Intraperitoneal Blood Transfusion in the Fetal Lamb

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Although it is known that red blood cells can be transferred intact from the peritoneal cavity to circulating blood by lymphatic channels (Florey and Witts, 1928; Courtice et al., 1953), the rate and efficiency of absorption from this site during intrauterine life has received little attention. However in recent years, the administration of blood to the human fetus by the intraperitoneal route in severe erythroblastosis fetalis has aroused further interest in this subject. In 1922, Cunningham carried out experiments on fetal kittens; after exposing the fetus to the presence of India ink in the peritoneal cavity for one hour, he found that the entry of material into mediastinal lymph nodes only occurred in association with the respiratory activity which he observed in older fetuses. Since then, the role of diaphragmatic movement in accelerating the rate of absorption of particulate matter and red cells from the peritoneal cavity has been established (Morris, 1953; Yoffey and Courtice, 1956). Thus it was postulated that uptake of blood might be slow and less efficient in the fetus owing to the absence of respiratory activity under normal intrauterine conditions.

The purpose of this communication is to present some preliminary data regarding the absorption of radioisotope tagged red cells from the peritoneal cavity of the fetal lamb and the effects of intraperitoneal blood transfusion on cardiovascular and acid-base status of the fetus.

Material and Methods

The fetal lamb was prepared by a surgical procedure under general anesthesia to permit the introduction of indwelling siliconized catheters

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into the femoral artery and vein and peritoneal cavity of the fetus; electrodes were also secured in subcutaneous tissues of the right abdomen and left leg. After replacing the fetus and repairing the uterine and abdominal walls, the catheters and electrodes were secured to the external surface of the mother. Fetal arterial blood samples were withdrawn at intervals to obtain measurements of pH, $P_{CO_2}$, base excess, hematocrit and oxygen saturation. Fetal arterial pressure and fetal ECG were recorded at intervals.

After the operative procedure when pH and blood gas values were stable in both mother and fetus, red cell volume of the fetal circulation was determined by a radioisotope dilution technique. Blood from a donor ewe whose red cells had been tagged with $^{59}Fe$ in vivo was introduced into the fetal circulation and a sample of fetal blood withdrawn 30 minutes later to measure radioactivity in a well-type scintillation counter. The activity of the donor’s blood was approximately 15,000 cpm/ml RBC. It had been found previously that $^{59}Fe$ forms a very stable tag for sheep red cells and that 98% of initial activity remained after five days following the introduction of tagged red cells directly into the fetal circulation.

Whole blood was withdrawn from the same donor ewe in plastic syringes to which heparin was added for anticoagulation or into acid-citrate-dextrose solution. In some experiments the red cells were concentrated by withdrawal of plasma after collection of the blood. The blood was slowly introduced into the fetal peritoneal cavity over a period of several hours through the siliconized indwelling catheter (I.D. 0.75 mm). During intraperitoneal transfusion, fetal ECG and arterial blood pressure were monitored constantly; intraperitoneal and venous pressures were also measured and all pressure measurements corrected for ambient intrauterine pressure.

Fetal arterial blood samples were withdrawn daily thereafter to measure radioactivity. When the activity of fetal blood began to decrease (usually on the fifth day after transfusion) the experiment was concluded by repeating the measurement of blood volume using adult sheep red cells tagged with $^{51}Cr$ in vitro. However, the rapid elution of $^{51}Cr$ from sheep red cells, observed by Drury and Tucker (1958) and confirmed by our own observations, appeared to be responsible for an overestimation of blood volume and thus a falsely high value for the quantity of tagged donor cells present in fetal blood at the conclusion of the experiment. For this reason it has been assumed that the only alteration in red cell volume which took place over the period of study was due to the uptake of donor cells from the peritoneal cavity. Calculations were based on the following equation:

$$(RBCV + y) a_1 = y a_2$$