Figs 12A and B: (A) B-mode ultrasound image of sagittal section of the spine shows unilateral absence of the 3 to 4 ossification centers of transverse processes, with a skin bleb, suggestive of spinal canal defect with elevated but intact skin; (B) the three-dimensional rendered image of the same in coronal plane shows the asymmetrical absence of ossification centers in the lumbar spine, but also shows similar defect in the lower sacral spine. A large rounded balloon-like lesion is seen overlying the lumbosacral spine correlating with the skin bleb seen on the B-mode image



Figs 13A to C: (A) B-mode ultrasound image of a fetus of 16 weeks gestational age, showing the spine in a plane that is neither true coronal or true sagittal, but the spine still shows unilateral absence of ossification centers of the thoracolumbosacral spine. There is posterior deviation of the ossification centers of the lumbosacral spine, all suggestive of major spinal canal defects. Not being a true orthogonal plane, the skin integrity was difficult to establish. The head though showed no abnormalities; (B) three-dimensional rendered coronal image of the same fetus clearly shows the spinal canal abnormality with surrounding skin involvement seen; and (C) the same fetus after birth shows evident meningocele

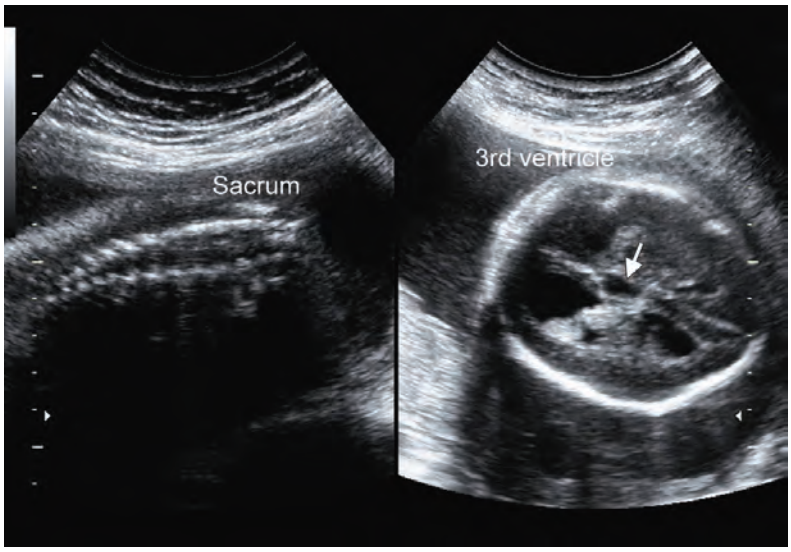


Fig. 14: B-mode ultrasound image of the spine of a fetus aged 21 weeks shows marked widening of the spinal canal, though the bilateral symmetry of the ossification centers of the transverse processes of the vertebral bodies is maintained. This indicates a minor, may be an occult spinal canal defect. But the axial section of the cranium of the same fetus shows flattening of the frontal bones and dilated lateral and 3rd ventricles as a consequence of the same. This case is an evidence to state that there is no correlation between the extent of the spinal canal lesion and its effects on the ventricles due to obstruction of the aqueduct and backpressure changes

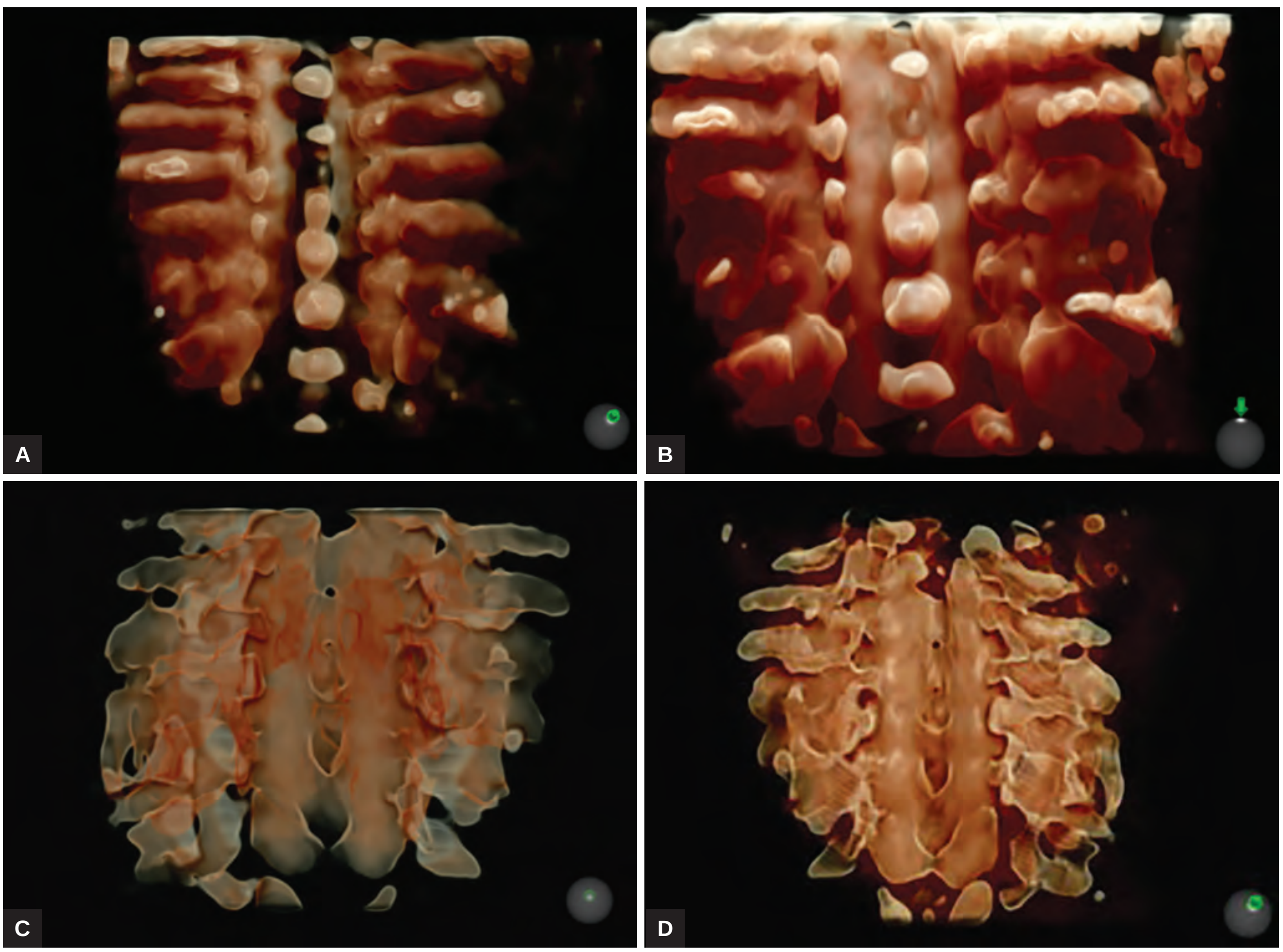


Fig. 15A to D: (A to D) The anatomy of the fetal spine at 34 weeks of gestation rendered on HDlive mode with silhouette. The planes depict the anatomy from posterior to anterior, demonstrating the osseous as well as the soft tissue anatomy of the vertebral column

