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Review Article

# Current status of fetal surgery

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ABSTRACT

Fetal surgery has come a long way since its inception in 1980s.[1] It has evolved from open laparotomy to minimally invasive techniques over the last three decades. As prenatal diagnosis becomes more sophisticated, the list of conditions amenable to fetal therapy will expand. Level I evidence from trials such as Eurofetus[2] and MOMS[3] have firmly placed fetal therapy as the standard of care for these hitherto untreatable conditions. Evidence from these trials has also answered many questions regarding maternal safety in fetal surgery. In the Indian context, there is an urgent need to increase awareness amongst obstetricians, sonologists and the public about treatable fetal conditions. It is equally important to establish referral pathways to dedicated centres so that patients who need and want fetal therapy are not denied the opportunity and are able to access treatment at the earliest. Only tertiary care centres equipped with the logistics and expertise in terms of a multidisciplinary 'perinatology' team including maternal–fetal medicine specialist, pediatric cardiologist, pediatric surgeon, pediatric urologist and neonatologist experienced in looking after sick and operated babies, should be offering fetal therapy. Since the case load of these uncommon conditions will always remains low, there is a need to establish a formal pathway directing patients to designated centres where fetal therapy is offered under strict protocols and guidelines. Formulation of a Fetal Surgery Society will be invaluable in achieving this.



## 1. Introduction

Fetal surgery is the branch of medicine which aims at treating the fetal patient. Although the first documented fetal surgery in animals dates back to 1884,[4] it was not until 1963 that Liley first treated the fetus as a patient by giving an intraperitoneal transfusion for erythroblastosis fetalis.[5] In the current era of readily available ultrasound machines, it seems almost impossible to comprehend how his team used to blindly inject radio-opaque contrast media through the maternal abdomen into the amniotic cavity, then wait for the fetus to swallow the

*Abbreviations:* MOMS, Management of myelomeningocele study; UCSF, University of San Francisco; NICU, Neonatal intensive care unit; TTTS, Twin twin transfusion syndrome; DVP, Deepest vertical pool; CRL, Crown rump length; SLCPV, Selective laser coagulation of placental vessels; NIHCD, National Institute of Child Health and Human Development trial; TRAP, Twin reversed arterial perfusion; LUTO, Lower urinary tract obstruction; PLUTO, Percutaneous vesicoamniotic shunting in lower urinary tract obstruction; FETO, Fetoscopic endoluminal tracheal occlusion; CNN, Cable news network.

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contrast media, take abdominal X rays to get an estimate of the fetal position and then again blindly guide a 17 gage Touhy needle through the mother's abdomen into the presumed fetal abdominal cavity to finally give an intraperitoneal transfusion in an otherwise unsalvageable case of hydrops fetalis. With the advent of ultrasound and its application in obstetrics in the 1960s,[6] things became relatively simpler and it became possible to give intrauterine transfusion in a relatively noninvasive manner, first fetoscopically and then under imaging guidance.[7,8] As prenatal diagnosis becomes more sophisticated with increasing expertise in scanning skills and increasing availability and quality of ultrasound machines, more and more fetal abnormalities are being diagnosed antenatally and some of these will invariably qualify for fetal therapy making it a clinical reality.

## 2. Rationale for fetal surgery

Fetal surgery aims at mitigating the effect of a fetal abnormality that, if left untreated, would result in fetal demise in utero. The aim is to prolong gestation such that the fetus reaches viability or reasonable maturity. However, there can be a broad spectrum of an abnormality ranging from the most severely affected fetuses in whom an intervention will not be of any benefit and those in whom the disease is so mild that they would do well even without in utero therapy; therefore the art and science of fetal therapy is in correctly identifying fetuses who will benefit maximally from intervention. This can be achieved by careful ultrasound evaluation and serial monitoring.

## 3. Evolution of fetal surgery

Fetal surgery evolved greatly in the 1980s led by Michael Harrison,[1] a pediatric surgeon from the University of San Francisco (UCSF). Ironically the first two published cases of fetal intervention resulted in a poor outcome[9,10] and the importance of accurate prenatal diagnosis and appropriate patient selection was recognised. This gave rise to the branch of Fetal Medicine wherein a trained person would do ultrasound to make an accurate diagnosis, rule out associated structural and genetic abnormalities and liase with colleagues from related specialities to formulate a plan and select fetuses suitable for in utero therapy. The Fetal medicine specialist would also follow up patients serially to differentiate fetuses with mild, indolent condition which would not require in utero therapy from those that worsen progressively and would result in intra-uterine fetal demise or significant postnatal morbidity in absence of timely intervention. The rapid advances in pediatric surgery and increasing survival rates of premature infants due to better NICU facilities, availability of antenatal steroids for lung maturity and magnesium sulphate for neuroprotection, postnatal surgery following elective premature delivery has became a feasible option. Thus the cohort of fetuses who would indeed benefit from in-utero therapy needs to be strictly defined. These criteria were first laid out by Harrison et al in 1982[1] (Table 1). It is not surprising that most of these criteria still hold true three decades hence. An in-utero intervention can only be ethically justified if there is a reasonable probability of benefit to the fetus.

The next milestone in the field came with the adaptation of endoscopic instruments for fetal interventions in the 1990s. The Eurofetus research project funded by the European union selected fetal medicine centres in Europe and one endoscopic instrument company to design new fetoscopes and instruments suitable for fetal surgery.[11] Thus fetal surgery moved from laparotomy and stapled hysterotomies under general anesthesia to minimally invasive surgeries under local anesthesia.

## 4. Fetal interventions pertaining to specific conditions

A detailed discussion of all fetal surgeries is outside the purview of this writeup; hence the most relevant conditions amenable to fetal intervention are summarized in Table 2 along with the underlying pathophysiology, rationale for in-utero therapy and the evidence supporting these therapies.[12–24] Fetal interventions which are available at the few dedicated Fetal Medicine centres across India, including ours, are discussed in detail.

**Table 1 – Pre-requisite for considering fetal surgery.[a]**

1. Fetal conditions which warrant in utero therapy are usually simple structural defects that interfere with normal fetal development but if corrected will allow normal development to proceed
2. Accurate prenatal diagnosis
3. Exclusion of associated structural and genetic abnormalities
4. Normal fetal karyotype
5. An understanding of the natural history of the disease with established prognosis - fetal intervention is justified only if there is a reasonable probability of benefit from it
6. Serial evaluation of the fetus to differentiate those with mild disease who may not need intervention from those with severe disease who will not survive without intervention
7. Therapy proven to be useful at least in animal models
8. Informed consent after detailed discussion with the family regarding risks and benefits including long term outcomes
9. Multidisciplinary team comprising obstetrician with interest in high risk pregnancy, fetal medicine specialist, neonatologist, pediatric surgeon and psychologist
10. Centre equipped with the logistics, instruments, expertise and intensive care nursery to deal with these uncommon procedures

[a] Adapted from Harrison et al, 1982[1]