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Challenges in the Prenatal Diagnosis of Cloaca

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Abstract

Background: Cloaca is a common excretory channel for the genital, urinary, and gastrointestinal tracts. It is considered a severe anorectal malformation caused by failed partitioning of the genital, rectal, and urinary tracts.

Methods: We report 5 infants with cloaca at birth who were identified prenatally by one or more of the following on prenatal ultrasound (US): ambiguous genitalia, a cystic pelvic/abdominal mass, hydronephrosis, ascites, a single umbilical artery, and oligohydramnios.

Results: A cystic pelvic/abdominal mass and ambiguous genitalia were each observed in 3 cases by prenatal US. Ambiguous genitalia was observed in all 5 neonates at birth. There were 2 twin pregnancies (dichorionic/diamniotic and monochorionic/monoamniotic), with only 1 twin in a set affected with cloaca.

Conclusion: Pediatricians should be alert to the prenatal US findings that may raise suspicion of a persistent cloaca to improve both prenatal counseling and family preparation.

Keywords

pediatrics, neonatology, pediatric urology, prenatal, cloaca

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Highlights

What Do We Already Know about this Topic?

Cloaca is a severe anorectal malformation caused by failed partitioning of the genital, rectal, and urinary tracts.

How Does Your Research Contribute to the Field?

Our research reported 5 infants with cloaca at birth who were identified prenatally by one or more of the following on prenatal ultrasound: ambiguous genitalia, a cystic pelvic/abdominal mass, hydronephrosis, ascites, a single umbilical artery, and oligohydramnios.

What Are Your Research's Implications toward Theory, Practice, or Policy?

Pediatricians should be alert to the prenatal ultrasound findings that may raise suspicion of a persistent cloaca to improve both prenatal counseling and family preparation.

Introduction

Cloaca is a common orifice for the genital, gastrointestinal, and urinary systems. Though this is normal anatomy for some animal species, this is a severe congenital anomaly in humans. It is caused by failure of the rectal, urethral, and genital openings to separate creating a single common perineal orifice.[1-8] During ontogeny the confluence of the genital, urinary, and gastrointestinal

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tracts persists to the 5th week of gestation.[5,7,9] The urorectal septum arises at the 7th week of gestation and divides the cloaca into the anterior (urogenital sinus) and posterior (anorectal canal) sections.[5,7,10] The persistent cloaca is due to failure of this early embryonic event.

With a worldwide incidence of between 1:50 000 and 1:250 000 live births, a congenital persistent cloaca represents 10% of all anorectal malformations.[1,4,5,7,8,11] A cloacal orifice may be associated with spinal, renal, urogenital, cardiovascular, and gastrointestinal abnormalities.[7,8] It is often diagnosed between 19 and 33 weeks of gestation.[4,7] Classic findings observed on prenatal US may include a cystic pelvic mass which may be filled with debris, hydronephrosis, neural tube defects, omphalocele, distended bladder, oligohydramnios, bowel dilatations, vertebral anomalies, ascites, and ambiguous genitalia.[1-5,7,10,12-14] Hydrocolpos is noted in approximately 30% to 50% of neonates with cloaca due to urinary outlet obstruction and reflux into the vaginal cavity.[1,3,5,13,14] This may impede bladder emptying and may cause ureteric obstruction and hydronephrosis.[3,7,14] Additionally, oligohydramnios may develop as a result of urinary tract obstruction or severe renal dysplasia, leading to pulmonary hypoplasia.[2,5,7] Prenatal diagnosis of congenital anomalies is often challenging using US since there are other rare medical conditions that may mimic cloaca, such as megacystis microcolon intestinal hypoperistalsis syndrome, imperforate hymen, or urogenital sinus with a normal rectum.[7,8] Most genital anomalies are diagnosed at birth. Early identification of cloaca permits appropriate parental counseling and better prepares the families for the perinatal course.[5]

The main objective of our study was to increase the awareness of the rare pathology of cloaca which allows for parental counseling and delivery planning at a tertiary care center. We present 5 unique cases of a persistent cloaca, 4 of which had characteristic prenatal US features suggestive of cloaca. We discuss the challenges in prenatal diagnosis of a persistent cloaca, the characteristic prenatal and postnatal US findings, the differential diagnosis, neonatal surgical interventions, and the multidisciplinary management of this rare condition.

