

C37- IMAGING THE UNCOMMON: FETAL MRI AND ULTRASOUND IN CONJOINED TWINS AND ECTOPIA CORDIS



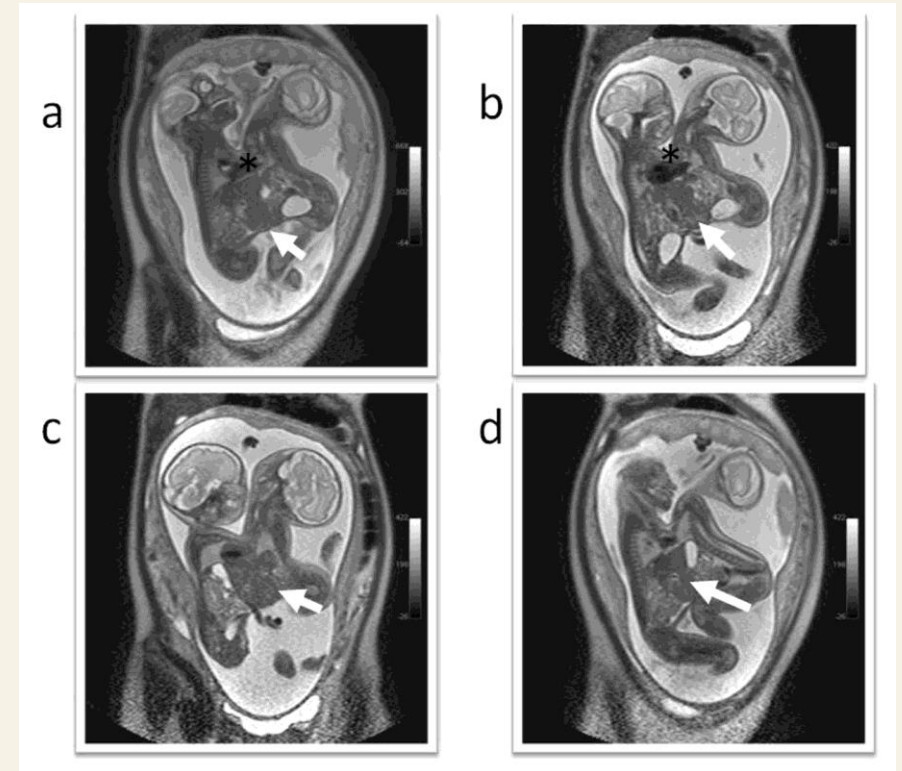
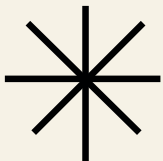
OBJECTIVES:

- Understand the different imaging modalities used in diagnosing Conjoined Twins and Ectopia Cordis
- Define Conjoined Twins and Ectopia Cordis
- Discuss the role of Fetal MRI and Ultrasound in these diagnoses
- Discuss the advantages and limitations of using these forms of imaging
- Describe the different treatments for both congenital diseases



INTRODUCTIO

- **N** Fetal Magnetic Resonance Imaging (MRI) uses radio waves and an immensely powerful magnetic field to create detailed images of a fetus inside a mother's womb.
- Ultrasound is an imaging tool that produces live pictures/videos of internal organs and structures.
- Conjoined Twins are twin fetuses that are connected to one another via different body parts or organs.
- Ectopia Cordis is a rare congenital condition where some or all of a fetus's heart resides outside of the chest wall, only covered by a layer of skin
 - The combined use of Fetal MRI and Ultrasound significantly improves the early detection, anatomical characterization, and treatment plans of both Conjoined Twins and Ectopia Cordis.



Fetal MRI of Thoraco-omphalopagus conjoined twins | BMJ case reports. (n.d).
<https://casereports.bmj.com/content/2017/hcr-2017-219793>

FETAL MRI (FETAL MAGNETIC RESONANCE IMAGING):

- **Fetal MRI:** Uses radio waves, a computer, and an immensely powerful magnetic field to produce detailed 3D images of the fetus inside a mother's womb.
- **MRI Machines:** Large cylindrical tubes surrounded by a circular magnet with a table that moves into the machine towards the center of the magnet.
 - The radio waves re-align hydrogen atoms that naturally exist within the human body.
- **Common Uses:**
 - Confirm potential abnormality seen on an ultrasound
 - Evaluate the severity of the abnormalities (*RSNA and ACR, 2023*)



MRI (Magnetic Resonance Imaging). Humber River Health. (2024, May 8). <https://www.hrh.ca/programs/medical-imaging/mri-magnetic-resonance-imaging/>



