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EFFECT OF PLACENTAL INSUFFICIENCY ON STATE AND RESPONSE TO ANOXIA OF RAT FETUSES

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Complications observed in the newborn infant frequently arise as a result of pathological labor. The importance of an enfeebled state of the fetus before birth and its resistance to the effects of birth stress has received less study. This is true mild disturbances of the state and, in particular, moderate delay of its development, which is frequently observed and may be difficult to diagnose under clinical conditions.

The course of acute asphyxia in rat fetuses, with normal and delayed development, was studied.

EXPERIMENTAL METHOD

Operative reduction of the utero-placental circulation was performed surgically in 35 Wistar rats under aspetic conditions under ether anesthesia on the 16th day of pregnancy, by ligation of about 40% of the placental vessels at each implantation site in one uterine cornu. The other uterine cornu was left intact, and the fetuses contained in it served as the control. On the last (21st) day of pregnancy the animals were fixed to a frame, laparotomy performed under local procaine anesthesia, the umbilical cords of the fetuses were ligated successively through small incisions in the uterus, and divided, and the fetuses also were consecutively removed from the uterus and immediately (before the first inspiration) placed in physiological saline with a constant temperature of 37°C. The cardiac activity and asphyxial respiratory movements of the fetuses were recorded in the course of asphyxia by impedance rheography. The following parameters were determined by analysis of the traces: heart rate, time of appearance of marked cardiac arrhythmia, duration of survival until the last cardiac contraction, time of appearance of the first inspiration, number of respiratory movements, and duration of asphyxial breathing. Altogether these parameters characterized the resistance of the fetus to anoxia — a factor which often complicates the transition to extrauterine life. After the experiment the fetuses and placentas were weighed, and kept at constant temperature of 56°C to dry them to constant weight. Comparison of the wet and dry weights enabled the degree of hydration to be determined. Altogether 106 fetuses with delayed development and 99 control fetuses were investigated.

EXPERIMENTAL RESULTS

Judging by their weight, the experimental fetuses were significantly but not drastically delayed in development compared with the control fetuses remaining in the intact uterine cornua of the same animals (Table 1). They showed a higher degree of hydration than the control fetuses. We know that in rats, just as in many other species of animals with multiple

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TABLE 1. Characteristics of States and Response to Anoxia of Fetuses with Delayed Development

Group of animals	Weight, g		Hydration		Response to anoxia		Number of respiratory movements	Length of survival, min
	Of fetus	Of placenta	Of fetus	Of placenta	Latent period, sec	Duration of respiration, min		
Experimental	3,45±0,051 n=105	0,488±0,0102 n=106	86,89±0,0516 n=106	84,68±0,0693 n=102	47,81±8,329 n=15	19,72±0,401 n=65	38,97±1,329 n=68	42,34±1,187 n=54
Control	3,68±0,035 n=99	0,529±0,0122 n=99	86,71±0,0316 n=99	84,85±0,0712 n=96	26,73±1,429 n=31	21,36±0,499 n=77	43,51±1,336 n=59	45,1±1,233 n=57
P	<0,01	<0,01	<0,01	>0,05	<0,05	<0,05	<0,05	>0,05

pregnancy, physiological delay is observed in the development of fetuses present in the uterus under unfavorable conditions (located in the middle of the uterine cornu) [4].

An additional analysis accordingly was undertaken: All fetuses, irrespective of whether experimental or control, were distributed by weight and correlation determined between the weight of the fetuses and their degree of hydration. In this case the number of fetuses with low body weight included both experimental and control fetuses. During analysis in this way any possible direct harmful effect of manipulations connected with ligation of preplacental vessels on the fetus could be excluded.

Significant negative correlation was found between two parameters: the weight of the fetuses and their degree of hydration ($r = -0.534$). Disturbance of transplacental fluid and electrolyte exchange evidently plays a definite role in the pathogenesis of delay in fetal development. Another form of this disturbance, namely dehydration, is observed in female rats and rabbits in conjunction with placental insufficiency caused in the early stages of pregnancy in fetuses under gestation age, those retarded in development [1, 3]. When development of human and rat fetuses is delayed, changes also are observed in the ultrastructure and permeability of the amnion and chorion, which are involved in the transplacental exchange of fluid between mother and fetus [5].

Despite the drastic intereference with the placentas, leading to death of some of the fetuses during the first days after ligation of the preplacental vessels, the placentas did not differ significantly from normal in shape, although they were significantly less in weight (Table 1). Hydration of the placentas was not observed.

Asphyxia with the intrauterine type of course was studied in these experiments, since the fetus had not taken its first breath and, consequently, no changes in its hemodynamics characteristic of the transition to extrauterine life had yet occurred. The characteristics of the cardiac and respiratory activity of the fetuses could give some idea of the state of maturity of these systems in fetuses at full term, not yet exposed to birth stress. As Table 1 shows, the clearest feature distinguishing the response of the experimental fetuses was lengthening of the latent period of the first inspiration, which is regarded as a decrease in excitability of the respiratory center, and also a reduction in the duration of the period of respiration and the number of respiratory movements [2]. So far as cardiac activity is concerned, a detailed analysis of it revealed certain distinguishing features in fetuses with delayed development. However, the only significant difference was the earlier onset of marked disturbances of rhythm, namely the appearance of irregular intervals between cardiac contractions, compared with the control.

Even moderate delay in fetal development is thus combined with incomplete development of the neuromuscular system, responsible for respiratory movements. This state may explain to some extent the pathogenesis of complications during adaptation of the newborn infant with delayed development to extrauterine life.

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