Methods

Under an Institutional Review Board (IRB)-approved protocol, we performed a retrospective review of 5 infants who had a persistent cloaca at birth and were evaluated by a pediatric urologist at our Institution. We also reviewed the prenatal records of their mothers. Specific data extracted from medical records included demographics, obstetrics, laboratory results, and US findings. Four of the 5 pregnant women underwent serial prenatal US. Three women were managed by maternal-fetal medicine specialists, and 1 was evaluated by pediatric neurosurgery. All 5 infants were delivered by C-section.

Ethical Approval and Informed Consent

The Chair/Vice-Chair of the University of Louisville Institutional Review Board (IRB Number 18.0896) determined that our study is exempt according to 45 CFR 46.101(b) under category 4: Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded in a de-identified manner. As the patients in this study were less than 5 years of age, the patients' mothers provided written consent.

Results

Prenatal Findings

The median gestational age at the first abnormal fetal US was 23 weeks (interquartile range 8 weeks), and the median age of gestation at birth was 35 weeks (interquartile range 35 weeks). Table 1 depicts the pre- and postnatal findings associated with persistent cloaca at our Institution. A cystic pelvic/abdominal mass and ambiguous genitalia were each observed in 3 cases by prenatal US (Figure 1A, 1B). The most common prenatal US findings included an obstructed urinary system as evidenced by megacystis or hydronephrosis, single umbilical artery, ascites, and oligohydramnios (Figures 1C, 2A, 2B). There were 2 twin pregnancies (dichorionic/diamniotic and monochorionic/monoamniotic), with only 1 twin in a set affected with cloaca.

Several maternal risk factors were noted in the pregnant women, including gestational diabetes mellitus (DM), advanced maternal age (35 years or older), late prenatal care, antepartum obesity, previous preterm delivery, placenta previa, and illicit drug use (Table 1). The pregnant woman in Case 3 underwent limited US at 19- and 37-weeks gestation due to suspected intrauterine growth restriction, both of which revealed no fetal abnormalities.

Postnatal Findings

Ambiguous genitalia was observed in all 5 of the neonates at birth (Table 1) (Figure 3). Two infants were diagnosed with hydrometrocolpos, and one had a distended bowel. Four infants had evidence of spinal

Table 1. Prenatal and Postnatal Findings Associated with Cloaca at Our Institution.

Case	Time to Abnml US (WGA)	Time to birth (WGA)	Maternal risk factors and maternal age (years) at infant's birth	Prenatal findings					Postnatal findings
				Midline cystic structure	Hydro-nephrosis	Ascites	Oligo-hydramnios	Other	
1	38	39	39 GDM, AMA, LPC	Yes	Yes	No	No	Ambiguous genitalia Echogenic bowel	Ambiguous genitalia Hydrometrocolpos Hydronephrosis
2	23	34	27 PPD	No	Yes	No	No	Tetralogy of Fallot, VSD, ASD Absent left kidney Single umbilical artery	VACTERL Low-lying CM Hypoplasia of 1st metacarpal
3	19	39	24 IDU, Hepatitis C	Yes	No	No	Yes	None	Ambiguous genitalia VSD Sacral agenesis with vertebral anomaly Syrinx of spinal cord
4	27	35	37 GDM, AMA, Thyroid disease	Yes	Yes	Yes	No	Ambiguous genitalia Pericardial effusion Single umbilical artery	Di-di twin IUGR Ambiguous genitalia Hydrometrocolpos Low-lying CM
5	11	31	24 DM, IDU, POS, Trichomoniasis	Yes	Yes	No	No	Ambiguous genitalia Absent left kidney Myelocystocele OEIS sequence Single umbilical artery	Mono-mono twin Ambiguous genitalia Perineal mass Absent left kidney Lumbosacral myelomeningocele

Abbreviations: Abnml, abnormal; WGA, weeks gestational age; GDM, gestation diabetes mellitus; AMA, advanced maternal age; LPC, late prenatal care; AO, antepartum obesity; PPD, previous preterm delivery; PP, placenta previa; IDU, illicit drug use; POS, polycystic ovary syndrome; VSD, ventricular septal defect; ASD, atrial septal defect; VACTERL, vertebral defects, anal atresia, cardiac defects, tracheo-esophageal fistula, renal anomalies, and limb abnormalities; CM, conus medullaris; IUGR, intrauterine growth restriction; OEIS, omphalocele, exstrophy of the cloaca, imperforate anus, and spinal defects.

