Gastroschisis, Omphalocele, Pentalogy of Cantrell

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MATERNAL-FETAL MEDICINE

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Gastroschisis, Omphalocele and Pentalogy of Cantrell

- Pathophysiology
- Genetics
- Ultrasound findings
- Antepartum management
- Postpartum outcomes

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GASTROSCHISIS

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Gastroschisis (epidemiology)

- A defect of the anterior abdominal wall with herniation of intestine and abdominal organs into the amniotic fluid

- In the united states incidence is 4-5 per 10,000 births
- Gastroschisis is the most common congenital defect of the abdominal wall
- Between 2006-2012 the prevalence increased by 30% in the US- cause unknown
- In 95% of cases the defect is to the right of umbilical cord

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Gastroschisis (Risk factors)

- Young maternal age (<20)
- Maternal infections (STI, UTI)
- Smoking
- Use of antidepressants
- Use of paracetamol in first two months of pregnancy
- Drug use in first month of pregnancy

- HIGH BMI appears to be protective

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Gastroschisis (pathophysiology)

- The defect occurs in the first ten weeks of pregnancy
- Several theories

- Feldkamp et al: teratogen exposure near week 4 causes failure of fusion of the lateral folds

-Kluth and Lambrecht : rupture of an omphalocele

-Bargy and Beaudoin : rupture of amnion surrounding the eviscerated loops during physiologic herniation

- Interruption of the left omphalomesenteric artery, abnormal involution of the right umbilical artery

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Gastroschisis (diagnosis)

- Easily made in second trimester 90% accuracy
- Be cautious in the first trimester due to physiologic herniation of the gut which should disappear by 12 weeks (Early detection does not alter management)

- 1) small abdomen 2)defect to the right of the umbilical cord 3) extruded abdominal contents

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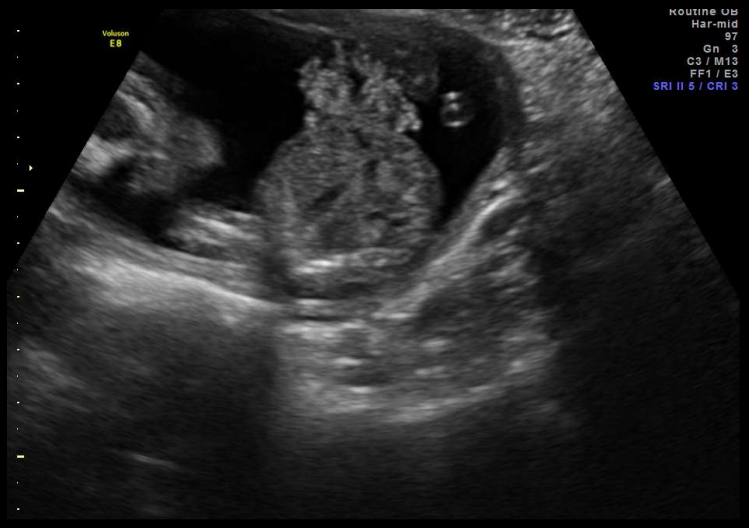
GASTROSCHISIS



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Gastroschisis (genetics)

- Not associated with aneuploidy
- No known recurrence risk

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Gastroschisis (antenatal)

- Fetal death risk is 4.5% compared to the normal 0.6%
  appears to be related to compression of the umbilical cord due to the herniated viscera.
- Growth restriction occurs in 24-67% due to the loss in the size of the abdomen (not usually uteroplacental insufficiency) but also due to loss of nutrients from the exposed bowel

AFI is usually normal but a high AFI can indicate a bowel problem (intestinal atresia)

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Gastroschisis : FGR

- It seems reasonable that formulas for calculating fetal weight will underestimate EFW in babies with gastroschisis
- However all biometric parameters tend to be small in affected fetuses
- There is a formula (Siemer) designed specifically for babies with gastroschisis and omphalocele
- Hadlock overestimates FGR – in one study of patients with gastroschisis 72% were diagnosed with FGR but only 52% were confirmed at birth

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Gastroschisis (Antenatal): Complex vs Simple

- Complex gastroschisis is defined by the presence of additional bowel complications and has a 17% neonatal mortality vs (4.5% for simple)
- Atresia
- perforation
- necrosis
- Vovulus

- Not possible to control complex features but we can reduce morbidity and mortality by monitoring and appropriate management.

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Gastroschisis : what should be monitored Wall Thickness

- Randomized controlled trial looking at bowel wall thickness
- A cutoff of 2.5mm
- Wall thickening was not found to be related to atresia, perforation, necrosis or volvulus
- Believed to be an inflammatory reaction

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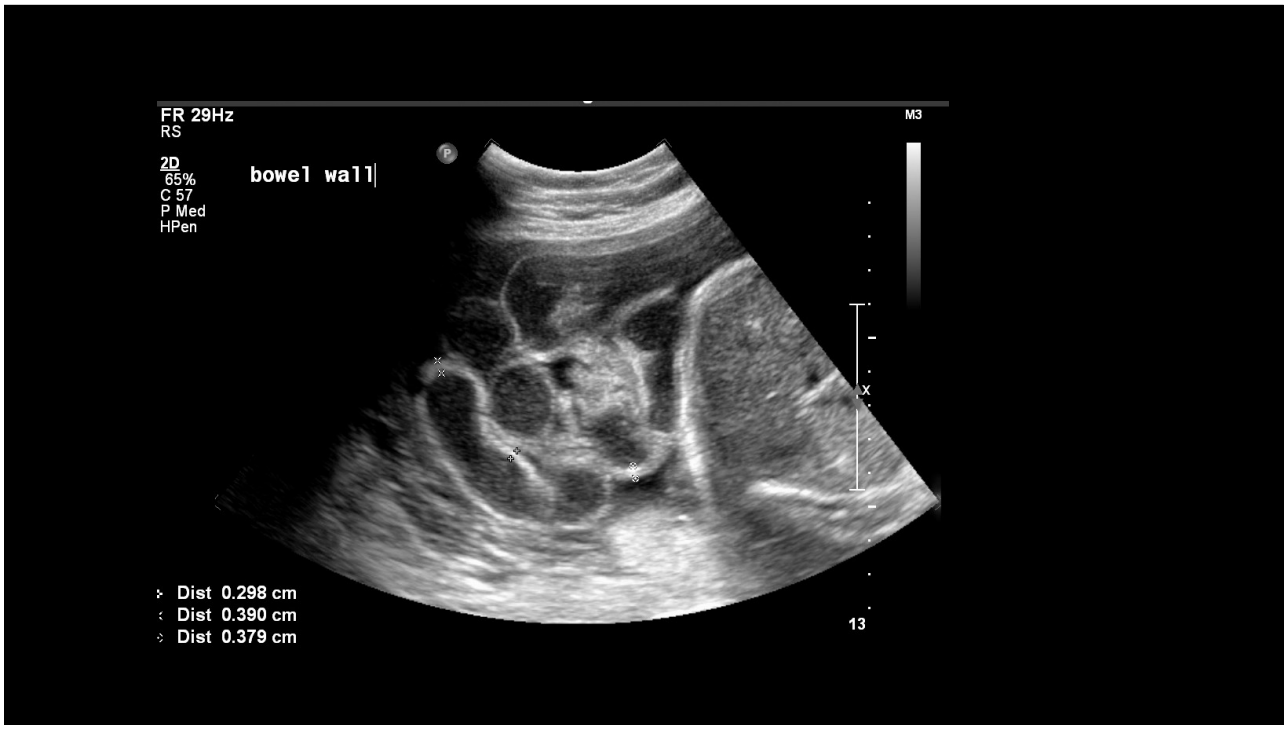

