SURGERY FOR CONGENITAL HEART DISEASE

EDITORIAL: ARTIFICIAL PLACENTA—A NEED FOR FETAL SURGERY?

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The ongoing research on fetal cardiovascular physiology, a growing understanding of the fetal natural history of congenital heart defects, and newly developed fetal diagnostic abilities, as well as the establishment of clinical fetal intervention for noncardiac structural lesions, have provided important insights into the concept of intrauterine correction of fetal cardiac lesions. Intrauterine surgical repair of certain forms of congenital heart disease during the early phase of cardiac development may provide a better chance of survival by preventing or ameliorating a cascade of complex anatomic and physiologic derangements.

Since the first fetal intervention with Liley's successful blood transfusion into the peritoneal cavity of a fetus affected with erythroblastosis fetalis,¹ significant strides have been made during the last years on research of fetal cardiovascular physiology,^{2,3} extracorporeal circulatory support,⁴⁻⁹ and the pathophysiologic responses of the extracorporeal circuit in the fetomaternal unit.¹⁰⁻¹⁴ Anesthetic management of the fetus during fetal surgery that does not provoke detrimental effects on fetal cardiac function and placental blood flow has also been rigorously studied.¹⁵⁻¹⁷ The cumulative knowledge gained has permitted application of techniques that inhibit fetal stress and block placental dysfunction,¹⁸ resulting in a high degree of recovery and long-term survival after fetal cardiac bypass in lambs.^{19,20}

There are a number of congenital heart defects for which prenatal corrective or palliative surgical procedures offer significant advantages over current postnatal surgical approaches. However, a period of time after the intervention must be provided, that is, the remainder of gestation, during which the fetal heart is exposed to a very low resistance circulation pattern^{21,22} and has the potential for hyperplastic growth.²³⁻²⁶ As a result, a more normal anatomy can develop in preparation for changes in the postnatal circulation (conversion from parallel to in-series circulation). This period provides a critical advantage, when the heart can recover without stress to the overall fetus. However, premature labor remains a serious and frequent complication of fetal surgery.²⁷ It occurs 100% of the time after hysterotomy, and our ability to control uterine contractions after hysterotomy remains a great challenge in human fetal surgery.

The work of Sakata and associates, published in this issue of the Journal (see page 1023), reports an important advance in the field of fetal surgery. The authors have developed a new system to support premature fetuses in an extrauterine environment and maintain fetal cardiocirculatory physiology. It is important to emphasize three major points: (1) The pump flow achieved near normal umbilical blood flow. (2) Oxygen saturation was maintained near physiologic fetal levels. (3) A centrifugal pump with a low circuit prime volume of 95 ml was used. However, this prime volume still represents about one quarter of the estimated total blood volume of the fetuses with 2 kg body weight (180 ml/kg body weight, as stated by Creasy and associates²⁸). The use of newer pump technology, for example, an in-line axial flow pump, could eliminate the prime completely.²⁹ In summary, the preparation of Sakata and associates approaches physiologic fetal circulatory patterns in many respects and is an important contribution.

Nevertheless, additional work is necessary in this

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area to determine the ideal circuitry. An extensive preparation in primate models should be a prerequisite for anyone considering the clinical application of these complex and dangerous procedures.

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