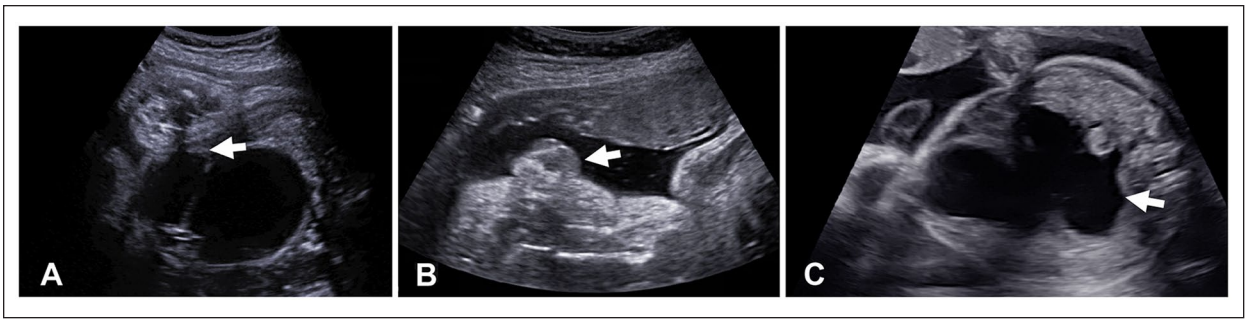

Figure 1. Prenatal ultrasounds. (A) Cystic mass measuring 5.94 × 6.1 × 6.11 cm (arrow) noted adjacent to the bladder. (B) Ambiguous genitalia (arrow). (C) Bladder is markedly distended and irregular in shape (AP dimension of 6.67 cm and widest transverse diameter of 4.13 cm) (arrow).

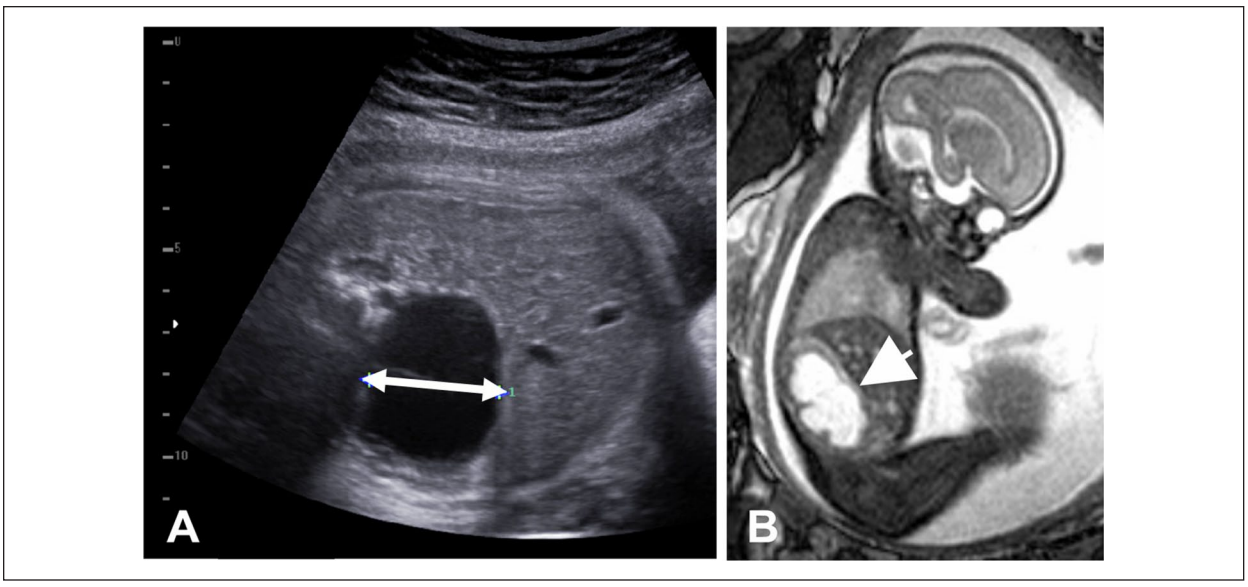

Figure 2. (A) Prenatal ultrasound of unilateral hydronephrosis (arrow). (B) Prenatal MRI of severe hydronephrosis (arrow).

abnormalities, including sacral vertebral anomalies (n = 3) and a low-lying conus medullaris (CM) (n = 2). Two infants were diagnosed with significant congenital syndromes: VACTERL (vertebral defects, anal atresia, cardiac defects, tracheo-esophageal fistula, renal anomalies, and limb abnormalities) and OEIS sequence (omphalocele, exstrophy of the cloaca, imperforate anus, and spinal defects).