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Intra-abdominal bowel dilation

- In one meta-analysis
- IABD >10mm between 20-22 weeks had a 96% specificity for predicting complex gastroschisis
- This finding was associated with short bowel syndrome, longer hospital stays and longer time to enteral feeds

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Extra-abdominal bowel dilation

- A retrospective review found higher mortality and length of hospital stay with a specificity of 89% and sensitivity of 64% and a negative predictive value of 91%

Weeks gestation	maximum bowel dilation
25	8mm
26	9mm
27	10mm
28	11mm

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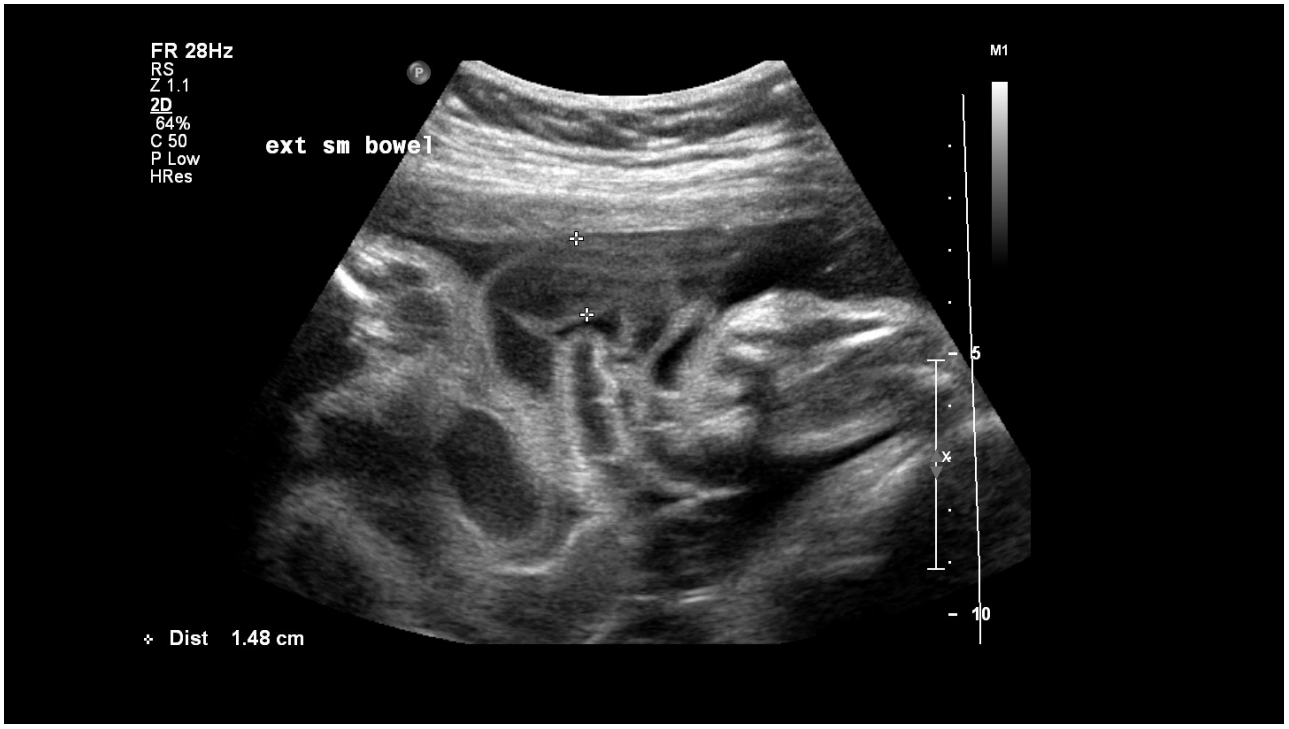

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Gastroschisis: the size of the defect

- Does the size of the defect change? YES
- It should be measured if possible at each visit
- But also as the baby grows the size of the bowel increases
- Be aware and on the lookout for vanishing gastroschisis

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Gastroschisis : vanishing

- Ischemic changes of the bowel due to compression of bowel loops and mesentery by the narrowing defect
- I have found that its difficult to measure the defect as the pregnancy progresses
- The mesenteric artery should be evaluated when possible

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Gastroschisis : vanishing (3 types)

- Type 1 : the exposed bowel is connected to the intra-abdominal bowel by an atrophied segment of bowel with a tight narrow defect.
- Type 2: All of the exposed bowel is atrophied and protrudes through a tiny defect
- Type 3: complete closure of the defect with extensive atresia of bowel.

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Gastroschisis (prognostic US markers)

- Intra-abdominal intestinal dilation (IABD) limits by gestational age (25-30)12mm; (30-35)19mm; (35-40)24mm
- Extra-abdominal intestinal dilation (EABD) diagnosed at (>10mm)
- Intestinal wall thickening (>3mm)
- Polyhydramnios

Associated with adverse neonatal outcomes

need for intestinal resection

increased time on TPN

prolonged hospital stay

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Gastroschisis (prognostic US markers)

- Ok now what do you do about them ?
- Probably the most important marker is the size of the defect and ? blood flow in the superior mesenteric artery.