SECTION 3: NEUROSONOGRAPHY

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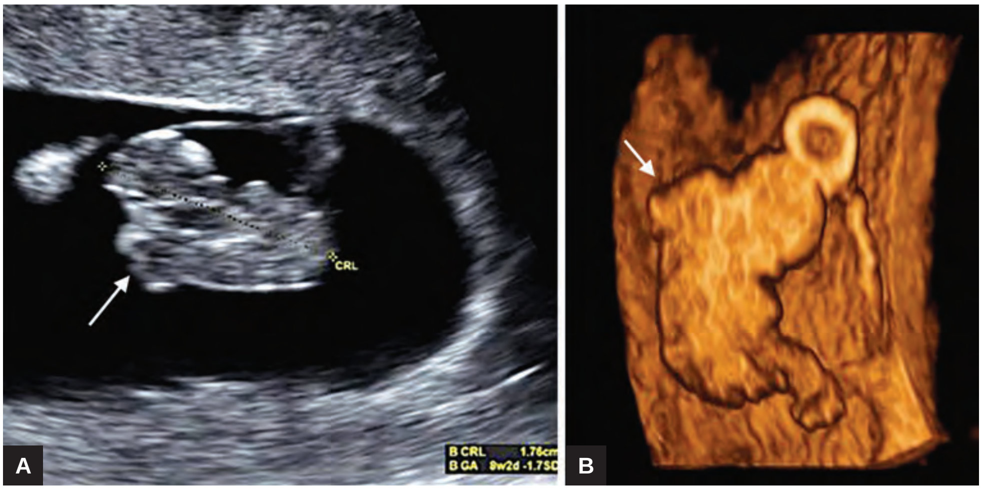
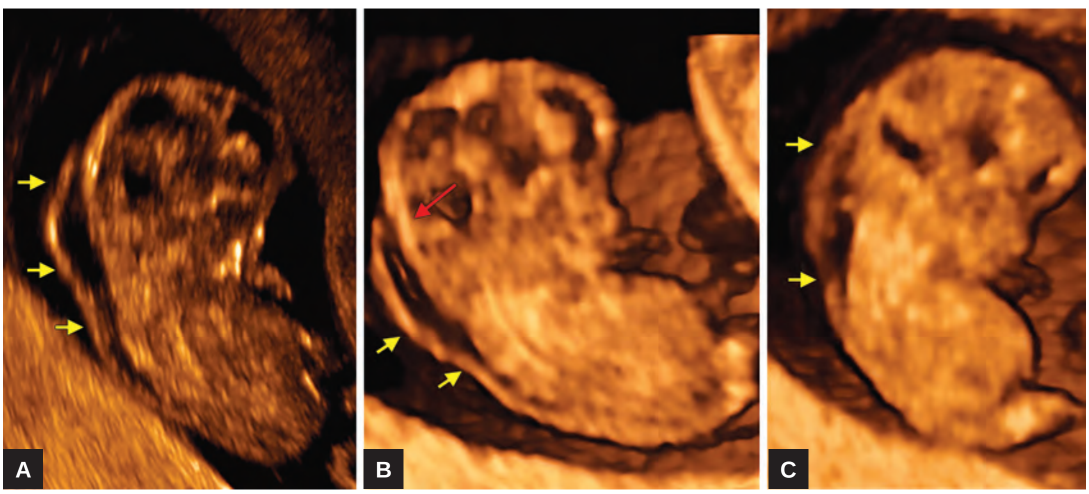


Figs 1A and B: (A) Sagittal view of an 8-week embryo demonstrating an occipital encephalocele (*white arrow*). The prominence in the occipital area represents a defect in the skull and dura with extracalvarial extension of intracranial structures enclosed by overlying skin; (B) three-dimensional image demonstrating the prominence in the occipital area (white arrow). The differential diagnosis includes cystic hygroma, teratoma, vascular malformation or hemangioma, scalp edema



Figs 2A to C: (A) Sagittal view of a 9-week embryo demonstrating cystic hygroma with extension of the edema to the upper back (yellow arrows); (B, C) three-dimensional image demonstrating cystic hygroma (yellow arrows). In image B, note the intact calvarial bones (red arrow) representing the clue for differential diagnosis between encephalocele and cystic hygroma

