Clinical Policy Title: Fetal surgery in utero

Coverage policy

Select Health of South Carolina considers the use of fetal surgery in utero for the following conditions and/or diagnoses to be clinically proven and therefore, medically necessary, when the following criteria are met (Miller 2017, Soni 2016, Grivell 2015, Rossi 2008, Jani 2009):

A. Myelomeningocele repair:
   • Myelomeningocele with upper boundary of the lesion located between T1 and S1.
   • Evidence of hindbrain herniation.
   • Singleton pregnancy.
   • Gestational age 19 to 26 weeks.
   • Normal fetal karyotype.

B. Serial amniocentesis for twin-to-twin transfusion syndrome:
   • Women after 26 weeks of gestation.
   • Evidence of abnormal blood flow documented by Doppler studies in one or both fetuses.
   • Evidence of polyhydramnios in the recipient fetus.
   • Donor fetus is oligohydramniotic.
C. Vesico-amniotic shunting as a treatment of urinary tract obstruction:
   • Bladder distension.
   • Bilateral hydronephrosis due to urinary tract obstruction.
   • Evidence of progressive oligohydramnios or anyhydramnios.
   • Adequate renal function.
   • No other lethal abnormalities or lethal chromosomal abnormalities.

D. Fetoscopic or open laser ablation of anastomotic vessels, with or without serial amniocentesis, as treatment for twin-to-twin transfusion syndrome when both of the following criteria are met:
   • Diagnosis of severe twin-to-twin transfusion syndrome is confirmed clinically and by ultrasound between 15 and 26 weeks of gestation.
   • The benefits of laser surgery outweigh the risks to a previable fetus that is not a candidate for delivery, and has a high mortality rate otherwise.

E. Resection of malformed pulmonary tissue, or placement of a thoracoamniotic shunt as a treatment for any of the following:
   • Congenital cystic adenomatoid malformation when both of the following criteria are met:
     o Evidence of fetal hydrops.
     o Presence of one lesion, consisting of a single large cyst.
   • Extralobar pulmonary sequestration, when there is evidence of tension hydrothorax and/or fetal hydrops.
   • Fetal pleural effusion when all of the following criteria are met:
     o Fetal gestational age is 32 weeks or less.
     o Failure, contraindication, or intolerance to fetal thoracentesis.
     o Evidence of fetal hydrops and/or hypoplasia.

F. In utero needle access and open resection of sacrococcygeal teratoma as medically necessary for a previable fetus with or without early maternal pre-eclampsia, when there is evidence of fetal hydrops, placentomegaly, or polyhydramnios.

Optimal outcomes of fetal surgery in utero are found at facilities with the expertise, multidisciplinary teams, services, and highly credentialed surgeons who specialize in fetal surgery in utero, thus providing a high level of intensive care. (Rigorous patient care selection that offers the best outcomes with the least risk is important.)

G. Documentation is provided from the requesting physician stating that the anticipated outcome from proposed in utero surgery has a greater likelihood of a positive outcome than surgery performed post-delivery. This documentation must contain all necessary test results and studies that lead to a positive outcome.
Limitations:

Select Health of South Carolina considers the use of the following in fetal surgery in utero to be investigational, and therefore, not medically necessary for any of the following conditions:

- Fetal tracheal occlusion for congenital diaphragmatic hernia.
- Amnioexchange procedure for gastroschisis.
- Treatment of cleft lip and/or palate.
- Treatment for aqueductal stenosis (i.e., hydrocephalus).
- Amniotic band syndrome.
- Treatment of congenital heart defects.
- In utero gene therapy.
- In utero hematopoietic stem cell transplantation for stem cell diseases.

All other uses of fetal surgery in utero are not medically necessary.

Alternative covered services:

Post-delivery and obstetrical management and treatment.

Background

For decades, experimental fetal surgery proved essential in studying normal fetal physiology and development, and pathophysiology of congenital defects. Clinical fetal surgery started in the 1960s with intrauterine transfusions. In the 1970s, the advent of ultrasonography revolutionized fetal diagnosis and created a therapeutic vacuum. Fetal treatment, medical and surgical, is slowly trying to fill the gap. Most detected defects are best treated after birth and require a modification in the time, mode, and place of delivery for optimal obstetrical and neonatal care. Surgical intervention in utero should be considered for the following conditions:

- Malformations that may cause progressive damage to the fetus and lead to death or severe morbidity.
- Malformations that can be corrected or palliated in utero, with a reasonable expectation of normal postnatal development.
- Malformations that cannot wait to be corrected after birth (regardless of preterm delivery), and are not accompanied by chromosomal or other major anomalies.

At present, congenital hydronephrosis is the most common indication for fetal surgery, followed by obstructive hydrocephalus.

Congenital diaphragmatic hernia is an uncommon but severe condition in which there is a developmental defect in the fetal diaphragm, resulting in liver and bowel migrating to the chest cavity
and impairing lung development and function for the neonate. Prenatal interventions described to date have included maternal antenatal corticosteroid administration and fetal tracheal occlusion, with both methods aiming to improve lung growth and maturity.