** at least one study indicates doppler of the superior mesenteric artery do not predict poor neonatal outcome (Abuhamad 1997)

- The other markers as isolated findings should be watched. Some of them will change with vanishing gastroschisis

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Gastroschisis: US markers

- Concern for vanishing gut (abnormal flow in mesenteric artery, defect becoming smaller, extra-abdominal bowel dilation and wall thickening) is an indication for preterm birth in gastroschisis -

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Gastroschisis :antenatal surveillance

- Monthly growth (expect FGR)
- Measure defect size at each growth scan
- Initiate weekly BPP at 32 weeks
- If concern for FGR weekly dopplers
- +/- wall thickness
- +/- extra abdominal and intra abdominal bowel dilation

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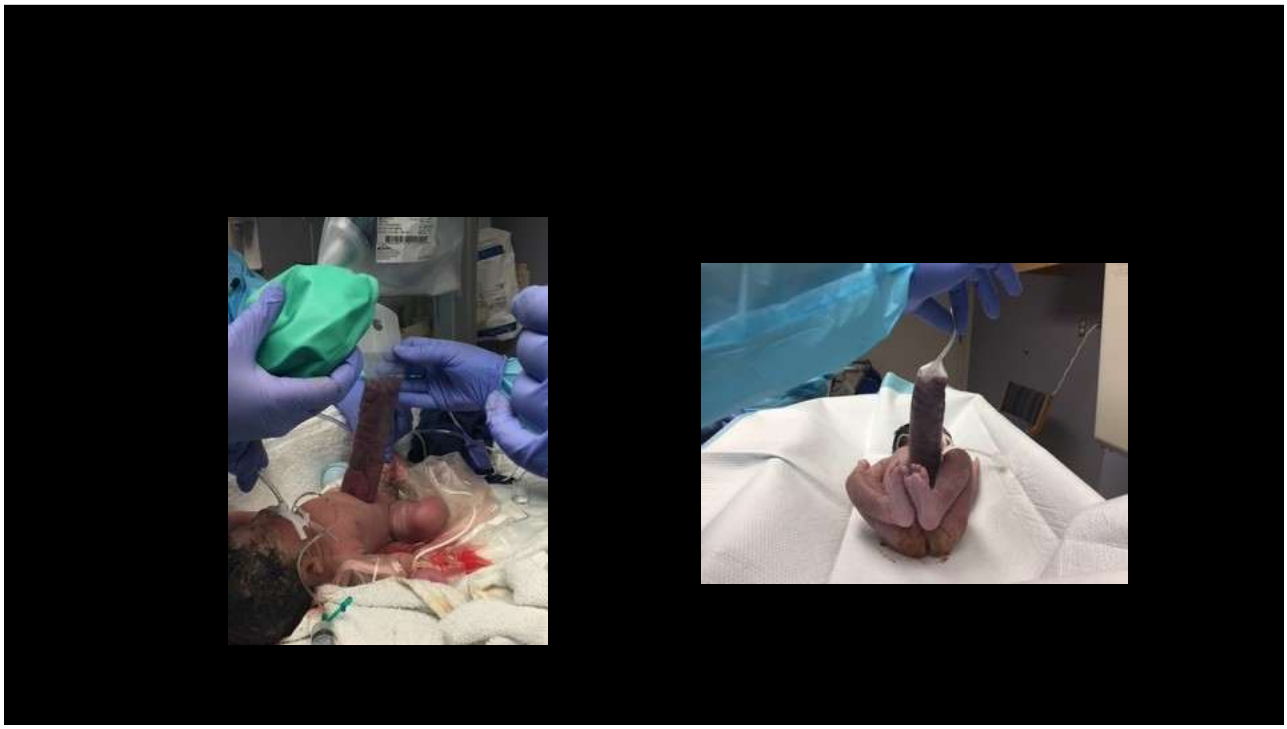

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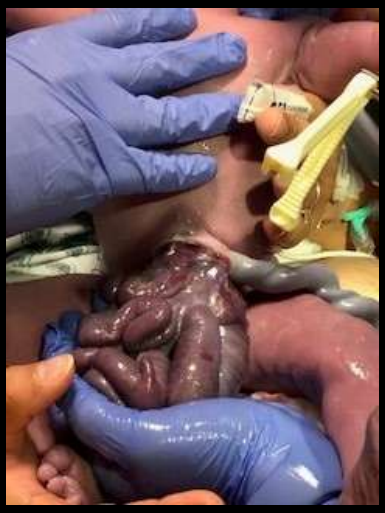

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Gastroschisis (whats new)

- In 2023 there was a case report of intrauterine repair of a gastroschisis. At 48 hours the closure failed and baby was delivered.
- Currently an ongoing trial of Fetal repair of complex gastroschisis
- NCT05704257 (A safety and feasibility trial currently recruiting)

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Gastroschisis: Delivery

- Fetal death is more common in babies with gastroschisis and the risk increases after 37 weeks.
- Preterm newborns with gastroschisis have worse outcome
  - rates of sepsis
  - prolonged mechanical ventilation
  - short bowel syndrome
  - death

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Gastroschisis : Delivery

- For every 100g of additional weight the odds of a primary closure increase by 9% (vs delayed closure)
- Delivery is recommended around 37-38 weeks
- If preterm delivery necessary -steroids enhance both lung maturity and bowel maturity
- No difference in vaginal birth vs Cesarean section in neonatal outcomes.