Within 24 hours of birth, the cohort underwent a diverting colostomy. Two infants had vaginostomy drains placed, and one required nephrostomy tube insertion. One infant underwent placement of a suprapubic catheter, subsequent vesicostomy placement, and peritoneal dialysis catheter with dialysis initiation at 4 days of age (Figure 3). There was one mortality at 5 months of age (Case 5), while the other 4 infants with cloaca are still alive (ages 2-4 years old).

Follow-Up

At 4 years of age, the infant in Case 1 underwent a renal and bladder US which revealed no evidence of renal or bladder pathology. She had a vaginoplasty when she was 2 years old. At 4 years of age, the infant in Case 2 underwent a renal and bladder US which revealed a solitary kidney with compensatory hypertrophy and hydronephrosis. She was g-tube dependent. The 3-year-old infant in Case 3 had sustained recurrent urinary tract infections secondary to cystitis cystica and underwent a vaginoplasty. The infant in Case 4 had a ureteral stent placement at 1 ½ years of age.

Discussion

Following the development of successful surgical treatment for infants with persistent cloaca in the 1950's,

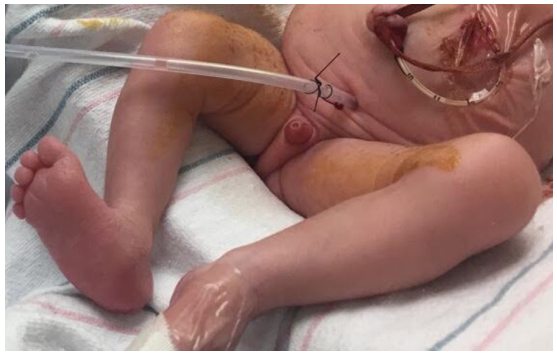

Figure 3. Cloaca with a small phallic structure, an imperforate urethral meatus, and imperforate anus. Note the suprapubic catheter that was placed 3 hours after birth since it was not possible to pass a catheter to the obstructed urinary system.

efforts were made to diagnose cloaca prenatally.[10] Serial US are beneficial in observing the evolution of abnormalities throughout gestation, as features of a persistent cloaca may not be apparent early in fetal life.[10,14] For example, the mother in Case 4 in our study underwent prenatal US at 20- and 23-weeks gestational age (WGA), both of which revealed no fetal abnormalities. It was not until her third prenatal US at 27 WGA that distinguishing features of cloaca were identified.

Early detection of characteristic findings associated with cloaca by prenatal US prepares parents for the upcoming birth and allows multidisciplinary coordination through the prenatal and perinatal periods. Cloacal anomaly is often characterized by a midline cystic structure on prenatal US.[1] The addition of hydronephrosis, hydrometrocolpos, intrapelvic fluid collection, dilated distal bowel, spinal and/or sacral deformities, uterine or vaginal duplication, or absent kidney in a female fetus may be suggestive of a cloacal anomaly. Not all classic findings were seen in our series (Table 1).[14,15] The phenotype varies based on the length of the common channel. For example, with a short common channel, obstruction of the genitourinary (GU) and gastrointestinal (GI) channels is less common, making a prenatal diagnosis less likely.[7] The differential diagnosis of a persistent cloaca includes any pathology which may form a midline cystic structure such as ovarian cysts, obstructive uropathy, intestinal duplication or atresia, isolated hydrocolpos, urogenital sinus, bowel atresia, distended vagina, and megacystis microcolon intestinal hypoperistalsis syndrome.[1,5,7,10,16] Exclusion of other diagnoses may be best performed with serial fetal US, MRI, and/or amniotic fluid digestive enzyme analysis, and cyst fluid biochemisty.[1]

Bischoff and colleagues performed a retrospective review of 489 patients born with cloaca, of which 95 had prenatal US.[12] Of the 270 abnormalities on these prenatal US, an abdominal/pelvic cystic mass, hydronephrosis, oligohydramnios, distended bowel/bowel obstruction, and ascites were most commonly observed.[12] Interestingly, the radiologists who interpreted these studies only suspected cloaca in 6 cases. These authors encourage increased suspicion for cloaca with abdominal cystic masses as well as a combination of gastrointestinal and urological abnormalities. With the plethora of distinguishing findings of cloaca in 4 fetuses in our study, the possibility of cloaca was only broached in one case prenatally reflecting the challenging diagnosis of this condition. Cloaca may not be diagnosed prenatally when only limited US are performed, as exemplified in Case 3 where the US at gestation weeks 19 and 37 were considered "normal."