Although most prenatally diagnosed malformations are best managed by appropriate medical and surgical therapy, after maternal transport and planned delivery at a tertiary care center, an expanding number of simple anatomical abnormalities with predictable, lethal consequences have been successfully corrected before birth. A malformation amenable to prenatal surgical intervention must fulfill a number of conditions. It must be severe enough to warrant the risks associated with in utero treatment and must be reliably detectable before birth. Additionally, the pathophysiology must be reversible by fetal surgery, significantly improving the prognosis over post-natal treatment. Many technical intricacies of open fetal surgery have been solved, but preterm labor and premature rupture of membranes remain an omnipresent risk to both the mother and the fetus. To reduce maternal morbidity and the risk of prematurity, minimally invasive techniques to treat the fetus prenatally have been developed. Current indications of fetal surgery include the treatment of congenital diaphragmatic hernia, cystic adenomatoid malformation of the lung, sacrococcygeal teratoma, obstructive uropathy, twin-to-twin transfusion syndrome, and myelomeningocele. Minimally invasive surgical techniques (e.g., Fetendo) have significantly lessened the incidence of preterm labor and promise to extend the indications for fetal surgical intervention.

In utero fetal surgery involves a highly technical, multidisciplinary approach to correct malformations of the fetus that interfere with organ development and have potentially fatal outcomes, if left untreated. The procedure involves opening the gravid uterus through the less invasive laparoscopic technique, or through an open caesarian surgical incision, surgically correcting the fetal abnormality and closing the uterus to allow gestational development to complete.

Fetal surgery should be performed by highly trained physicians in advanced centers, which are equipped to provide extracorporeal membrane oxygenation in Level III newborn intensive care units. The multidisciplinary approach employs pediatric surgeons, intensive care specialists, geneticists, ethicists, perinatologists, gynecological specialists, maternal and fetal specialists, and pathologists, and uses highly specialized radiology.

Fetal endoscopic surgery, a recently developed method of treating congenital conditions, can lessen maternal morbidity and additional stress to the fetus, when the latter is removed from the amniotic fluid environment. Combined with the use of tocolytic drugs, this procedure may also decrease the occurrence of postoperative preterm labor.

Fetal intervention is recommended when preterm delivery is contraindicated and the condition can be corrected allowing for normal development. Experts generally recommend early surgical intervention after a confirmed diagnosis of fetal decompensation. In general, surgery is performed prior to 32 weeks of gestation. After that time, standard treatment consists of early delivery and medically necessary interventions.
Myelomeningocele:

Also referred to as spina bifida, myelomeningocele is the most commonly observed malformation of the central nervous system, affecting more than 1,000 fetuses annually in the United States. Myelomeningocele is characterized by protrusion of the meninges and spinal cord through a defect in the vertebral arches, muscle, and skin of a developing fetus. Although the condition is rarely fatal, MMC patients are often limited by a range of disabilities, including paraplegia, hydrocephalus, skeletal deformities, bowel and bladder incontinence, and cognitive impairment. The standard treatment for MMC is to close the defect postnatally; however, this approach does not address damage associated with exposure of the meninges and spinal cord to cerebrospinal fluid (CSF) while in utero. As a consequence, researchers have proposed the feasibility of intervening in utero to prevent this damage by establishing a normal CSF drainage pathway. In utero fetal surgery for myelomeningocele remains highly controversial because the myelomeningocele defect is not fatal, and postnatal treatment is much simpler and not traumatic to the mother. The present report evaluates in utero fetal surgery for myelomeningocele relative to standard postnatal treatment.

Hayes (2013) reported on fetal in-utero surgery and included 11 studies, which compared in utero fetal surgery with standard care (postnatal surgery) for myelomeningocele. The majority of the studies were published within the past five years and sample size ranged from 20 to 293 fetuses. Eight of the studies were retrospective and three were prospective, including a randomized controlled trial (RCT). In utero surgery was compared with postnatal surgery in all studies. None of the studies included blinding of patients to the surgical procedure. Surgeries were completed at five sites: (1) the Center for Fetal Diagnosis and Treatment at the Children’s Hospital of Philadelphia (CHOP) (five studies); (2) the Division of Pediatric Surgery and Fetal Treatment Center at the University of California, San Francisco (two studies); (3) the Division of Pediatric Urology, Vanderbilt University (five studies); (4) University Medical Center Groningen in the Netherlands (one study); and (5) University of North Carolina School of Medicine in Chapel Hill (one study). The gestational age at the time of in utero fetal surgery was 20 to 25 weeks for all studies except for two: one included a cohort that was operated on between 20 to 30 weeks, and another had a mean operation gestational age of 37 weeks. The timing of follow-up across studies varied considerably. Four studies included testing only during postnatal stay at the hospital, one study included a one-year follow-up, two included variable follow-up that was ≥ one year, one study included both a one-year and 30-month follow-up, and two studies included longer-term follow-up of three years and approximately nine to 10 years.