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OMPHALOCELE

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Omphalocele

- An omphalocele refers to herniation of abdominal contents through a defect of the abdominal wall at the umbilicus. In contrast to gastroschisis, the bowel is enclosed in a membrane.
- Affects 1 in 6000 live births

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Omphalocele (causes)

- Considered multifactorial
- May be associated with single gene disorder or a syndrome or aneuploidy

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Omphalocele (risk factors)

- African American
- High doses of vitamin E
- Smoking
- SSRIs

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Omphalocele (types)

- Epigastric : upper abdominal wall and does not reach umbilicus –the most severe of this type is pentalogy of Cantrell
- Central: the middle abdominal wall and the umbilicus – this is the most common type and the one most people think of
- Hypogastric :under the umbilicus and always have urorectal anomalies

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Omphalocele: Ultrasound

- Easily diagnosed in 2nd and 3rd trimester
- Detection by ultrasound should be 100%
- Characteristic images of a thin sac protruding from the abdomen containing viscera. The umbilical cord is inserted into the omphalocele sac.
- Both omphalocele and gastroschisis will have an elevated MSAFP

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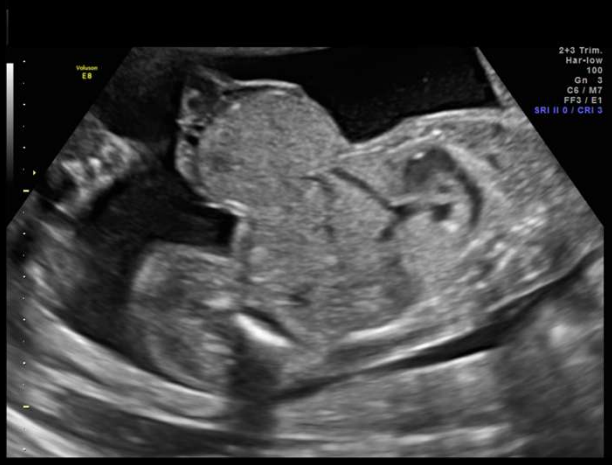

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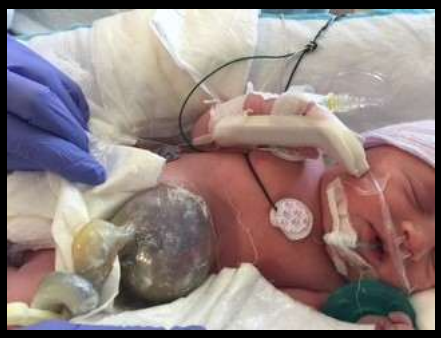
OMPHALOCELE



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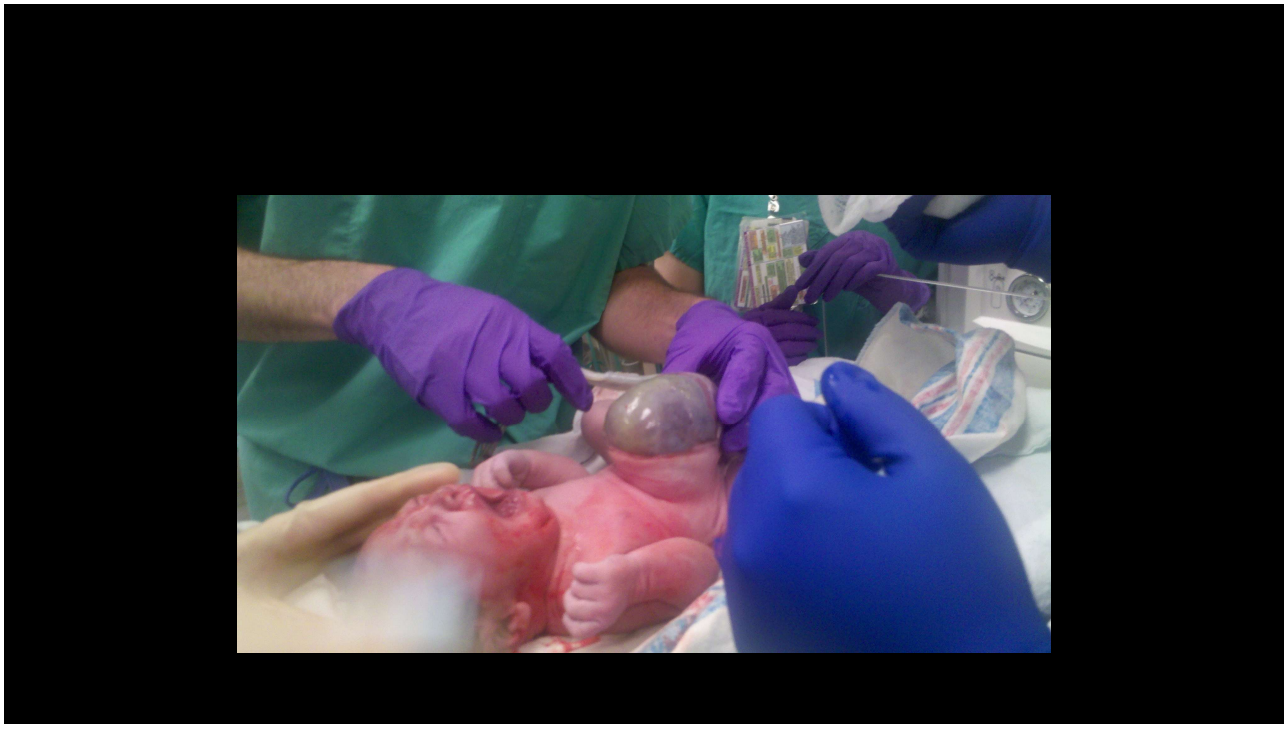

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Features	Omphalocele	Gastroschisis
Definition	Defect through the umbilicus	Defect adjacent to Umbilicus
Covering	Covered by peritoneal sac	Not covered
Size of Defect	Large defect, liver may herniate	Bowel exposed , may be small
Associated findings	Other congenital anomalies , Becwith-Weidmann Syndrome , T13, T18,T21	Less congenital anomalies, atresia and perforation common, usually normal chromosomes

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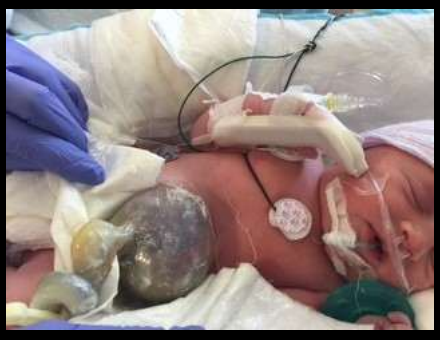

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Omphalocele : genetics

- 38-67% have a chromosomal defect
- Trisomy 18 (most common with an incidence of 77%)
- Trisomy 13 (incidence of 11.4%)

- This means that if there is a chromosomal defect it is most likely to be T18

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Omphalocele: genetics

- Familial syndromes have been reported
- Most often is Beckwith-Wiedemann syndrome (BWS)

- (BWS occurs due to paternal uniparental disomy of 11p15)

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Giant omphaloceles

- Giant omphaloceles : >5cm in diameter or liver out – 30% have a heart anomaly and 15% have a diaphragmatic hernia
- Giant omphaloceles are usually karyotypically normal
- However associated with a worse neonatal course – more likely to have respiratory distress, ventilator dependency and pulmonary HTN
- Small omphaloceles more likely to be aneuploid.

