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REVIEW

Fetoscopic surgery: Encouraged by clinical experience and boosted by instrument innovation

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Summary Today, modern ultrasound equipment and the wide implementation of screening programmes allow the timely diagnosis of many congenital anomalies. For some of these, fetal surgery may be a life-saving option. In Europe, open fetal surgery became poorly accepted because of its invasiveness and the high incidence of postoperative premature labour and rupture of the fetal membranes. In the 1990s, the merger of fetoscopy and advanced video-endoscopic surgery formed the basis for endoscopic fetal surgery. We review the current applications of fetal surgery via both methods of access. The first clinical fetoscopic surgeries were interventions on the umbilical cord and the placenta, often referred to as obstetrical endoscopy. The outcome of a randomized clinical trial demonstrating that fetoscopic laser coagulation of chorionic plate vessels is the most effective treatment for twin–twin transfusion syndrome (TTTS) has revived interest in endoscopic fetal therapy. Operating on the fetus is another more challenging enterprise. Clinical fetal surgery programmes were virtually non-existent in Europe until minimally invasive fetoscopic surgery made such operations clinically possible as well as maternally acceptable. At present, most experience has been gathered with fetal tracheal occlusion as a therapy for severe

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congenital diaphragmatic hernia. As in other fields, minimally invasive surgery has pushed back boundaries and now allows safe operations to be performed on the fetal patient. Whereas minimal access seems to solve the problem of preterm labour, all procedures remain invasive, and carry a risk to the mother and a substantial risk of preterm prelabour rupture of the membranes (PPROM). The latter problem may prove to be a bottleneck for further developments, although treatment modalities are currently being evaluated.

Fetal surgery: from an orphan status to a larger field of indications than ever before

The introduction of high-resolution ultrasound and wide offering of screening programmes have dramatically changed modern obstetrics. The information gathered as a consequence makes the unborn fetus a true patient. When fetal malformations, genetic diseases or in utero acquired conditions are suspected, patients are ideally referred to tertiary care units with more specialized skills, technical equipment, larger experience and multidisciplinary counsellors to define potential options. In some cases the consensus may be that intervention before birth is desirable. Sometimes this may be offered without any direct access to the fetus, as e.g. in transplacental administration of pharmacological agents for cardiac arrhythmias. Other conditions can only be treated by direct and hence invasive access to the uterus and fetus. A major breakthrough in fetal medicine was the feasibility of in utero transfusion of the anaemic fetus, first described in 1961. The procedure requires direct sampling and injection into the vascular compartment of the fetus. It can be offered safely and with good fetal and long-term outcome, provided that procedures are done by experienced operators.

Several fetal conditions are amenable to surgical correction, the majority of these being best managed after birth. Sometimes therapy cannot wait that long, and prenatal surgery may save the life of the fetus or prevent permanent organ damage. This can be achieved by correcting a malformation, arresting the progression of a disease, or treating some of the immediately life-threatening effects of a condition, delaying more definitive repair until after birth. A consensus, endorsed by the International Fetal Medicine and Surgery Society (IFMSS), has been reached on the criteria and indications for fetal surgery (Table 1).

Table 1 Criteria for fetal surgery

1. Accurate diagnosis and staging possible, with exclusion of associated anomalies
2. Natural history of the disease is documented, and prognosis established
3. Currently no effective postnatal therapy
4. In utero surgery proven feasible in animal models, reversing deleterious effects of the condition
5. Interventions performed in specialized multidisciplinary fetal treatment centres within strict protocols and approval of the local Ethics Committee with informed consent of the mother or parents

Adapted from Harrison, 1991.

In the 1980s and 1990s only a few conditions met these criteria, such as lower urinary tract obstruction, congenital diaphragmatic hernia, large space-occupying lesions of the thorax and sacrococcygeal teratoma. In the unusual situation where prenatal surgical intervention was indicated, it required maternal laparotomy, partial exteriorization of the fetus through a hysterotomy, and postoperative admission of the mother to an intensive care unit. Such 'open' procedures were associated with high fetal and significant maternal morbidity, prompting the question of whether the potential benefits outweighed the risks. The first open fetal operation was performed in San Francisco in 1982 by Harrison and colleagues, who created a vesicostomy in a fetus with obstructive uropathy. For years, and with the exception of a brief experience in Paris, open fetal surgery remained mainly an American enterprise, at the University of California of San Francisco or limited to a few centres trained by these leaders.

In the last decade we have seen a period of increased efforts by academic centres, private investors and public funding authorities, making the advent of minimally invasive surgery in fetal medicine possible. An increasing number of communications at the annual meetings of the International Fetal Medicine and Surgery Society (IFMSS) and the Fetoscopy group have dealt with what was often referred to as the 'new' fetoscopy. We, at the Centre for

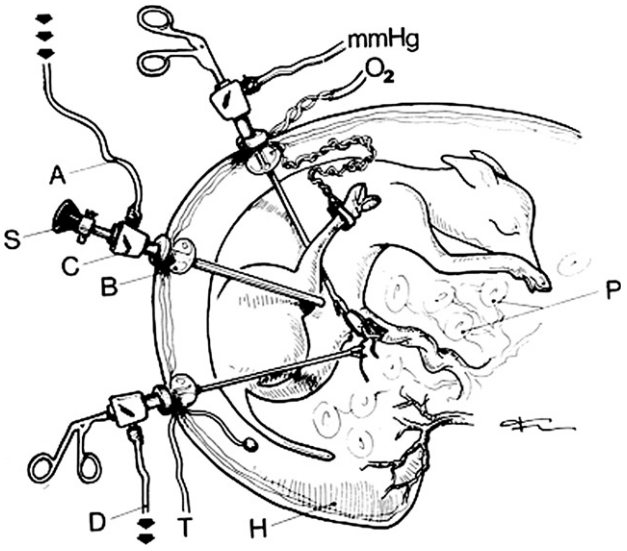

Figure 1 Ovine model for endoscopic fetal surgery. From Deprest et al. (1995)[1] with permission.