ULTRASOUND (US):

- **Ultrasound (US):** A non-invasive imaging tool that uses high frequency sound waves to create real time pictures/video of internal organs or other soft tissues, such as blood vessels (Cleveland Clinic, 2022)
- **Types:** Pelvic, abdominal, obstetric, transvaginal, transrectal, echo
 - Can be in 2D, 3D, or 4D
- **How does Ultrasound work?**
 - A device called a transducer, or probe is placed over the area of interest
 - Gel is applied to the skin to allow the ultrasound waves to be transmitted from transducer and into the body
 - The sound waves bounce off organs and tissues and return back to the probe
 - A computer is used to then convert the electrical signals from the soundwaves into live pictures or videos on a monitor



Professional, C. C. medical. (2026, January 7). *Ultrasound: What it is, purpose, procedure & results*. Cleveland Clinic. <https://my.clevelandclinic.org/health/diagnostics/4995-ultrasound>



CONJOINED TWINS:

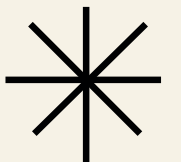
Conjoined twins are twin fetuses that are connected via body parts or organs (*Mayo Clinic, 2022*).

- Occurs when an embryo does not fully separate to form two fetuses
- Most common form of conjoined twins are connected at the chest, abdomen, or pelvis
 - This typically results in the twins sharing one or more internal organs (*Mayo Clinic, 2022*).

ECTOPIA CORDIS:

Ectopia Cordis is a rare congenital condition where a fetus' heart resides outside of the chest and is only covered by a thin layer of skin.

- Occurs when there is an abnormal formation of both the chest wall and abdominal wall structure.
- The heart can also develop in between the stomach, or sit higher more towards the neck (*Boston Children's Hospital, (n.d.)*).



ULTRASOUND IN CONJOINED TWINS:

How Early Can it Be Detected?

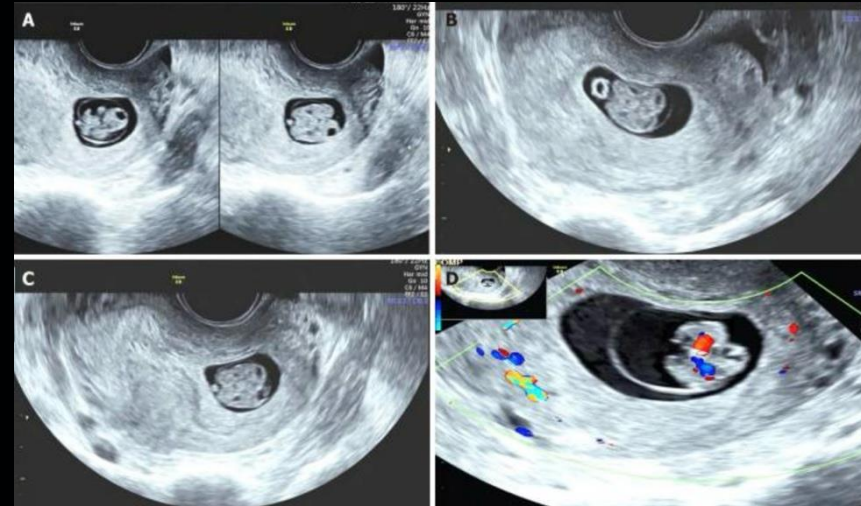
- Can be diagnosed as early as 7-12 weeks gestation
 - Using 2D and 3D Ultrasound and color doppler
 - Provides detailed images of shared organs (*Ultrasound: What it is, purpose, procedure & results, 2026*).

What are the most common points of connection?

- Chest
 - **Thoracopagus** (share heart)
- Abdomen
 - **Omphalopagus** (share abdomen/liver)

Case Study:

- Patient 7 weeks pregnant with low progesterone levels
 - Ultrasound showed a single yolk with two embryos
 - Also shown were 2 spines, 2 brains, 2 stomachs, 2 bladders, and just 1 beating heart (*Liang et al., 2020*).