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Omphalocele

- With a chromosomal anomaly mortality as high as 40%
- Antenatally – high risk of PTB and fetal demise
- Monthly growth
- Weekly BPP starting at 32 weeks

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OMPHALOCELE : outcomes

- Cesarean recommended for Giant omphaloceles
- Baby will usually be admitted to the NICU
- 13% of babies develop SBO in first year
- Babies with Giant omphaloceles at risk for chronic lung disease
- Giant omphaloceles less likely to have chromosomal abnormalities

These babies may develop pulmonary HTN especially with the Giant omphaloceles.

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Omphalocele: Polymalformative syndrome

- This is a type of syndrome that has been found to be recurrent in some families and therefore likely genetic .
- OEIS (hypogastric omphalocele, bladder exstrophy,imperforate anus and spina bifida) deletion of 1p36
- Pentalogy of Cantrell (discussed next) epigastric omphalocele

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PENTALOGY OF CANTRELL

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Pentalogy of Cantrell

- 1958 James R. Cantrell MD was a surgeon at Johns Hopkins. He wrote a case report of 5 patients with "an unusual combination of congenital defects" in the *Journal of Surgery, Gynecology and Obstetrics*
- 1) a midline abdominal wall defect
- 2) a defect of the lower sternum
- 3) deficiency of the anterior diaphragm
- 4) a defect in the diaphragmatic pericardium
- 5) intracardiac defect

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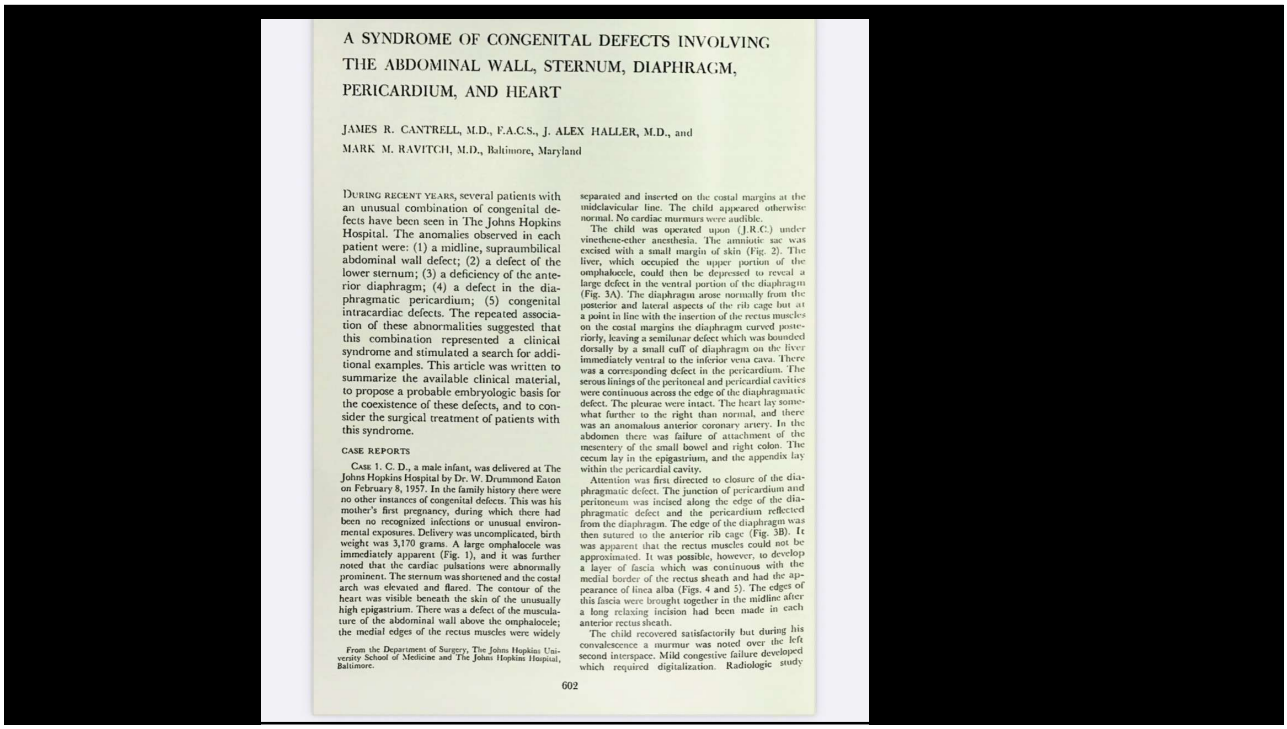

A SYNDROME OF CONGENITAL DEFECTS INVOLVING THE ABDOMINAL WALL, STERNUM, DIAPHRAGM, PERICARDIUM, AND HEART

JAMES R. CANTRELL, M.D., F.A.C.S., J. ALEX HALLER, M.D., and MARK M. RAVITCH, M.D., Baltimore, Maryland

During recent years, several patients with an unusual combination of congenital defects have been seen in The Johns Hopkins Hospital. The anomalies observed in each patient were: (1) a midline, supraumbilical abdominal wall defect; (2) a defect of the lower sternum; (3) a deficiency of the anterior diaphragm; (4) a defect in the diaphragmatic pericardium; (5) congenital intracardiac defects. The repeated association of these abnormalities suggested that this combination represented a clinical syndrome and stimulated a search for additional examples. This article was written to summarize the available clinical material, to propose a probable embryologic basis for the coexistence of these defects, and to consider the surgical treatment of patients with this syndrome.

CASE REPORTS

Case 1. C. D., a male infant, was delivered at The Johns Hopkins Hospital by Dr. W. Drummond Eaton on February 8, 1957. In the family history there were no other instances of congenital defects. This was his mother's first pregnancy, during which there had been no recognized infections or unusual environmental exposures. Delivery was uncomplicated, birth weight was 3,170 grams. A large omphalocele was immediately apparent (Fig. 1), and it was further noted that the cardiac pulsations were abnormally prominent. The sternum was shortened and the costal arch was elevated and flared. The contour of the heart was visible beneath the skin of the unusually high epigastrium. There was a defect of the musculature of the abdominal wall above the omphalocele; the medial edges of the rectus muscles were widely separated and inserted on the costal margins at the midclavicular line. The child appeared otherwise normal. No cardiac murmurs were audible.