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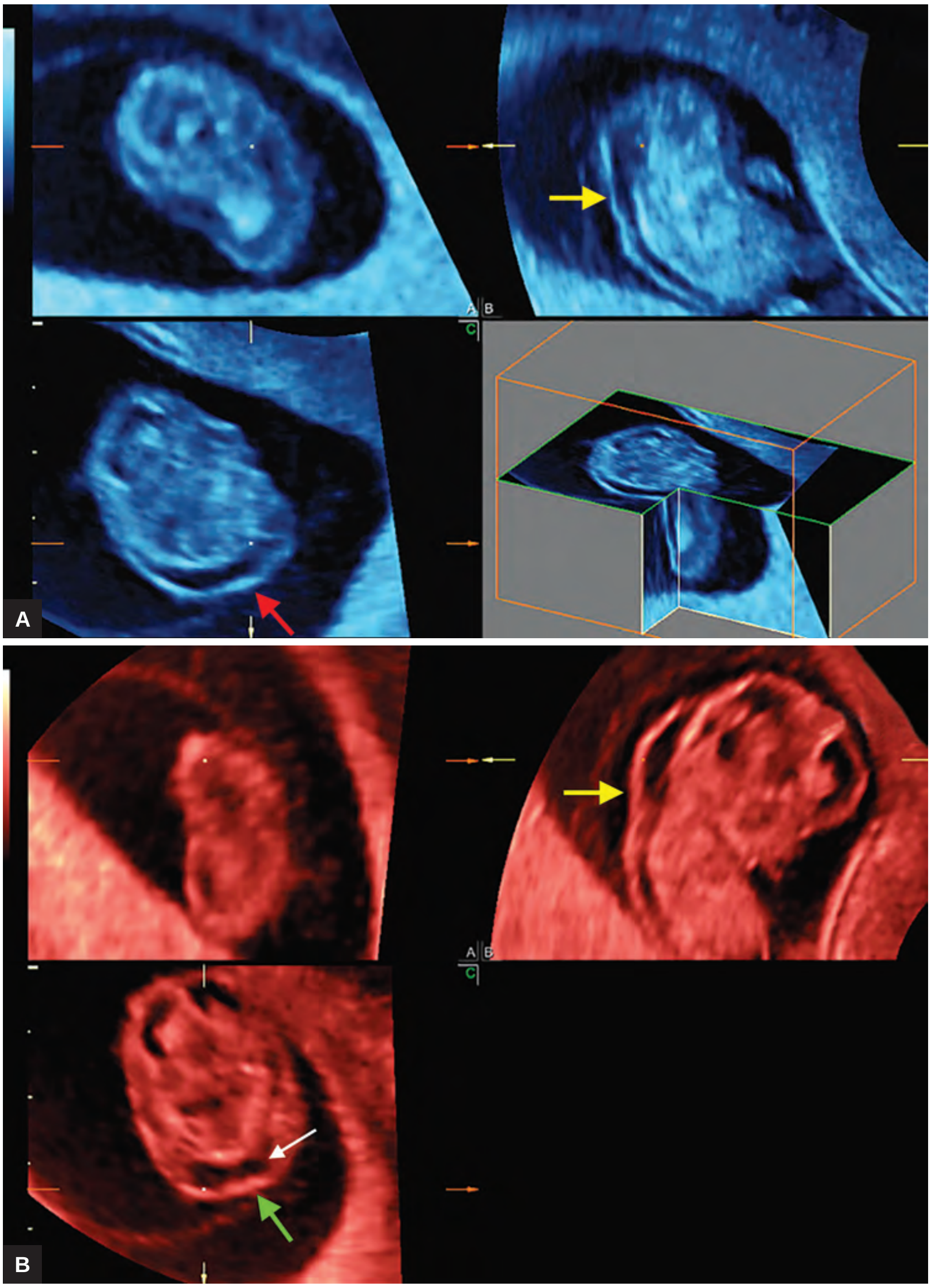
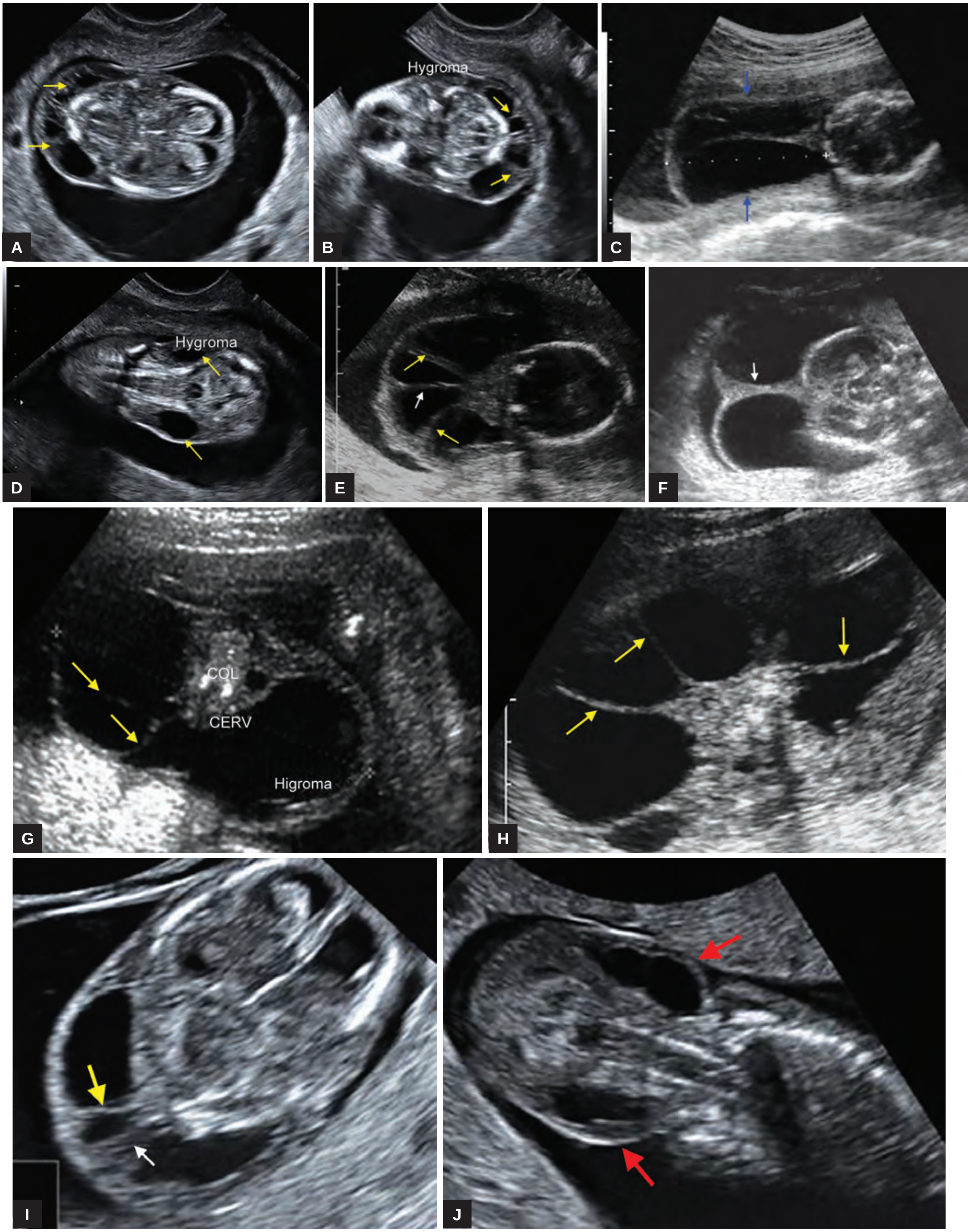
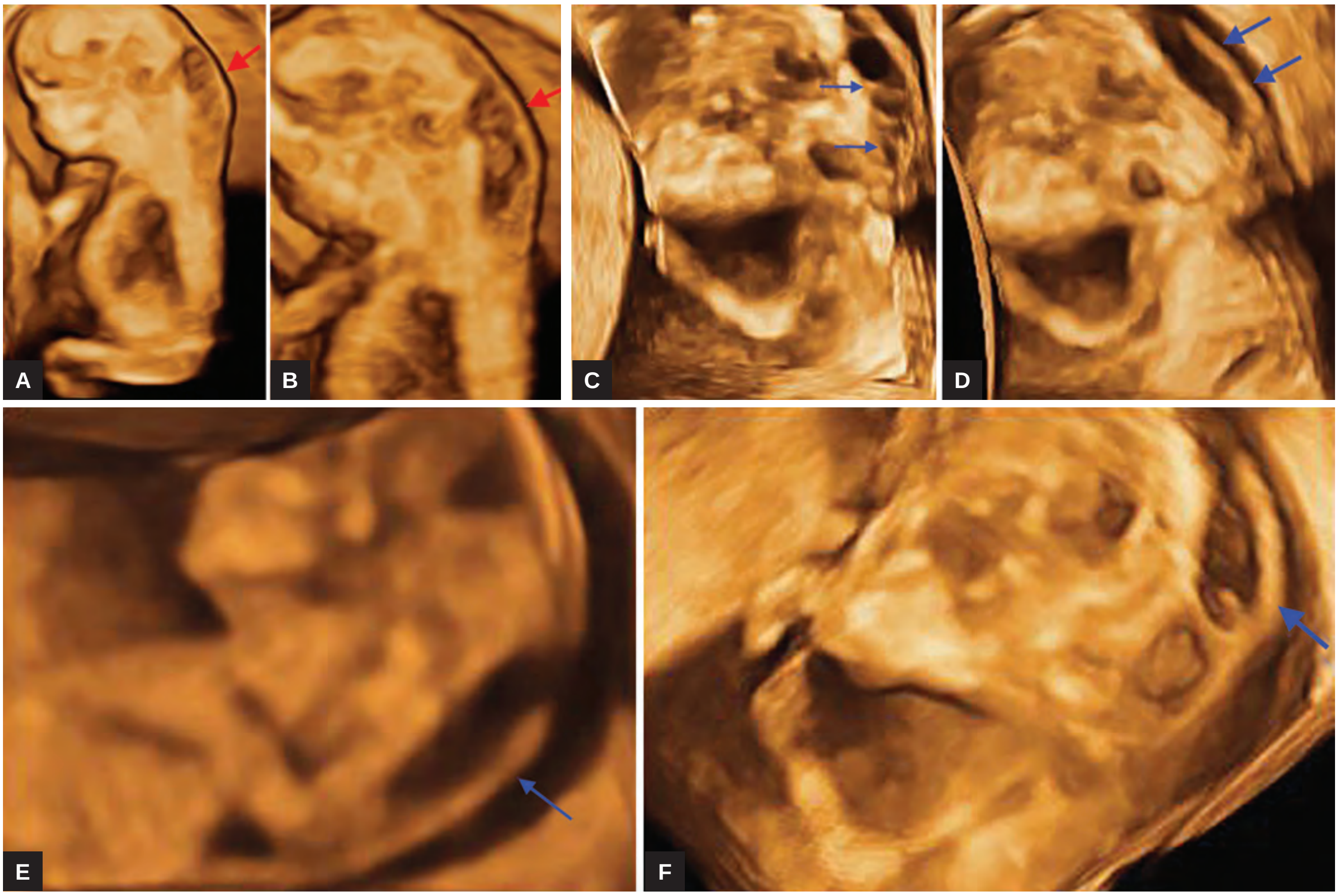