The conclusion per Hayes report is: One RCT and 10 nonrandomized controlled studies compared in utero fetal surgery with standard postnatal surgery for myelomeningocele and provided moderate quality evidence that IUFS is associated with improved motor function, excretory function, and neuroanatomical outcomes, and a reduced need for shunt placement. However, in utero fetal surgery did not influence cognitive outcomes and did result in lower gestational age at birth (premature birth) relative to postnatal controls. Most of the studies were retrospective and did not follow up on the developmental outcomes of in utero fetal surgery past three years of age. As a consequence, the
relationship between many of the findings and longer-term clinical outcomes is not clear at this time. Some of the reviewed published evidence suggests that safety and impact on health outcomes are at least comparable to standard treatment. However, substantial uncertainty remains about safety and/or impact on health outcomes, because of poor-quality studies, sparse data, conflicting study results, and other concerns (Hayes, 2013).

Management of myelomeningocele study:

In February 2003, the National Institutes of Health (NIH) began the Management of myelomeningocele study. Three centers (Vanderbilt University, CHOP, and the University of California at San Francisco) were chosen to participate in the study of 183 randomized fetuses: 91 for fetal repair and 92 for postnatal repair. The study took eight years to complete at a cost of $22.5 million. Of the 1,087 fetuses and mothers initially screened for the study, 183 met all the inclusion criteria. The CHOP treated 77 patients, University of California at San Francisco treated 54 and Vanderbilt University treated 52.

Prenatal surgery was done at the assigned center between 19 and 25 weeks of pregnancy. Deliveries for both groups were performed by C-section at the assigned Management of myelomeningocele study Center, at approximately 37 weeks of pregnancy. The infants in the postnatal surgery group had their spina bifida closed at the Management of myelomeningocele study Center as soon as possible after delivery, usually within 48 hours. Medical information on the mothers and babies were gathered throughout the study and follow up of their progress continued until the child reached at least two-and-a-half years of age. Two outcomes were considered: the first, at 12 months, was death or need for a ventricular shunt; the second, measured at 30 months, was a composite score of standardized tests for mental and motor development.

Outcome of the trial:

An interim analysis conducted in December 2010, made public in February 2011, and released in the New England Journal of Medicine (NEJM) 2011, showed a statistically significant benefit to the surgery, and the trial was subsequently closed. The trial demonstrated that outcomes after prenatal spina bifida treatment are improved, to the degree that the benefits of the surgery outweigh the maternal risks. Results were reported in the NEJM (Adzick 2011).

Specifically, the study found:
- Babies who underwent fetal repair of spina bifida were half as likely to need a ventricular shunt.
- Chiari malformation was less common in the fetal repair group.
- Standardized test scores for motor skills were superior in the fetal surgery group, and twice as many children were walking independently at 30 months, as compared to the postnatal surgery group.

Based on these outcomes, fetal repair of spina bifida is now considered a standard of care at some fetal centers. However, prenatal repair is a complex and challenging procedure, requiring the most expert,
comprehensive care for both mother and fetus. The surgical team’s level of experience in all aspects of care surrounding the operation is of paramount importance.

Adzick (2010) stated that myelomeningocele is a common birth defect associated with significant lifelong morbidity. Little progress has been made in the postnatal surgical management of the child with spina bifida. Postnatal surgery is aimed at covering the exposed spinal cord, preventing infection, and treating hydrocephalus with a ventricular shunt. In utero repair of open spina bifida is now performed in selected patients and presents an additional therapeutic alternative for expectant mothers carrying a fetus with myelomeningocele. As of 2010, it is estimated that about 400 fetal operations have been performed for myelomeningocele worldwide. Despite these numbers, the technique remains of unproven benefit. Preliminary results suggest that fetal surgery results in reversal of hindbrain herniation (the Chiari II malformation), a decrease in shunt-dependent hydrocephalus, and possibly improvement in leg function, but these findings might be explained by selection bias and changing management indications. A prospective, RCT (the Management of myelomeningocele study) was conducted by three centers in the United States in 2010. The author stated that further research is needed to better understand the pathophysiology of myelomeningocele, the ideal timing and technique of repair, and the long-term impact of in utero intervention.

**Twin-to-twin transfusion syndrome:**

Twin-to-twin transfusion syndrome is a complication unique to monochorionic twin pregnancies, in which twins share a common placenta, and unequal blood exchange from one twin (donor) to the cotwin occurs through placental arteriovenous anastomoses. The diagnosis is posed with the sonographic detection of oligohydramnios in the donor’s sac, as a consequence of hypervolemia, and polyhydramnios in the recipient’s sac, resulting from hypervolemia. The severity of twin-to-twin transfusion syndrome is assessed according to the Quintero staging system, which is based on five stages that range from visualization of the donor’s bladder to intrauterine demise of one or both twins. Because laser therapy has proven to be the optimal treatment for twin-to-twin transfusion syndrome, management of twins affected with twin-to-twin transfusion syndrome consists of preoperative and postoperative assessment of the twins by ultrasound examination.