The child was operated upon (J.R.C.) under vinethene-ether anesthesia. The amniotic sac was excised with a small margin of skin (Fig. 2). The liver, which occupied the upper portion of the omphalocele, could then be depressed to reveal a large defect in the ventral portion of the diaphragm (Fig. 3A). The diaphragm arose normally from the posterior and lateral aspects of the rib cage but at a point in line with the insertion of the rectus muscles on the costal margins the diaphragm curved posteriorly, leaving a semilunar defect which was bounded dorsally by a small cuff of diaphragm on the liver immediately ventral to the inferior vena cava. There was a corresponding defect in the pericardium. The serous linings of the peritoneal and pericardial cavities were continuous across the edge of the diaphragmatic defect. The pleurae were intact. The heart lay somewhat further to the right than normal, and there was an anomalous anterior coronary artery. In the abdomen there was failure of attachment of the mesentery of the small bowel and right colon. The cecum lay in the epigastrium, and the appendix lay within the pericardial cavity.

Attention was first directed to closure of the diaphragmatic defect. The junction of pericardium and peritoneum was incised along the edge of the diaphragmatic defect and the pericardium reflected from the diaphragm. The edge of the diaphragm was then sutured to the anterior rib cage (Fig. 3B). It was apparent that the rectus muscles could not be approximated. It was possible, however, to develop a layer of fascia which was continuous with the medial border of the rectus sheath and had the appearance of linea alba (Figs. 4 and 5). The edges of this fascia were brought together in the midline after a long relaxing incision had been made in each anterior rectus sheath.

The child recovered satisfactorily but during his convalescence a murmur was noted over the left second interspace. Mild congestive failure developed which required digitalization. Radiologic study

From the Department of Surgery, The Johns Hopkins University School of Medicine and The Johns Hopkins Hospital, Baltimore.

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Pentalogy of Cantrell (epidemiology)

- Rare
- Incidence reported as 1:65,000 to 200,000 live births
- Slight male predominance 1.35:1

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Pentalogy of Cantrell

- The type of heart defect can vary

-VSD is most common

-ASD

-Tetralogy of fallot

-Pulmonary stenosis

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Pentalogy of Cantrell

- The sternal defect can vary from a very mild cleft to ectopia cordis
- Ectopia cordis may be present but is not required for the diagnosis

More recent data indicates Pentalogy varies in penetrance (severity)

-Patients with all 5

-Patients with 4defects (includes heart and ventral wall)

-Patients with no heart defect or missing one of the other defining features

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Pentalogy of Cantrell

- More likely Pentalogy falls in the spectrum of diseases resulting from improper closure of lateral and craniocaudal folds
- These include

-OEIS (omphalocele,exstrophy, imperforate anus, spina bifida)

-LBWC (limb body wall complex)

The event (whatever it is) likely occurs between day 14-18 and the wide spectrum may reflect the difference in the time the error occurs

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Pentalogy of Cantrell (genetics)

- No single gene has been identified
- Associations with T21,T18 and 45XO
- Case reports of affected siblings (polymalformative syndromic)
- There is an x-linked dominant form in the region Xq25-q26

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Pentalogy of Cantrell (prenatal diagnosis)

- Can be diagnosed in first trimester with large omphalocele or ectopia cordis
- Most common diagnosis at 20 week scan
- If you suspect pentalogy its important to do fetal echo to know the cardiac defect because that's one of the biggest indicators of survivability. However, the literature also states that precise diagnosis may not be available until surgery.
- Offer amniocentesis for microarray – aneuploidy is common (NIPT can be the first step)

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Pentalogy of Cantrell (postnatal)

- Some of these babies do survive
- Baby will undergo additional imaging to define the defect(s)
- Babies with lethal aneuploidies (13,18) may not be candidates for surgical repair
- Surgery aims to repair the heart, restore cardiac position and anatomy, repair abdominal wall and diaphragm defects

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Pentalogy of Cantrell (post natal)

- Survival is 37%
- Very few patients with ectopia cordis survive
- Incomplete pentalogy with no ectopia cordis has a reported survival as high as 61% with surgical repair

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Pentalogy of Cantrell (Delivery When and How)

- Well it depends
- Is the baby euploid
- Is there a risk of injury to the liver - then C/S
- If there is ectopia cordis and the parents desire heroic measures delivery should be by C/S

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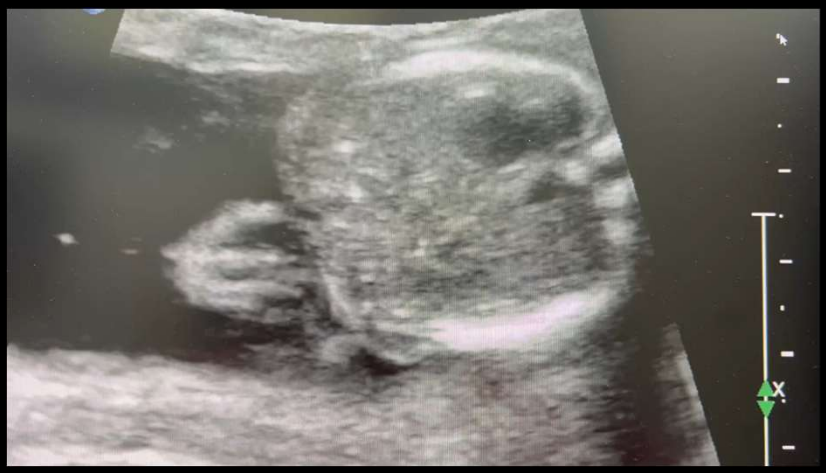
Ectopia cordis