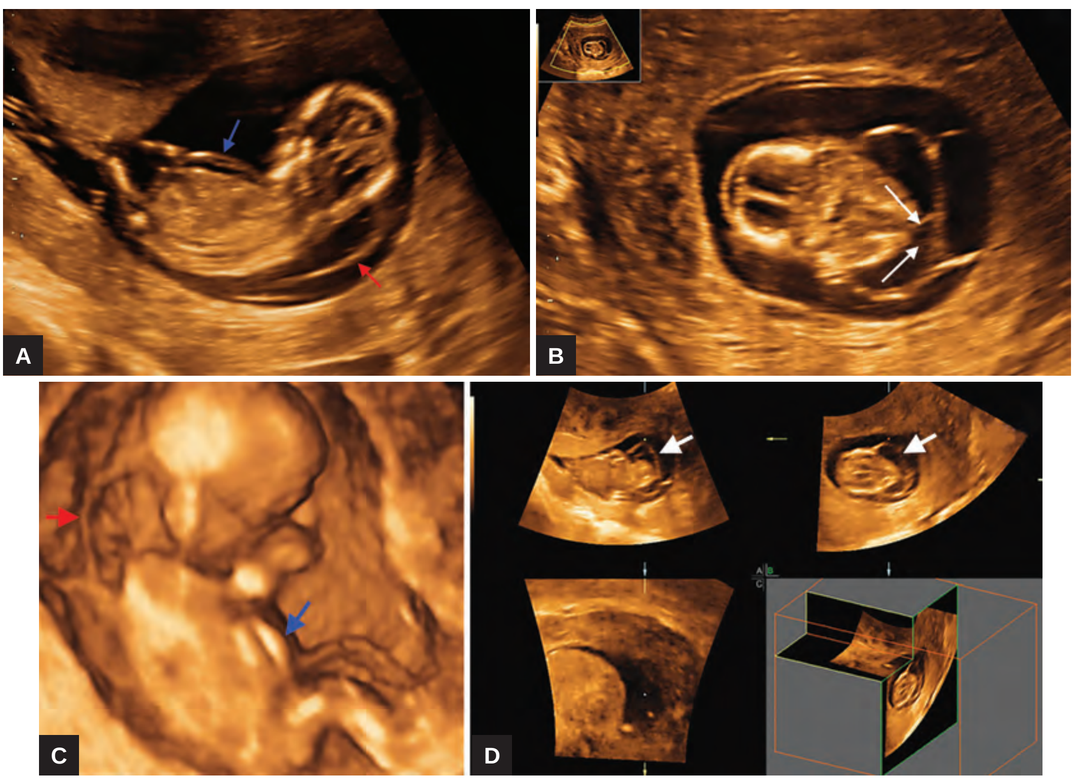
Figs 3A and B: (A) Sectional planes of an 8-week embryo demonstrating cystic hygroma with extension of the edema to the upper back (yellow arrow). Axial view (red arrow) of septated cystic hygroma. (B) Sectional planes of a 9-week$^{(+2\ days)}$ embryo demonstrating a typical cystic hygroma (yellow arrow). Axial view demonstrating intact calvarial bones (green arrow) and the nuchal ligament (thin white arrow)



Figs 4A to J: Cystic hygroma in different cases of turner syndrome; (A, B) transverse view through the fetal neck demonstrating cystic hygroma with obvious septations (arrows); (C) turner syndrome fetus with huge cystic hygroma (arrows); (D) a typical nonseptated cystic hygroma demonstrating cystic spaces on either side of the fetal neck which are dilated cervical lymphatics (arrows); (E to I) axial view of septated (yellow arrows) cystic hygroma in turner syndrome, in early second trimester. The nuchal ligament is identified (white thin arrow); and (J) fetal head and neck in coronal image demonstrating two focal cystic spaces around the neck (red arrows) representing cystic hygroma in Turner syndrome