Standard interventions include selective termination, serial amniocentesis, and fetoscopic laser surgery, performed percutaneously or through open surgery. The most severe cases are those diagnosed prior to 25 weeks of gestation. If twin-to-twin transfusion syndrome is diagnosed in the second trimester and left untreated, the mortality rate rises to 80 percent – 90 percent. By 28 weeks of gestation, chances for survival improve, although the surviving fetus is prone to neurological damage and developmental impairment.

The most widely used therapy for twin-to-twin transfusion syndrome is serial amniocentesis, which seeks to equalize the volume of amniotic fluid between the twins. This treatment involves serial amniocentesis and is recommended for pregnancies of gestation later than 26 weeks, if delivery is not
an option. Serial amniocentesis does not correct the underlying vascular abnormality. Survival rates are reported to be 50 percent – 65 percent with this intervention (CHOP 2017).

Fetoscopic laser surgery corrects the underlying circulatory imbalance. The surgery may be performed through an open approach or percutaneously. Laser energy is used to ablate the placental anastomoses, thus interrupting fetal blood flow transfusion and restoring the circulatory balance. The reported survival rates average 67 percent, with 80 percent of pregnancies having at least one surviving twin).

The laser ablation may be nonselective or selective. In nonselective laser treatment, all anastomosed vessels that cross the inter-twin septum are ablated, thereby creating a dichorionic placenta. In the selective approach, the ablation is limited to the participating vessels. Fetal and neonatal survival rates following selective ablation are higher than those following nonselective ablation, with a lower rate of spontaneous abortion.

Multiple pregnancies represent 2 percent of all pregnancies, but account for 20 percent of admissions to neonatal intensive care units. The outcome of multiple pregnancies is mainly dependent on chorionicity. Most perinatal complications are three to 12 times more prevalent in monochorionic pregnancies. The increased mortality and morbidity in this setting are mainly related to vascular anastomoses on the chorionic plate, joining the two fetal circulations. Intrauterine death of a monochorionic twin leads to exsanguination of the survivor, with fatal outcome in 20 percent to 30 percent of cases and a similar rate of severe ischemic complications. The most severe and acute complication is the twin-to-twin transfusion syndrome. The main clinical manifestations of twin-to-twin transfusion syndrome are the polyuric polyhydramnios – oliguric oligohydramnios sequence in the recipient and donor twin, respectively. The twin-to-twin transfusion syndrome is associated with a perinatal mortality rate of around 90 percent, and neurological sequelae are present in 20 percent – 40 percent of survivors born at around 25 weeks.

An intrauterine fetoscopic surgical treatment has been developed for twin-to-twin transfusion syndrome. A 2-mm endoscope and a diode laser fiber are introduced percutaneously, under local anesthesia, through a single 3-mm trocar coagulation of feto-fetal anastomoses on the chorionic plate, which leads to the survival of at least one twin in around 80 percent of cases, at 33 weeks. Fewer than 10 percent of survivors have sequelae, mainly related to prematurity. The long-term outlook of these infants is good, with up to six years of follow-up.

**Fetal urinary tract obstruction:**

Lower urinary obstruction in the fetus is an obstruction to the flow of urine out of the bladder, causing backup of urine and damage to the kidneys. The most common cause of bladder obstruction is posterior urethral valves in males, although the condition may be linked to a genetic abnormality. The patient selection criteria for intervention are based on fetal urine electrolyte studies, beta²-microglobulin levels, and the use of ultrasound. Conditions of minimal renal dysfunction and normal pulmonary development can be treated after delivery. Unilateral obstruction does not lead to oligohydramnios (decrease in
amniotic fluid). However, bilateral urinary obstruction in the fetus is often associated with serious adverse outcomes, such as pulmonary hypoplasia, secondary to oligohydramnios.

Some authors have investigated endoscopic surgery (i.e., fetoscopic cystoscopy with laser) to visualize the posterior urethral valves; however, the data is limited, and further studies are needed to support safety and efficacy. The most common surgical approach to repair the obstruction is vesicoamniotic shunting, by means of a shunt or a stent inserted into the urinary tract above the obstruction, and then passed through the abdominal wall to drain into the amniotic sac. This method of treatment restores amniotic fluid, preventing pulmonary hypoplasia. In the event that the shunt becomes displaced, or if it cannot be inserted, and if the fetus is at less than 22 weeks of gestation, the authors recommend creating a surgical opening in the bladder (vesicostomy). Fetuses with severe renal damage are not considered candidates for this procedure, as it is not clear whether decompression can reverse the renal damage. Surgery is not curative and further evaluation and surgical treatment are necessary following delivery (Wu and Johnson, 2009).

**Fetal pleural effusions:**

Isolated fetal pleural effusions has an incidence rate of approximately 1:10,000 to 15,000 pregnancies and may be bilateral, but is most commonly unilateral. There are a variety of causes that include congenital abnormalities and chromosomal abnormalities. Congenital hydrothorax is a rare disorder and is defined by the accumulation of fluid in the pleural cavity. The persistence of pleural effusion in early pregnancy interferes with normal lung development and often results in pulmonary hypoplasia. Mediastinal compression resulting from effusion can cause hemodynamic compromise leading to fetal hydrops and perinatal death. Prenatal intervention is dependent on the severity of fluid accumulation and the gestational age of the fetus at the time of diagnosis. In some cases, spontaneous resolution occurs and no intervention other than observation is indicated.