While it has been suggested that surgical procedures may be performed prenatally such as drainage of hydrocolpos and placement of a vesico-amniotic shunt for severe oligohydramnios and severe hydronephrosis,[7,14,17] surgical intervention is mandatory in the perinatal period to treat obstruction of the GI (colostomy) and GU (vaginostomy) systems if needed.[3,8,14] A thorough examination of the genitourinary, gastrointestinal, cardiovascular, and neurological systems is warranted for confirmed persistent cloaca cases. Nephrourological abnormalities such as hydronephrosis, multicystic dysplastic kidney, absent kidney, megaureters, pelvic kidney, and horseshoe kidney are observed in approximately 90% of infants with cloaca.[5,8,14] Furthermore, one-half of patients with persistent cloaca will develop renal failure, requiring routine and life-long observation.[8] One recent paper suggested that prenatal interventions may improve perinatal outcomes; further studies are needed to verify this assertion.[17] Perinatal workups should include evaluation of the kidneys (BMP and renal US), heart (echocardiogram), spine (US or MRI), and rectum (Upper GI and KUB).

A constellation of pathological findings may be observed in conjunction with cloaca such as VACTERL and OEIS complex. A higher incidence of OEIS complex has been reported in twins, particularly monozygotic twins.[6,18] There may be similar findings in the prenatal US between cloacal anomaly and VACTERL, such as vertebral and renal anomalies as well as anorectal malformations. However, several additional features may be observed in VACTERL that should raise the suspicion for this diagnosis, including cardiovascular anomalies, tracheoesophageal fistula, esophageal atresia, and limb defects.[19] Pelvic cysts, hydronephrosis, oligohydramnios, and ascites are frequently

demonstrated on US in persistent cloaca. Abnormalities are mainly internal for patients with persistent cloaca. Patients with cloacal exstrophy, as seen with OEIS complex, often have anomalies that are visible on the body surface, such as omphalocele, myelomeningocele, and abnormal genitalia, all of which are detected by US.[20]

Prenatal counseling is warranted in all cases of twins and whenever cloaca may be suspected, with particular consideration of dialysis for premature infants with abdominal wall defects.[13] Several maternal risk factors have been reported as being associated with persistent cloaca.[21] Significant positive associations were confirmed between persistent cloaca and the use of any fertility medication or assisted reproductive technology procedure as well as for any cloacal defect with maternal obesity (BMI $\geq 30\,kg/m^2$).[21]

Our study highlights the classic findings indicative of a persistent cloaca on prenatal US. We report numerous risk factors that the pregnant women faced during gestation in addition to the host of pathological abnormalities observed in their fetuses. Our study encourages a complete observation of the fetus and after birth by US and physical examination to confirm the associated gastrointestinal, urological, cardiac, and spinal defects that may accompany cloaca. The limitations of our study include its retrospective nature, limited number of cases, and lack of thorough prenatal investigations, specifically, sparse utilization of prenatal MRI.

Conclusions

An accurate prenatal diagnosis of cloaca may be challenging with US but allows for a multidisciplinary approach to counsel the family on the expected perinatal challenges. Delivery at a tertiary care hospital with a neonatal intensive care unit and surgical subspecialists may be anticipated by prenatal US suggestive of a persistent cloaca. It is important for pediatricians to be aware of the prenatal US findings suggestive of a persistent cloaca.

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Author Contributions

LBES made substantial contributions to the conception and design, analyzed and interpreted the data, performed the literature search, and was the major contributor in the writing of the manuscript. JTW, DSP, and ER made substantial contributions to the conception and design, analyzed and interpreted the data, and revised the draft critically for important intellectual content. All authors read and approved the final manuscript.

Declaration of Conflicting Interests

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Informed Consent

We have obtained written informed consent from the mothers of the infants to publish their cases.

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