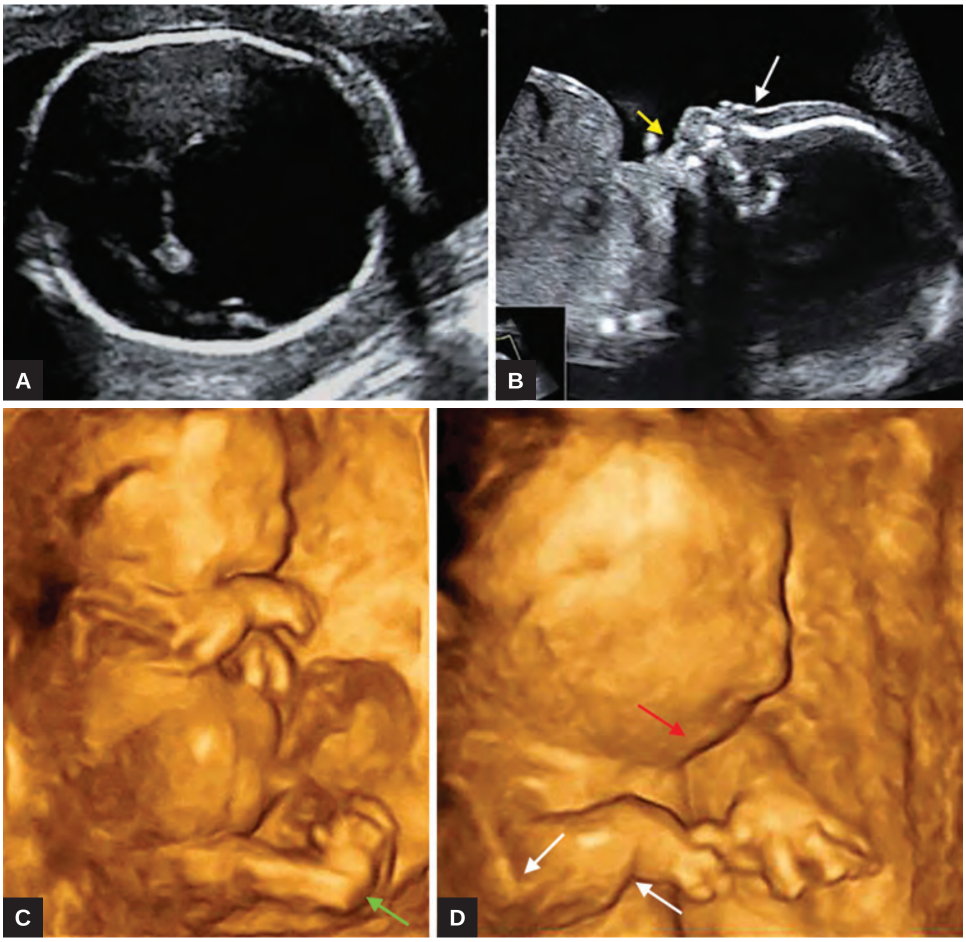


Figs 5A to F: Three-dimensional sonograms demonstrating cystic hygroma in different cases of Turner syndrome: (A, B) Septated cystic hygroma (arrows) at 13 weeks gestational age; and (C to F) septated cystic hygroma (arrows) at 12 weeks gestational age

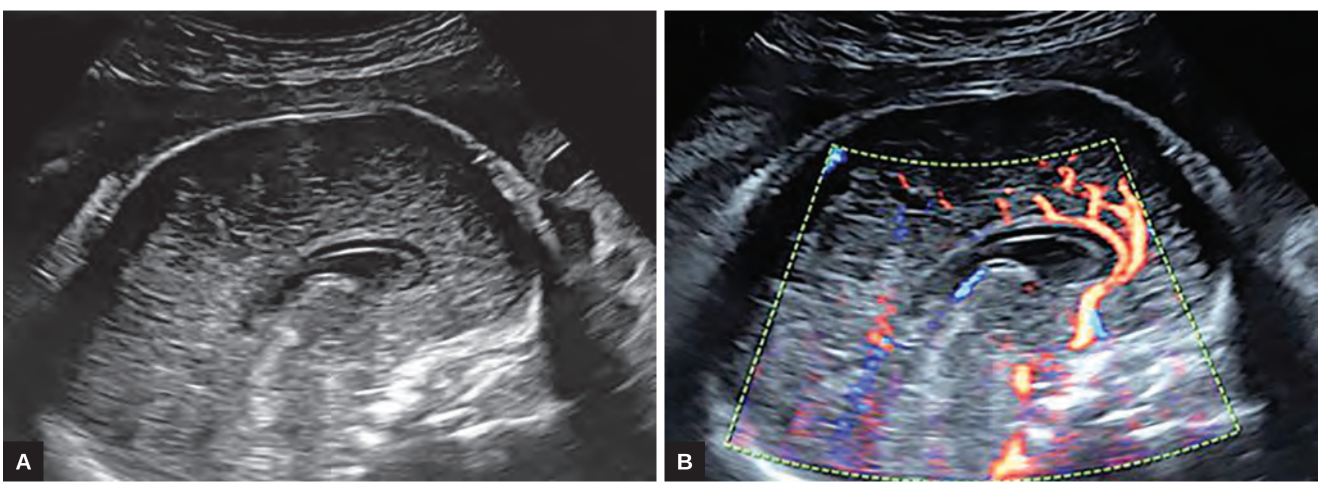


Figs 6A to D: Monosomy X (Turner syndrome) in a 13-week fetus. (A) Sagittal view of a 13-week fetus demonstrating cystic hygroma (red arrow) and edema (blue arrow); (B) axial view of septated (white arrows) cystic hygroma in Monosomy X (45,X); (C) three-dimensional sonogram demonstrating cystic hygroma (red arrow) and edema (blue arrow); and (D) sectional planes of a 13-week fetus demonstrating cystic hygroma (white arrows)

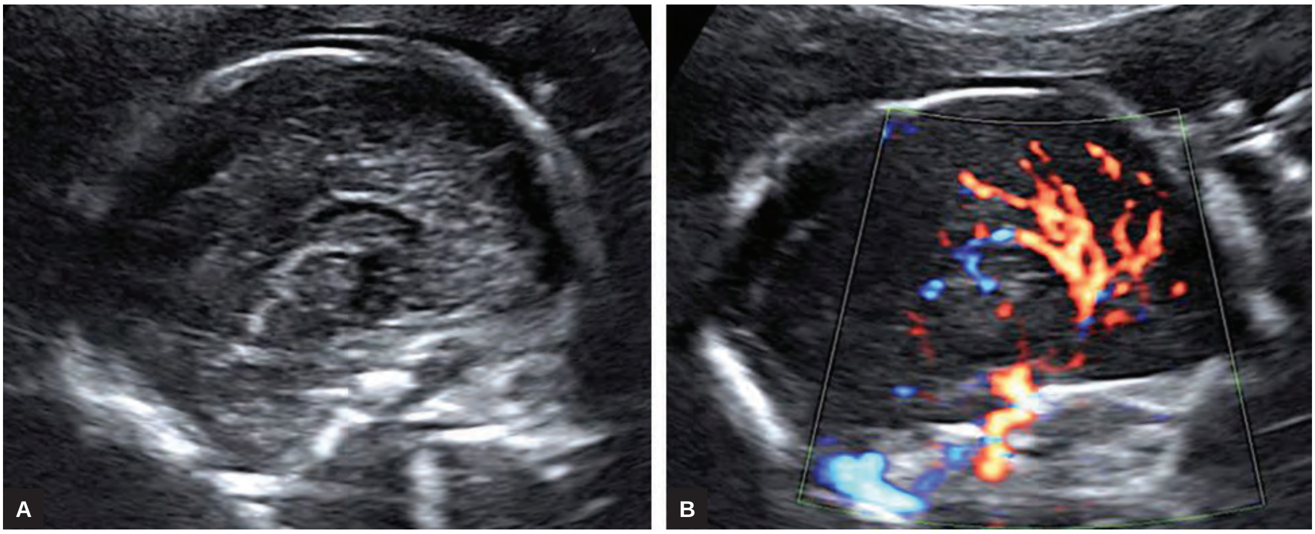
Figs 7A to H: (A, B) Gross images of fetus with massive septated cystic hygroma; (C, D) gross images of an 18-week gestational age fetus with Turner syndrome and large cystic spaces around the neck; (E, F) gross images of a 16-week gestational age fetus with Turner syndrome and cystic hygroma; and (G, H) gross images of a 15-week gestational age fetus with Turner syndrome and cystic hygroma