**Aqueductal stenosis (hydrocephalus):**

Stenosis of the aqueduct of Sylvius leads to congenital hydrocephalus. The aqueduct of Sylvius is a space that connects the third and fourth ventricles of the brain and allows for flow of CSF. Obstruction of the flow dilates the ventricles and leads to compression of the brain, eventually compromising brain function. When hydrocephalus is diagnosed, the treatment options include termination or continuation of the pregnancy, with monitoring for progression of the disease and detection of additional anomalies. Traditionally, the condition is detected and then treated after birth with a shunt procedure. Researchers suggest that decompressing the ventricles may prevent adverse effects on the developing brain, although in utero treatment with ventriculoamniotic shunts has not led to improved perinatal outcomes.

If isolated hydrocephalus occurs, it is followed with serial ultrasounds, because with increasing length of gestation, the outcome is variable and worsening developmental outcomes may result. Nonetheless,
outcomes after early shunting and delivery have been poor; hence, such treatment is not recommended until 32 weeks of gestation.

Sacrococcygeal teratoma:

Sacrococcygeal teratoma is a tumor derived from more than one embryonic germ layer. Most tumors are benign, but the odds of malignancy increase with increasing age. In many cases, the abnormal size of the uterus (from either the tumor or polyhydramnios) leads to diagnosis by ultrasound. Less commonly, presentation may include maternal pre-eclampsia. The standard treatment is complete excision after birth if not detected prenatally. When sacrococcygeal teratoma is detected prenatally, early surgical intervention may be performed to prevent the development of fetal hydrops. These are extremely vascular tumors. Fetal hydrops develops as a result of vascular shunting between low-pressure vessels within the tumor, leading to cardiovascular collapse in cases of large lesions. Left uncorrected, sacrococcygeal teratoma, when it occurs in conjunction with high-output failure associated with placentomegaly or hydrops, results in 100 percent fetal mortality.

Additional methods that have been proposed for treating sacrococcygeal teratoma involve the use of laser ablation, radiofrequency ablation, and thermocoagulation. In laser ablation, the vessels leading to the tumor are ablated with the use of a laser. Radiofrequency ablation employs radiofrequency energy for the same purpose; this technique may be performed under ultrasound guidance with minimal access. In thermocoagulation, another minimal access method, an insulated wire is passed through a needle into the sacrococcygeal teratoma, heating the vessels until blood flow diminishes. Authors propose coagulating the vessels decreases the blood supply to the tumor, decreases cardiovascular demand, and ultimately reverses the fetal hydrops.

Searches

Select Health of South Carolina searched PubMed and the databases of:

- UK National Health Services Centre for Reviews and Dissemination.
- Agency for Healthcare Research and Quality’s National Guideline Clearinghouse and other evidence-based practice centers.
- The Centers for Medicare & Medicaid Services (CMS).

We conducted searches on November 20, 2017. Search terms were: “fetal survival, surgery in utero using the terms prenatal malformations, congenital diagnosis.”

We included:

- **Systematic reviews**, which pool results from multiple studies to achieve larger sample sizes and greater precision of effect estimation than in smaller primary studies. Systematic reviews use predetermined transparent methods to minimize bias, effectively treating the review as a scientific endeavor, and are thus rated highest in evidence-grading hierarchies.
• **Guidelines based on systematic reviews.**
• **Economic analyses**, such as cost-effectiveness, and benefit or utility studies (but not simple cost studies), reporting both costs and outcomes — sometimes referred to as efficiency studies — which also rank near the top of evidence hierarchies.

**Findings**

Fetal surgery has become an acceptable option for the treatment of select congenital anomalies. Evidence in the published peer-reviewed scientific literature and professional society position support improved clinical outcomes, and perinatal survival for conditions such as myelomeningocele repair, twin-to-twin transfusion syndrome, and bilateral urinary tract obstruction, to name a few. Early detection, treatment, and monitoring involve a multidisciplinary approach typically available at experienced fetal surgery centers. Nonetheless there remains significant risk to both fetus and mother and rigorous patient selection is important. For many conditions, data is still lacking. Well-designed RCTs evaluating in utero intervention for these conditions, compared to postnatal intervention are required to support improved survival rates.