Liang, X.-W., Cai, Y.-Y., Yang, Y.-Z., & Chen, Z.-Y. (2020a, November 6). *Early ultrasound diagnosis of conjoined twins at eight weeks of pregnancy: A case report*. World journal of clinical cases. <https://pmc.ncbi.nlm.nih.gov/articles/PMC7674739/>



ULTRASOUND IN ECTOPIA CORDIS (EC):

- Ectopia Cordis can be detected by ultrasound as early as 10 weeks gestation.
- Normal 2D ultrasound paired with a color doppler aids in making the diagnosis (*Kahveci et al., 2022*).
 - Shows basic visualization of the anatomy

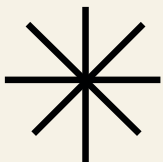
Case Study:

- At 18 weeks gestation the ultrasound detected the heart outside the thorax
- A detailed evaluation of the heart was done using a color doppler and showed no other anomalies
- Patient decided to go through with termination due to the poor chance of the fetus' survival

- The image shown on the right demonstrates the heart (a) to be outside the thorax (b) (*Kahveci et al., 2022*).



Kahveci, B., Melekoglu, R., Deger, U., & Demir, S. C. (2022, June). *Prenatal diagnosis of a rare isolated thoracic-type ectopia cordis with complete form: A case report*. Journal of ultrasound. <https://pmc.ncbi.nlm.nih.gov/articles/PMC9148348/>



ADVANTAGES AND LIMITATIONS OF ULTRASOUND:

Advantages:

- Non-invasive and safe
 - Does not use ionizing radiation which allows for repeat exams
- Cost effective
- Live imaging
 - Not concerned about movement of the fetus.

Limitations:

- Operator dependence
 - Image quality can vary depending on operator's skill and experience.
- Limited penetration
 - Does not penetrate bone or air well
- Image resolution
 - Resolution is lower compared to CT or MRI (Oracle, 2025).

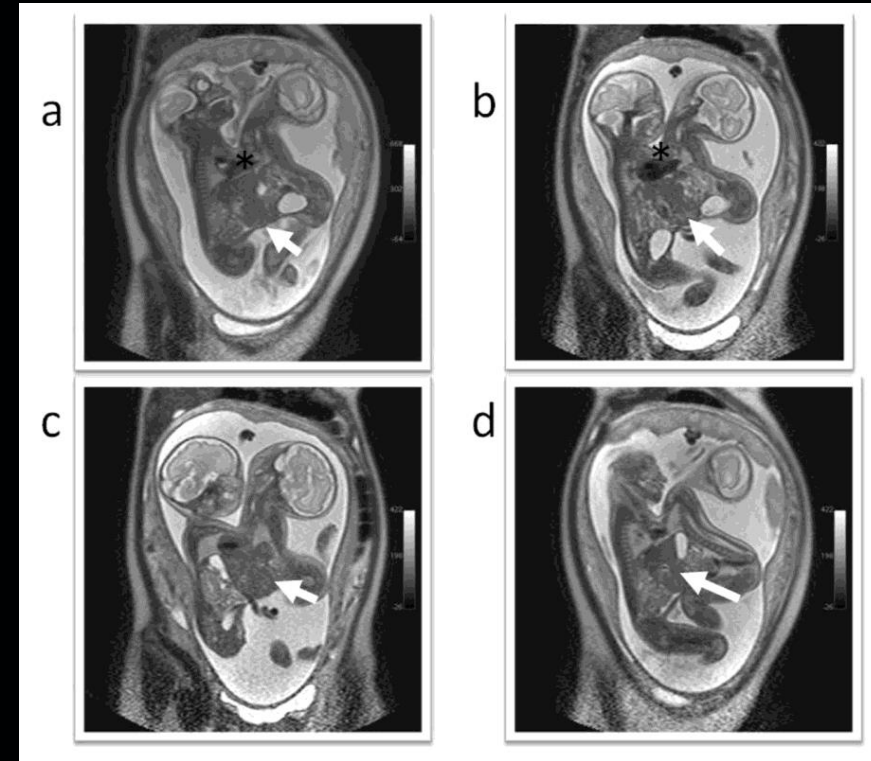


FETAL MRI IN CONJOINED TWINS:

How Fetal MRI aids in diagnosis:

- High resolution images are provided by fetal MRI compared to ultrasound.
- Gives clear visualization of what organs and structures are being shared between the twins (*Bioengineer, 2025*).
- Can visualize what blood supplies are being shared
- Helps devise a birth plan to try and ensure both health and survival of both twins.
- Can also show if there is a possibility it will not be fatal (*Bioengineer, 2025*).
 - Potential surgeries could be performed before or after birth depending on the health of each baby.

The image displayed on the right shows twins conjoined both at the chest and the abdomen. Neither baby survived birth (BMJ, (n.d.)).