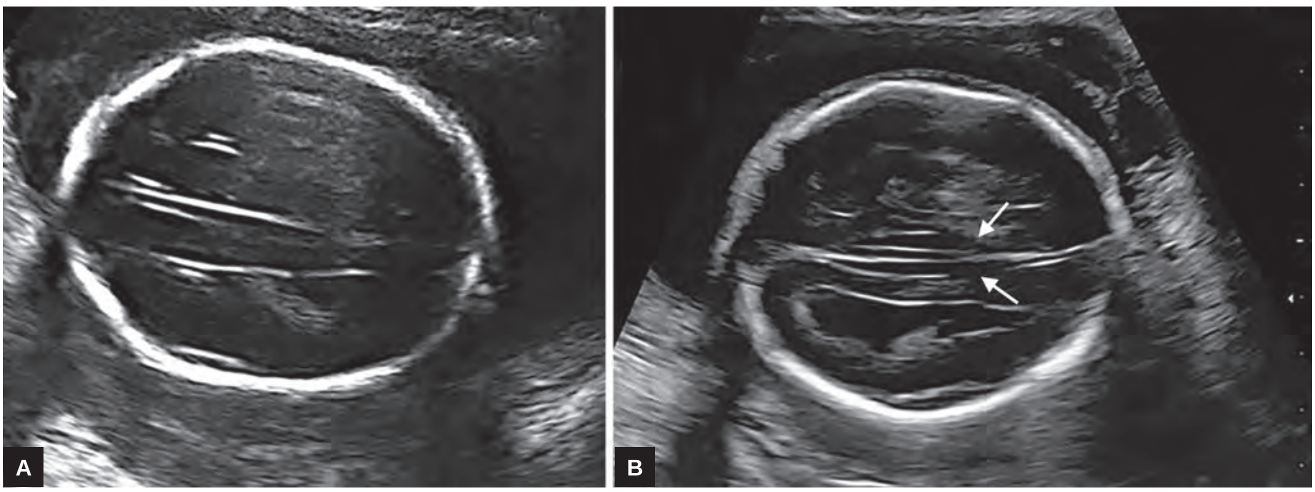
Figs 8A to D: Sonogram of a 20-week fetus with multiple anomalies. (A) Severe ventriculomegaly; (B) micrognathia (yellow arrow), abnormal nose (white arrow), and a flat profile; (C) three-dimensional image shows short limbs and bilateral talipes equinovarus (green arrow); and (D) three-dimensional image demonstrating pronounced micrognathia (red arrow), short limbs, and contractures of the elbow and wrist (white arrows). The condition is consistent with a lethal skeletal dysplasia



Figs 9A and B: (A) Midsagittal view of a 30-week fetal brain with a clear image of the corpus callosum visible on its entire length. The corpus callosum forms the roof of the cavum septum pellucidum; (B) Midsagittal view of a 30-week fetal brain showing corpus callosum and the pericallosal artery, which runs on the top



Figs 10A and B: (A) Midsagittal section of fetal head at 23 weeks. Partially absent corpus callosum. The anterior half of the corpus callosum is formed. (B) The small corpus callosum is highlighted by the course of the pericallosal artery



Figs 11A and B: Indirect signs of agenesis of the corpus callosum. (A) Axial scan of a 24-week fetal brain demonstrating the absence of the cavum septum pellucidum. The anterior horns are spread wider than normal; (B) The lateral ventricles are "tear shaped," with normal width or moderately enlarged. Note the increased separation of the hemispheres (arrows) with the bodies of the lateral ventricles parallel to each other and shifted laterally

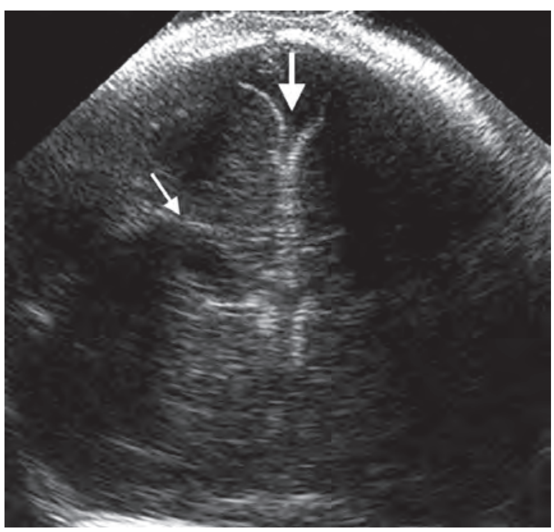
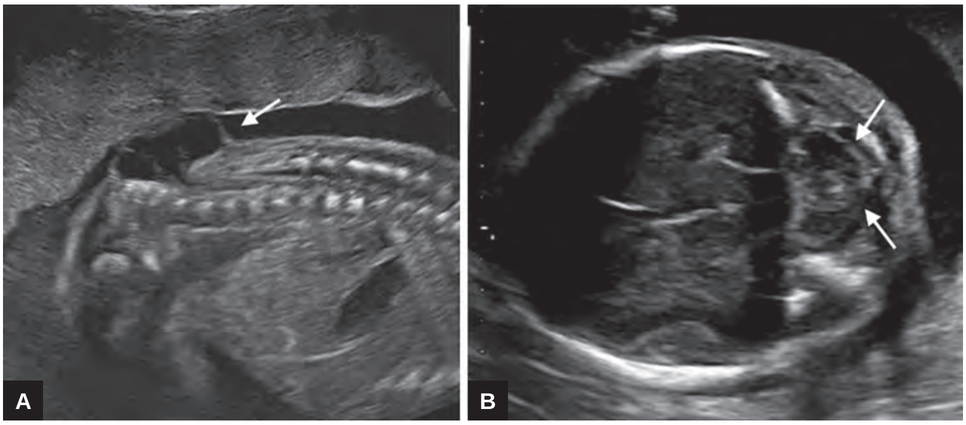
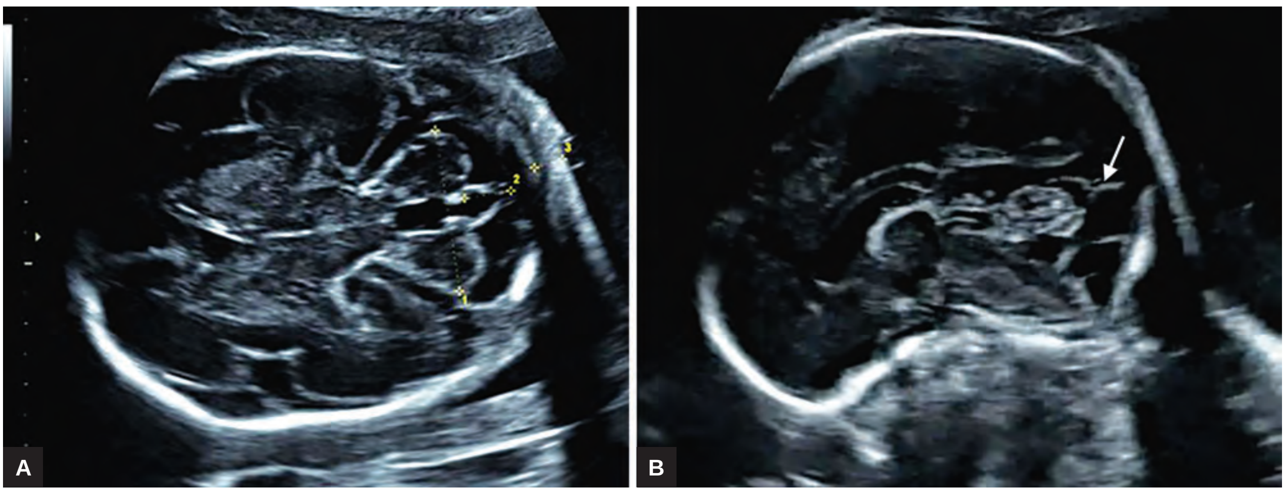