**Policy updates:**

The 2017 update included an UpToDate review on “Diagnosis and Management of Twin Reversed Arterial Perfusion (TRAP) Sequence” (Holland, et al., 2014) states on in utero therapy: “For continuing pregnancies with one or more poor prognostic criteria, antenatal intervention, delivery, and expectant management are options. As the acardiac twin is nonviable, treatment for TRAP sequence is focused on improving the outcome for the pump twin. Historically, intervention in pregnancies with TRAP sequence was limited to amnioreduction to reduce hydramnios or relief for the pump twin by selective delivery of the acardiac twin via hysterotomy or administration of sclerosing agents (e.g., alcohol) into the umbilical cord of the acardiac twin. For pregnancies between 18 and 27 weeks of gestation, current treatment modalities target occlusion of the umbilical cord of the acardiac twin and include laser ablation, bipolar cord coagulation, and radiofrequency ablation (RFA), which are performed with local anesthesia and conscious sedation. Fetoscopic cord ligation is an alternative, but is less common.”

The 2018 update included an UpToDate review on “Overview of Antenatal Hydronephrosis” (Baskin and Ozcan, 2014) states on fetal surgery: “Although there have been several prospective and retrospective studies of antenatal surgery in fetuses with sonographic findings consistent with lower urinary tract obstruction, there is no good evidence that this intervention improves renal outcome. These procedures increase the amount of amniotic fluid, thus potentially improving lung development and survival rate. However, there remains a high rate of chronic renal disease in the survivors, necessitating renal replacement therapy in almost two-thirds of the cases.”

Ruano (2013), evaluated the effect of early fetoscopic tracheal occlusion (22 to 24 weeks gestation) on pulmonary response and neonatal survival in cases of extremely severe, isolated congenital diaphragmatic hernia. This was a multi-center study involving fetuses with extremely severe congenital
diaphragmatic hernia (lung-to-head ratio less than 0.70, liver herniation into the thoracic cavity and no other detectable anomalies). Between August 2010 and December 2011, a total of eight fetuses underwent early fetoscopic tracheal occlusion. Data was compared with nine fetuses that underwent standard fetoscopic tracheal occlusion, and 10 without fetoscopic procedure, from January 2006 to July 2010. Fetoscopic tracheal occlusion was performed under maternal epidural anesthesia, supplemented with fetal intramuscular anesthesia. Fetal lung size and vascularity were evaluated by ultrasound, before and every two weeks after, fetoscopic tracheal occlusion. Post-natal therapy was equivalent for both treated fetuses and controls. Primary outcome was infant survival to 180 days and secondary outcome was fetal pulmonary response. Maternal and fetal demographic characteristics and obstetric complications were similar in the three groups (p > 0.05). Infant survival rate was significantly higher in the early fetoscopic tracheal occlusion group (62.5 percent) compared with the standard group (11.1 percent) and with controls (0 percent) (p < 0.01). Early fetoscopic tracheal occlusion resulted in a significant improvement in fetal lung size and pulmonary vascularity, when compared with standard FETO (p < 0.01). The authors concluded that early fetoscopic tracheal occlusion may improve infant survival by further increases of lung size, and pulmonary vascularity in cases with extremely severe pulmonary hypoplasia in isolated congenital diaphragmatic hernia. They stated that the findings of this study support formal testing of the hypothesis with an RCT.

Ruano (2014), reviewed the indications, technical aspects, preliminary results, risks, and clinical implications of fetoscopic tracheal occlusion for severe congenital diaphragmatic hernia performed outside the United States and its potential future directions in this country and globally. Congenital diaphragmatic hernia occurs in approximately one in 2,500 live births and results in high neonatal morbidity and mortality, largely associated with the severity of pulmonary hypoplasia and pulmonary arterial hypertension. With the advent of prenatal imaging, congenital diaphragmatic hernia can be diagnosed before birth, and in utero treatment is now available in some centers. The prognosis of congenital diaphragmatic hernia can be evaluated by assessing the fetal lung size, the degree of liver herniation, and the fetal pulmonary vasculature in isolated forms of congenital diaphragmatic hernia. These parameters help classify fetuses as having mild, moderate, severe, or extremely severe isolated congenital diaphragmatic hernia. Severe and extremely severe diaphragmatic hernias have poor outcomes and thus are candidates for innovative therapies such as fetoscopic tracheal occlusion. Fetoscopic tracheal occlusion is usually performed between 26 and 30 weeks of gestation. In utero, an endoscope is passed through the fetal mouth and down to the carina; the balloon is deployed just above the carina. After the procedure, ultrasound surveillance every two weeks ensures the balloon’s structural integrity and measures the fetal pulmonary response. At approximately 34 weeks of gestation, the balloon is deflated and removed. Fetoscopic tracheal occlusion is thought to improve outcomes by decreasing mortality and allowing more rapid neonatal stabilization. Ultimately, the goal of fetoscopic tracheal occlusion is to minimize pulmonary hypoplasia and pulmonary arterial hypertension. Following delivery, neonates still require diaphragm repair.

Fetal management of myelomeningocele repair < 23 weeks was associated with higher rates of preterm premature rupture of membranes and chorioamniotic membrane separation. Soni (2016) urged that fetal management of myelomeningocele repair be deferred until ≥ 23 weeks of gestation to mitigate
these complications. Nulliparity also appeared to increase the risk for preterm premature rupture of membranes.