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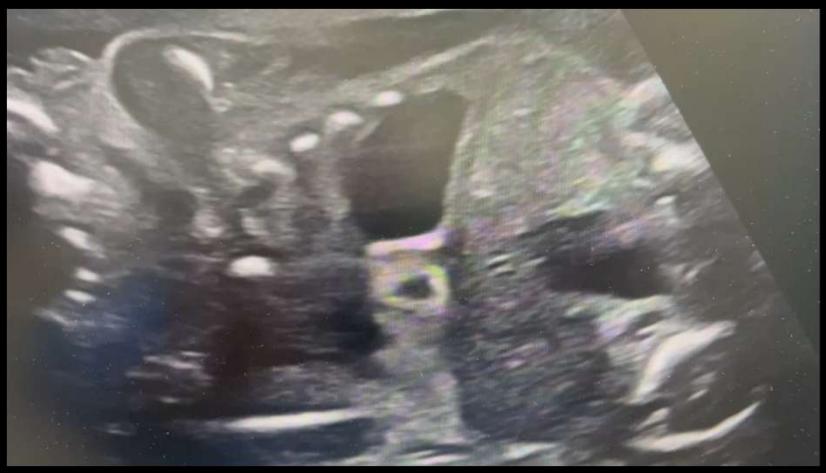

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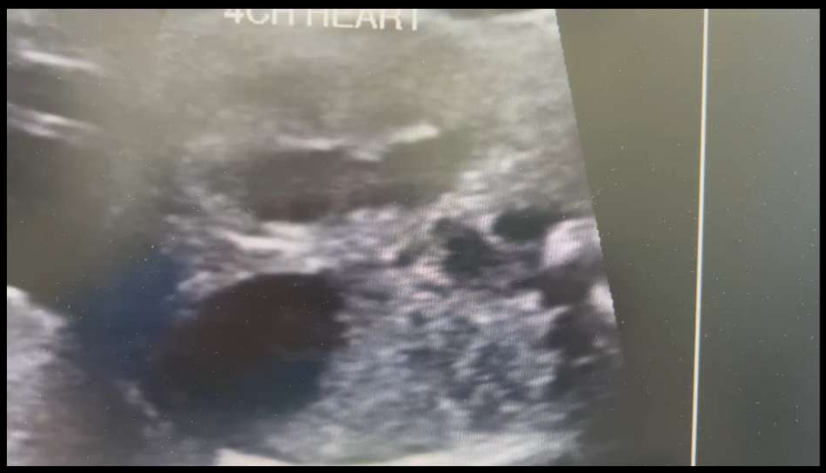

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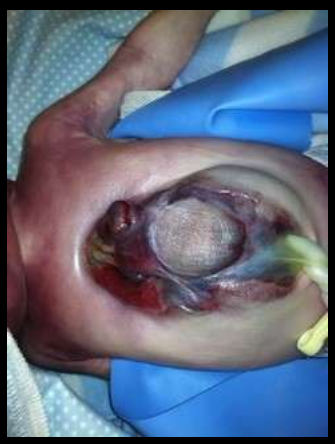
Pentalogy of Cantrell



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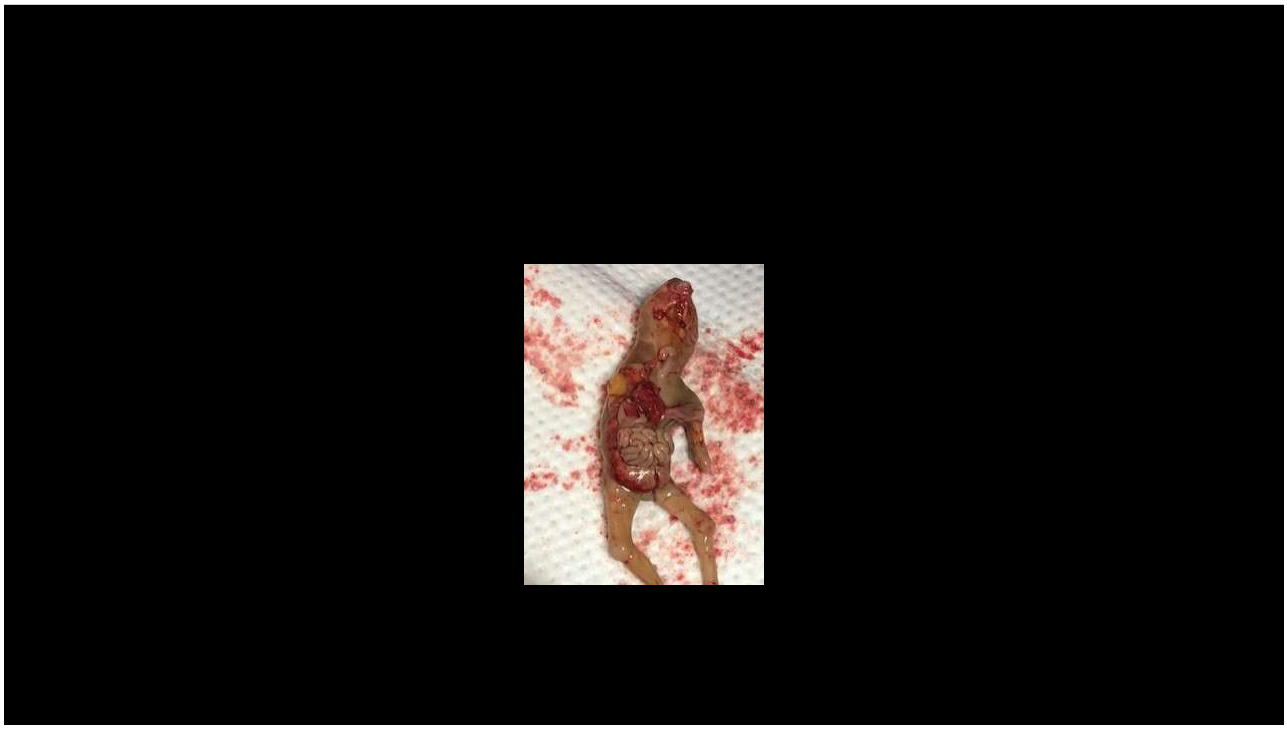