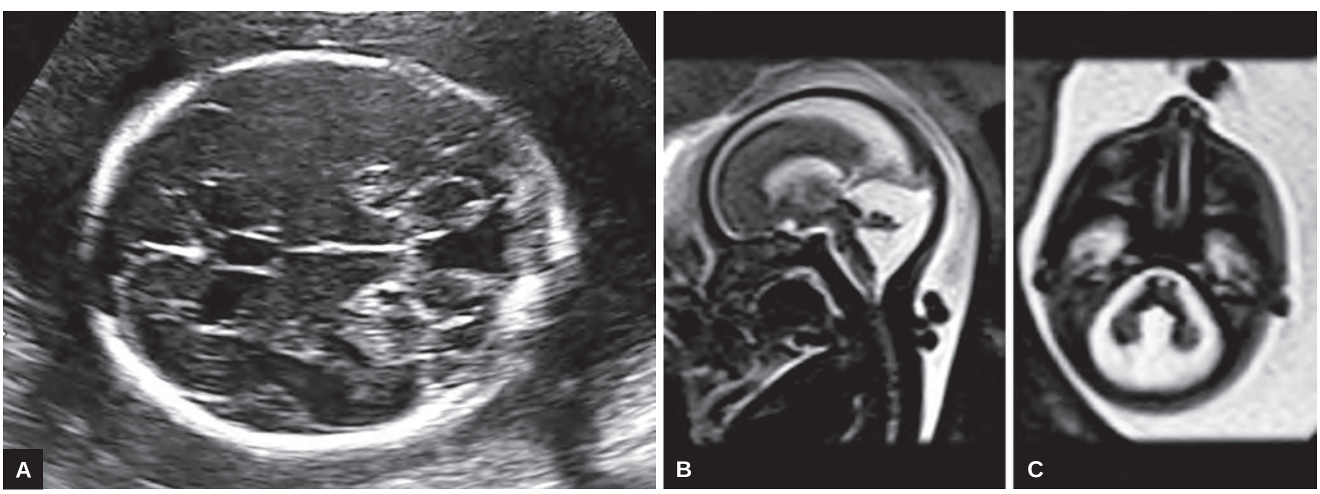
Fig. 12: A coronal transfontanellar view of a 32-week fetal brain. The cavum septum pellucidum is absent, as well as the corpus callosum. The interhemispheric fissure is visible (thick white arrow), as well as part of the anterior horns (thin white arrow). The falx cerebri is present, but there is complete separation of the two hemispheres. Visibility is limited due to increased bone density



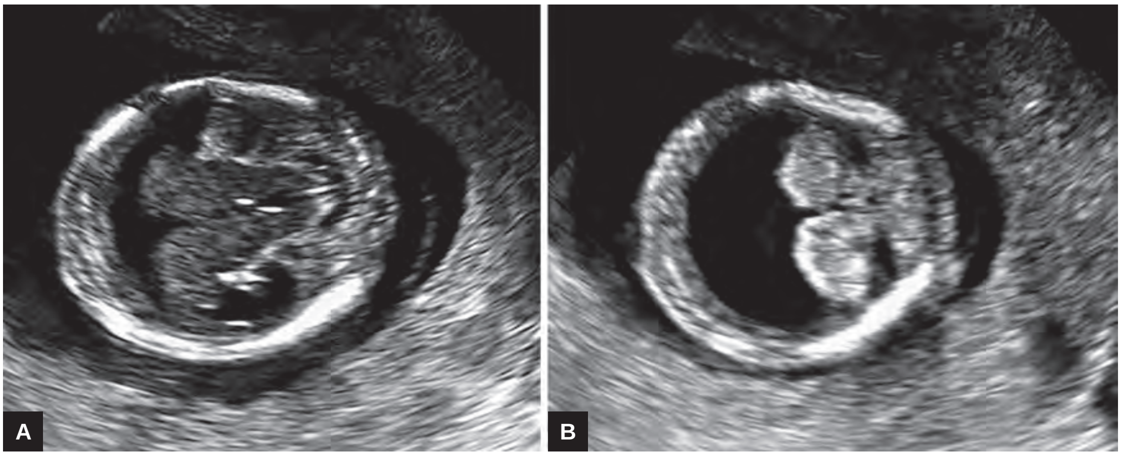
Figs 13A and B: (A) Open spina bifida. Sagittal plane of a 22-week fetus demonstrating the interruption of the double railway appearance of the spine and a cystic lesion bulging at this level, with a discontinuity of bony canal at L4 to L5 (arrow); (B) the fetal brain demonstrates the Chiari II malformation, with an abnormal shape of the cerebellum (banana sign, arrows). The low level of the spinal lesion has little impact on the brain anatomy



Figs 14A and B: Blake's pouch cyst. (A) Axial plane of a 24-week fetal brain demonstrating enlarged cisterna magna with *hour glass* shape and hypoplastic vermis; (B) the sagittal plane shows the vermis appearing slightly displaced upward, but of normal shape and size and a cystic image occupies the cisterna magna arising from the fourth ventricle (arrow)



Figs 15A to C: Dandy–Walker malformation. (A) Axial plane of a 21-week fetal brain demonstrating moderately cystic dilatation of the posterior fossa communicating with the fourth ventricle. The aspect overlaps partially the vermian hypoplasia. Sagittal section by ultrasound or magnetic resonance imaging (MRI) makes the differential diagnosis; (B) fetal MRI in the sagittal plane. Elevation of the tentorium is visible, with mild vermian hypoplasia; and (C) fetal MRI in the transverse plane. A cross-section at this level shows an enlarged posterior fossa with a square shape. The vermis is not visible in this plane, as it is elevated



Figs 16A and B: Holoprosencephaly. (A) Transverse section of the fetal head at 13 weeks demonstrating a single cerebral ventricle and lack of separation of the prosencephalon. The thalamic nuclei are visible, as well as the third ventricle; (B) There is some separation of the choroid plexuses, which may be suggestive of a rather semilobar holoprosencephaly