The methodological quality of studies of in-utero intervention for fetuses with congenital diaphragmatic hernia is variable and there is currently insufficient evidence to recommend this treatment as a part of routine clinical practice (Grivell, 2015). Neonatal surgical repair is possible, but even with early surgical repair and improving neonatal management, neonatal morbidity and mortality is high. More studies are needed to further examine the effect of in-utero fetal tracheal occlusion on important neonatal outcomes and long-term infant survival and health.

During the past twelve months there has been further information published regarding in-utero intervention for fetuses:

A narrative review (Miller, 2017) noted that maternal-fetal surgery for myelomeningocele repair is a major procedure for the woman and her affected fetus. Although there is demonstrated potential for fetal and pediatric benefit, there are significant maternal implications and complications that may occur acutely, postoperatively, for the duration of the pregnancy, and in subsequent pregnancies. Women with pregnancies complicated by fetal myelomeningocele who meet established criteria for in utero repair should be counseled in a nondirective fashion regarding all management options, including the possibility of maternal-fetal surgery. Maternal-fetal surgery for myelomeningocele repair should be offered only to carefully selected patients at facilities with an appropriate level of personnel and resources.

**Summary of clinical evidence:**

<table>
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<tr>
<th>Citation</th>
<th>Content, Methods, Recommendations</th>
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<td>Miller (2017)</td>
<td><strong>Key points:</strong></td>
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| Maternal-Fetal Surgery for Myelomeningocele | • Narrative review noted that maternal-fetal surgery for myelomeningocele repair is a major procedure for the woman and her affected fetus.  
• Although there is demonstrated potential for fetal and pediatric benefit, there are significant maternal implications and complications that may occur acutely, postoperatively, for the duration of the pregnancy, and in subsequent pregnancies.  
• Women with pregnancies complicated by fetal myelomeningocele who meet established criteria for in utero repair should be counseled in a nondirective fashion regarding all management options, including the possibility of maternal-fetal surgery.  
• Maternal-fetal surgery for myelomeningocele repair should be offered only to carefully selected patients at facilities with an appropriate level of personnel and resources. |
| Soni (2016)         | **Key points:**                   |
| Chorioamniotic membrane separation and preterm premature rupture of membranes complicating in | • A retrospective review of fetal myelomeningocele repair in 88 patients found 21 patients (23.9%) were diagnosed with chorioamniotic membrane separation by ultrasound and preterm premature rupture of membranes occurred in 27 (30.7%). |
Among the chorioamniotic membrane separation patients, 10 (47.6%) were diagnosed with global chorioamniotic membrane separation and 11 (52.4%) with local chorioamniotic membrane separation.

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Earlier gestational age at the time of fetal surgery was a significant risk factor for the development of chorioamniotic membrane separation (P = .01) and preterm premature rupture of membranes (P < .0001).

Chorioamniotic membrane separation was significantly associated with preterm premature rupture of membranes (59.1% versus 21.2%, P = .008) and earlier gestational age at delivery (32.1 ± 4.2 versus 34.4 ± 3.5 weeks, P = .01).

The average number of days from chorioamniotic membrane separation to preterm premature rupture of membranes was 11.0 ± 10.1 and from chorioamniotic membrane separation to delivery was 31.0 ± 22.5.

The mean time interval between fetal management of myelomeningocele repair and preterm premature rupture of membranes was 47.9 days.

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The mean time interval between fetal management of myelomeningocele repair and preterm premature rupture of membranes was 47.9 days.

The mean latency period from preterm premature rupture of membranes to delivery was 25 days.

Gestational age at delivery was significantly lower in patients with preterm premature rupture of membranes (31.6 ± 3.4 versus 34.9 ± 3.5 weeks, P = .0001).

Nulliparity, gestational age at fetal management of myelomeningocele repair, and membrane separation remained significant risk factors for preterm premature rupture of membranes.

The authors concluded that chorioamniotic membrane separation after fetal management of myelomeningocele repair is a significant risk factor for subsequent development of preterm premature rupture of membranes and preterm delivery.

A systematic review of 97 patients compared the effects of prenatal versus postnatal interventions for congenital diaphragmatic hernia on perinatal mortality and morbidity, longer-term infant outcomes and maternal morbidity; and found there were important differences dependent on how access was gained to the fetus and in the timing and mode of delivery.

There was no difference between groups in long-term infant survival (risk ratio [RR] 1.06, 95% confidence interval [CI] 0.66 to 1.69) in in-utero fetal occlusion by minimally invasive fetoscopy versus standard postnatal management.

Minimally invasive fetoscopy was associated with a small reduction in the mean gestational age at birth (mean difference 1.80 weeks, 95% CI -3.13 to -0.47), but there was no clear difference in the risk of preterm birth before 37 weeks (RR 1.75, 95% CI 0.78 to 3.92).

Long-term infant survival (three to six months) (RR 10.50, 95% CI 1.48 to 74.71) was increased with the intervention when compared with standard management, and there was a corresponding reduction in pulmonary hypertension (RR 0.58, 95% CI 0.36 to 0.93) associated with the intervention.