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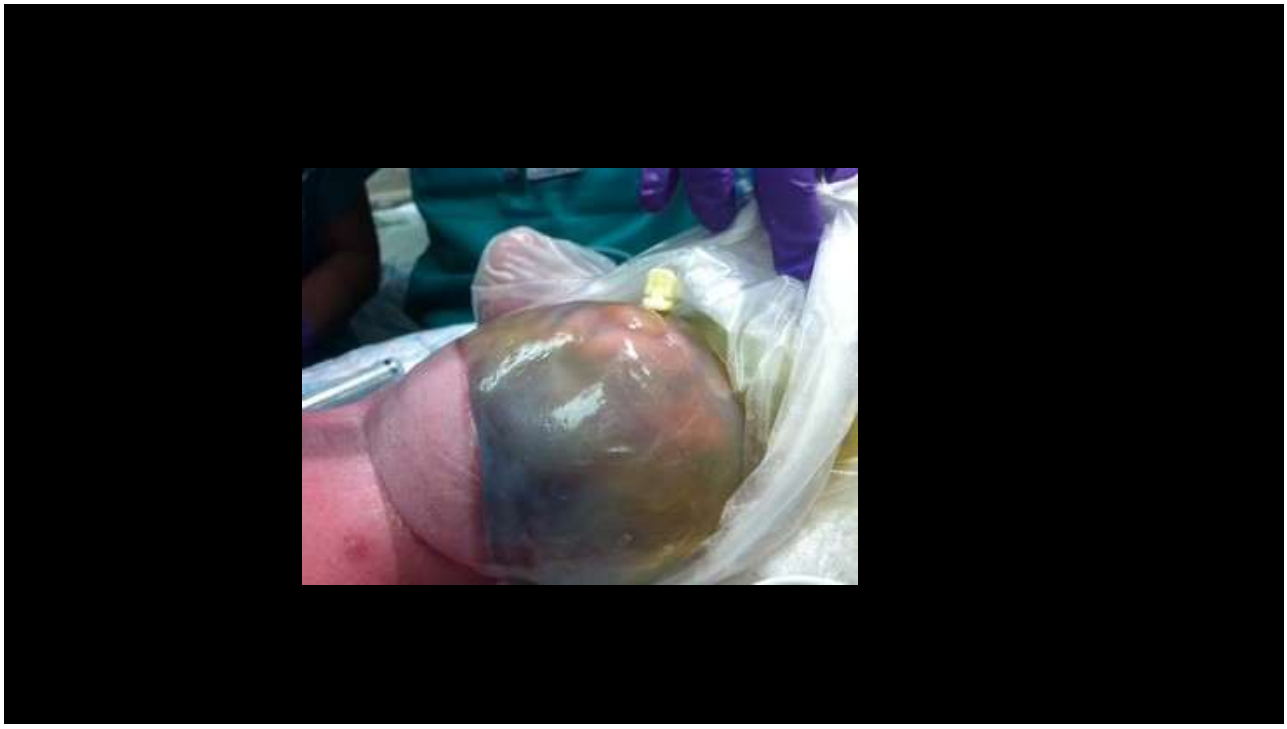

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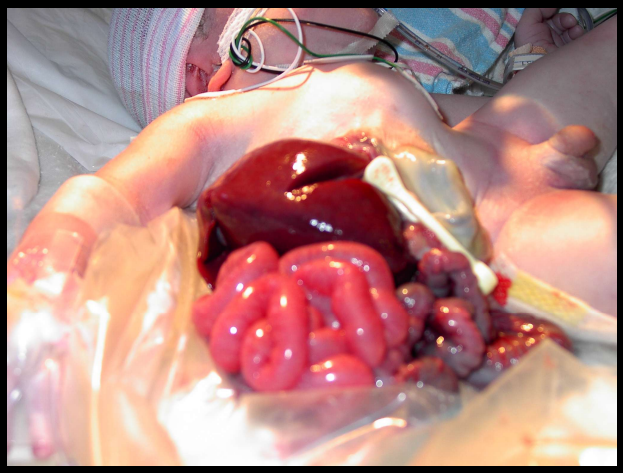
BODY STALK ?



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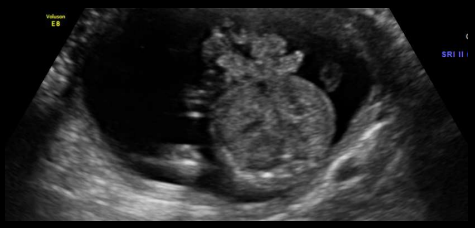
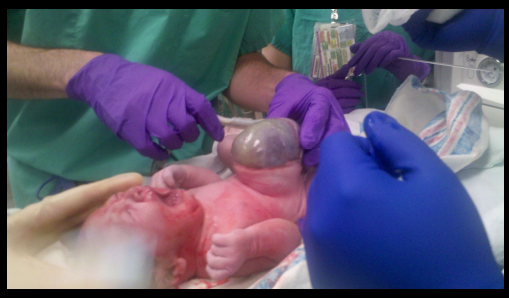
QUESTIONS?





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REFERENCES

- Williams et al. Pentalogy of Cantrell . Semin Pediatr Surg 2019 April 28(2):106-110
- Muniz et al. Gastroschisis : embryology, pathogenesis, risk factors, prognosis, and ultrasonic markers for adverse neonatal outcomes. J of Ultrasound (2024) 27:241-250
- Poaty et al. Omphalocele: a review of common genetic etiologies. Egyptian Journal of Medical Human Genetics 92019) 20:37
- Fogelstrom et al. Omphalocele: national current birth prevalence and survival. Pediatric Surgery International (2021)37:1515-1520
- Sun et al. Prenatal ultrasonographic markers for prediction of complex gastroschisis and adverse perinatal outcomes: a systematic review and meta-analysis. Arch Dis Child Fetal Neonatal Ed. 2022;107;F371-F379.
- Stoll et al. Omphalocele and gastroschisis and associated malformations. Am J Med Genet Part A 246A:1280-1285 (2008).
- Jaczynska et al. Prenatal ultrasound markers for prediction of complex gastroschisis- single center retrospective cohort study. Journal of perinatology (2024) 44:1325-1334
- Pontes et al. Fetal Gastroschisis: Review from diagnosis to delivery . J of Clinical Ultrasound.2025;53:1122-1130.
- Kumar et al. A Proposed Classification for the Spectrum of Vanishing Gastroschisis. Eur J Pediatri Surg 2013;23:72-75,

71

- Abuhamad et al. superior mesenteric artery doppler velocimetry and ultrasonograhic assessment of the fetal bowel in gastroschisis: a prospective longitudinal study. Am J Obstet Gynecol. 1997 May
- Lamoshi A. Current practice for gastroschisis prenatal surveillance among society for maternal fetal medicine (SMFM)members. Bulletin of the National Research Centre (2022) 46:93

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