Fetal MRI of Thoraco-omphalopagus conjoined twins | BMJ case reports. (n.d).
<https://casereports.bmj.com/content/2017/hcr-2017-219793>



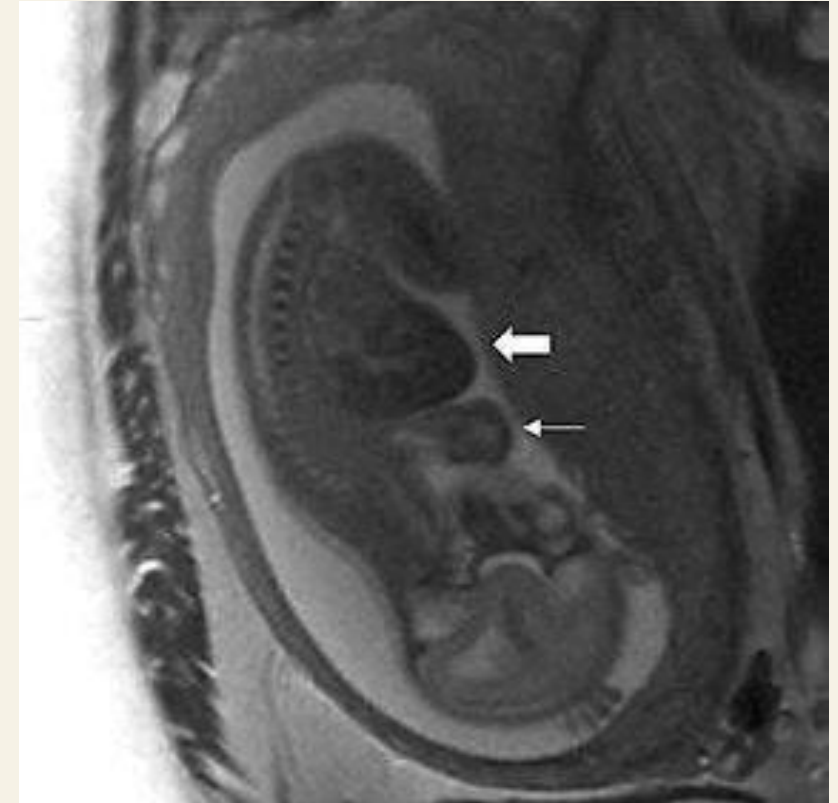
FETAL MRI IN ECTOPIA CORDIS (EC):

How Fetal MRI aids in diagnosis:

- Higher resolution images than ultrasound
- Shows defect in great detail
 - Allows for better visualization for diagnosis
 - Helps with post-natal surgical planning
- Can also exclude the possibility of any other abnormalities (Escobar-Diaz et al., 2016).

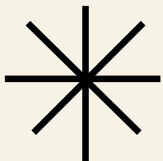
Research Study:

- Took place from 1995-2014
- 17 patients diagnosed with EC
- 2 terminations, 2 fetal deaths, 2 lost to follow-up, and 11 live births
 - The live born babies were able to survive due to surgeries performed to correct the defect
 - Fetal MRI greatly improved those odds with the high resolution images it provided (Escobar-Diaz et al., 2016).



In the image shown on the right, the skinny arrow shows the heart located outside the fetus' chest at 21 weeks gestation, and the wide arrow shows the herniation of the liver through the ventral wall defect.

Escobar-Diaz, M. C., Sunderji, S., Tworetzky, W., & Moon-Grady, A. J. (2016, December 19). *The fetus with Ectopia Cordis: Experience and expectations from two centers - pediatric cardiology*. SpringerLink. <https://link.springer.com/article/10.1007/s00246-016-1545-x?fromPaywallRec=true>



ADVANTAGES AND LIMITATIONS OF FETAL MRI

Advantages:

- Enables scanning in any plane to visualize complex anatomical relationships (*RSNA and ACR, 2023*).
- Detailed imaging of all internal organs and structures
- Can be used when US is inconclusive

Limitations:

- Maternal obesity
- Long term safety concerns if contrast is used
- Low amniotic fluid
 - Removes natural contrast agent
- Fetal movement
 - Images not as accurate (*RSNA and ACR, 2023*).



TREATMENTS/PROGNOSIS

Ectopia Cordis:

Treatment:

- Cover heart with soft tissue.
- Emergent surgery to then place the heart back inside chest and close the thoracic cavity.

Prognosis:

- High mortality rate
- 10% survival rate
- Many cases result in stillbirth or death within hours or days after birth (*Apollo Hospitals, (n.d.)*).