There was no difference between groups in terms of preterm ruptured membranes (< 37 weeks) (RR 1.47, 95% CI 0.56 to 3.88) or maternal infectious morbidity (RR 3.14, 95% CI 0.14 to 72.92), and there were no maternal blood transfusions.

It was a multi-center study of singleton pregnancies with congenital diaphragmatic hernia treated by fetoscopic tracheal occlusion.

The entry criteria for fetoscopic tracheal occlusion were severe congenital diaphragmatic hernia, on the basis of sonographic evidence of intra-thoracic herniation of the liver and low lung area to head circumference ratio, defined as the observed to the expected normal mean for gestation (o/e lung area to head circumference ratio).
Fetoscopic tracheal occlusion was carried out in 210 cases, including 175 cases with left-sided, 34 right-sided and one with bilateral congenital diaphragmatic hernia.

- In 188 cases, the congenital diaphragmatic hernia was isolated and in 22 there was an associated defect. Fetoscopic tracheal occlusion was performed at a median gestational age of 27.1 (range of 23.0 to 33.3) weeks.
- The first eight cases were done under general anesthesia, but subsequently either regional or local anesthesia was used.
- The median duration of fetoscopic tracheal occlusion was 10 (range of three to 93) minutes. Successful placement of the balloon at the first procedure was achieved in 203 (96.7%) cases.
- Spontaneous preterm prelabor rupture of membranes occurred in 99 (47.1%) cases at 3 to 83 (median of 30) days after fetoscopic tracheal occlusion and within three weeks of the procedure in 35 (16.7%) cases.
- Removal of the balloon was prenatal either by fetoscopy or ultrasound-guided puncture, intrapartum by ex-utero intrapartum treatment, or postnatal, either by tracheoscopy or percutaneous puncture.
- Delivery was at 25.7 to 41.0 (median of 35.3) weeks and before 34 weeks in 65 (30.9%) cases.
- In 204 (97.1%) cases, the babies were live born and 98 (48.0%) were discharged from the hospital alive.
- There were 10 deaths directly related to difficulties with removal of the balloon.
- Significant prediction of survival was provided by the o/e lung area to head circumference ratio and gestational age at delivery. On the basis of the relationship between survival and o/e lung area to head circumference ratio in expectantly managed fetuses with congenital diaphragmatic hernia, as reported in the antenatal congenital diaphragmatic hernia registry, these researchers estimated that in fetuses with left congenital diaphragmatic hernia treated with fetoscopic tracheal occlusion, the survival rate increased from 24.1% to 49.1%, and in right congenital diaphragmatic hernia survival, increased from 0% to 35.3% (p < 0.001).
- The authors concluded that fetoscopic tracheal occlusion in severe congenital diaphragmatic hernia is associated with a high incidence of preterm prelabor rupture of membranes and preterm delivery, but only a substantial improvement in survival. They also stated that these findings need to be tested in an RCT.

**Key points:**

- Inclusion criteria were diamniotic monochorionic pregnancy, twin-to-twin transfusion syndrome diagnosed with standard parameters, and peri- and neonatal outcomes well defined.
- Triplet and investigations on other topics of twin-to-twin transfusion syndrome rather than perinatal outcomes were excluded. A meta-analysis was performed by fixed-effect model (heterogeneity less than 25%). A total of 10 articles provided 611 cases of twin-to-twin transfusion syndrome (LT: 70 %; SA: 30 %) and included four studies comparing the two treatments (395 cases: LT, 58 %; SA, 42 %).
- Fetuses undergoing LT were more likely to survive than fetuses undergoing SA (overall survival rate: p < 0.0001; odds ratio [OR], 2.04; 95 % CI: 1.52 to 2.76; neonatal death: p < 0.0001; OR, 0.24; 95 % CI: 0.15 to 0.40; neurologic morbidity: p < 0.0001; OR, 0.20; 95 % CI: 0.12 to 0.33).
- The authors concluded that this meta-analysis showed that laser therapy is associated with better outcomes than serial amnioreduction.

**Rossi (2008)**

Current controversy on laser therapy versus serial amnioreduction performed for twin-to-twin transfusion syndrome; a search in PubMed from 1997 to 2007 was performed

<table>
<thead>
<tr>
<th>Citation</th>
<th>Content, Methods, Recommendations</th>
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<tbody>
<tr>
<td>Rossi (2008)</td>
<td>15</td>
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</table>
References

Professional society guidelines/other:


Peer-reviewed references:


Baskin LS, Ozcan T. Overview of antenatal hydronephrosis. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed February 2014.


Holland MG, Mastrobattista JM, Lucas MJ. Diagnosis and management of twin reversed arterial perfusion (TRAP) sequence. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed February 2014.


CMS National Coverage Determinations (NCDs):

No NCDs identified as of the writing of this policy.
Local Coverage Determinations (LCDs):

No LCDs identified as of the writing of this policy.

Commonly submitted codes

Below are the most commonly submitted codes for the service(s)/item(s) subject to this policy. This is not an exhaustive list of codes. Providers are expected to consult the appropriate coding manuals and bill accordingly.

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