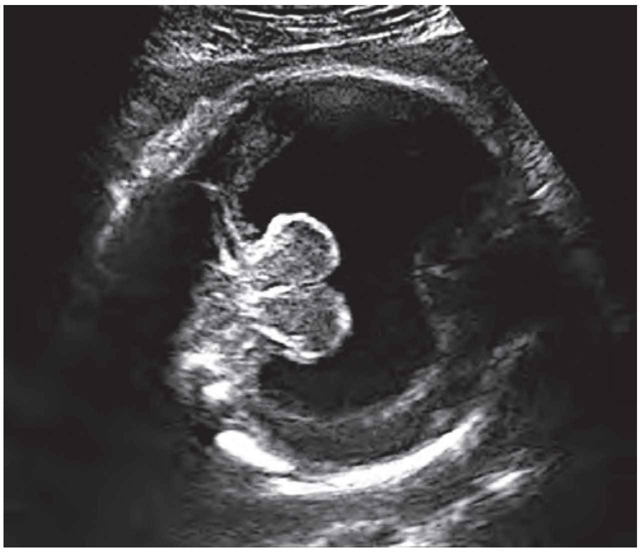
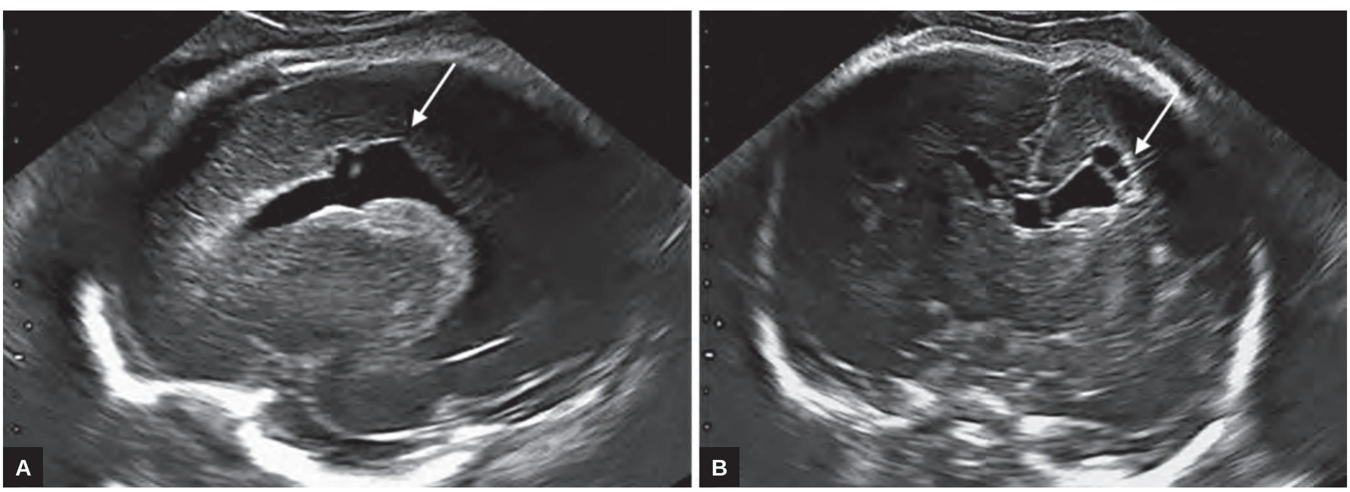
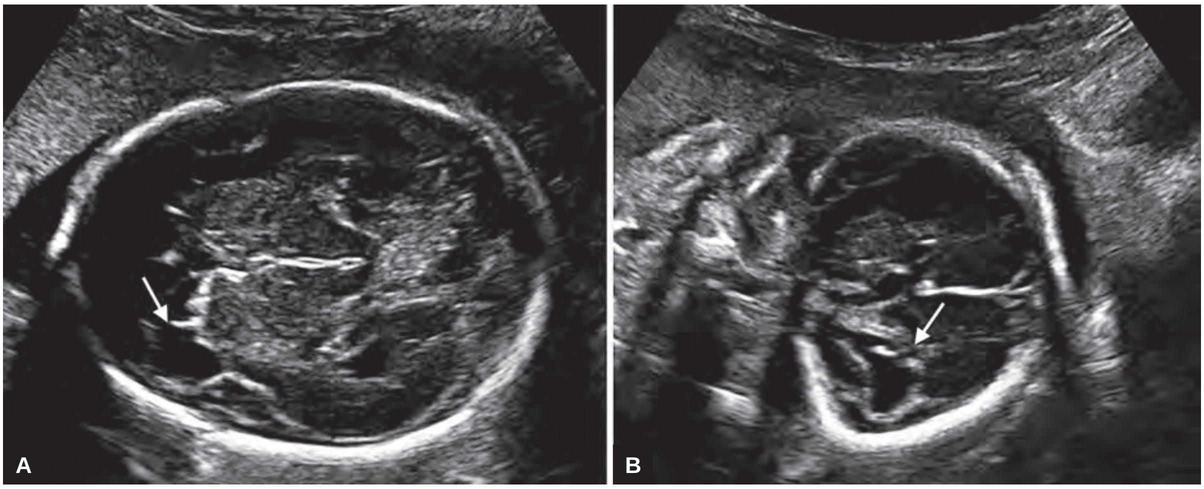


Fig. 17: Holoprosencephaly. Fetus with alobar holoprosencephaly at 30 weeks of gestation. Transverse section of the fetal head where a large fluid-filled cavity can be identified. The fluid-filled cavity demonstrates the monocavity of the holoprosencephalon and a large dorsal sac



Figs 18A and B: Intracranial cysts. Glioependymal cysts/ependymal cysts. Sagittal section (A) and coronal section (B) of the head in a 27-week fetus with two small isolated cystic-like lesions (white arrows) in the cerebral substance adjacent to the anterior horn of the lateral ventricle. The cysts communicate with the ventricle and there are no other brain anomalies suggestive of destructive lesions. These are typical images for subependymal pseudocysts



Figs 19A and B: (A) Transverse section of the fetal head at 22 weeks showing a small hyperechogenicity in the anterior horn (white arrow) with a defect in the adjacent cerebral substance; (B) coronal section of the fetal head from a lateral approach showing a defect in the cerebral substance in the area of the frontal lobe (white arrow), anterior to the Sylvian fissure

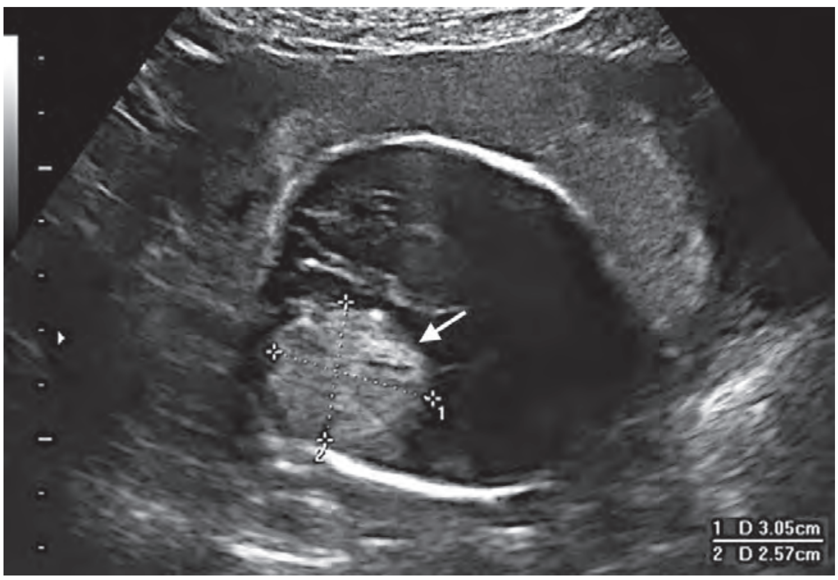


Fig. 20: Fetal intracranial tumor in a 31-week fetus. Large solid intracranial tumor (white arrow). The increased echogenicity and well-defined border are suggestive of a large lipoma developed in the body of a lateral ventricle