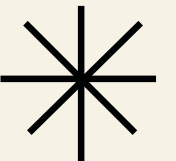
Conjoined Twins:

Treatment (after birth):

- Surgical separation
 - Performed between 3-12 months of age
- If separation is not possible due to shared vital organs surgeons may focus on any other associated medical issues such as heart defects or scoliosis (*Cleveland Clinic, 2025*).
- Palliative care

Prognosis:

- 45% live born
- Only about 8% survive



CONCLUSION

- Fetal ultrasound and MRI play complementary roles in diagnosing Conjoined Twins as well as Ectopia Cordis.
- Ultrasound is the primary screening tool due to accessibility and real-time imaging compared to MRI.
- Fetal MRI provides much more detailed images of internal organs and structures.
- The combination of these imaging tools significantly improves diagnostic quality for both Conjoined Twins and Ectopia Cordis, such as showing organ sharing, cardiac position, and associated anomalies.
- Early and accurate diagnosis supports informed parental counseling and ethical decision-making.
- Multidisciplinary care planning enhances delivery preparation and neonatal management.



REFERENCES



Bioengineer. (2025, August 15). *Exploring fetal MRI insights in conjoined twins*. BIOENGINEER.ORG. <https://bioengineer.org/exploring-fetal-mri-insights-in-conjoined-twins/>

Complex management of Ectopia Cordis complicated by pentalogy of Cantrell: Report of two cases and review of current evidence - sciencedirect. (n.d.-a). <https://www.sciencedirect.com/science/article/pii/S2210261225005395>

Ectopia Cordis. Ectopia Cordis | Boston Children's Hospital. (n.d.). <https://www.childrenshospital.org/conditions-treatments/ectopia-cordis>

Ectopia Cordis: Types, symptoms, causes, treatment and complications | Apollo Hospitals. (n.d.-b). <https://www.apollohospitals.com/diseases-and-conditions/ectopia-cordis-types-symptoms-causes-treatment-and-complications>

Escobar-Diaz, M. C., Sunderji, S., Tworetzky, W., & Moon-Grady, A. J. (2016, December 19). *The fetus with Ectopia Cordis: Experience and expectations from two centers - pediatric cardiology*. SpringerLink. <https://link.springer.com/article/10.1007/s00246-016-1545-x?fromPaywallRec=true>

Fetal MRI of Thoraco-omphalopagus conjoined twins | BMJ case reports. (n.d.-c). <https://casereports.bmj.com/content/2017/bcr-2017-219793>

Kahveci, B., Melekoglu, R., Deger, U., & Demir, S. C. (2022, June). *Prenatal diagnosis of a rare isolated thoracic-type ectopia cordis with complete form: A case report*. Journal of ultrasound. <https://pmc.ncbi.nlm.nih.gov/articles/PMC9148348/>

REFERENCES (CONT.):



Liang, X.-W., Cai, Y.-Y., Yang, Y.-Z., & Chen, Z.-Y. (2020, November 6). *Early ultrasound diagnosis of conjoined twins at eight weeks of pregnancy: A case report*. World journal of clinical cases. <https://pmc.ncbi.nlm.nih.gov/articles/PMC7674739/>

Mayo Foundation for Medical Education and Research. (2022, December 16). *Conjoined twins*. Mayo Clinic. https://www.mayoclinic.org/diseases-conditions/conjoined-twins/symptoms-causes/syc-20353910?cjdata=MXxOfDB8WXww&cjevent=8931c871069f11f182e400ae0a82b82a&cm_mmc=CJ--100357191--5250933--Evergreen%2BLink%2Bfor%2BMayo%2BClinic%2BDiet&utm_source=cj&utm_content=100357191&utm_campaign=3-months

MRI (Magnetic Resonance Imaging). Humber River Health. (2024, May 8). <https://www.hrh.ca/programs/medical-imaging/mri-magnetic-resonance-imaging/>

Professional, C. C. medical. (2026, January 7). *Ultrasound: What it is, purpose, procedure & results*. Cleveland Clinic. <https://my.clevelandclinic.org/health/diagnostics/4995-ultrasound>

Radiological Society of North America (RSNA) and American College of Radiology (ACR). (2023, March 20). *Fetal MRI*. Radiologyinfo.org. <https://www.radiologyinfo.org/en/info/fetal-mri>

What are conjoined twins?. Cleveland Clinic. (2025, September 25). <https://my.clevelandclinic.org/health/diseases/22895-conjoined-twins>

What are the benefits and limitations of using ultrasound as a diagnostic tool?. Dr.Oracle - The World's Most Powerful Medical Artificial Intelligence Platform. (2025, October 1). <https://www.droracle.ai/articles/377938/what-are-the-benefits-and-limitations-of-using-ultrasound>