METHOD OF PRODUCING ISOLATED ASPHYXIA OF THE FETUS

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Because of technical difficulties isolated asphyxia of the fetus has been studied only in acute experimental conditions [1-4]. The results of these studies have shed no light on the late sequelae of asphyxia, although these are of the greatest theoretical and practical interest. It was, therefore, decided to develop a method of producing isolated asphyxia of the fetus in situ. The most convenient object for such experiments was found to be the albino rat (16th-21st day of pregnancy).

The pregnant animal, anesthetized with ether, was tied with its abdomen uppermost to the operating table, consisting of a strong plastic frame into which a sheet of glass was fixed. A type STN-1 heating table was fixed beneath the glass, capable of maintaining its temperature between 37 and 38° (Fig. 1). The animal's skin was incised along the midline, and a polyethlyene towel was attached to the edges of the incision. The rat was then untied and the glass surface of the table was painted with spirit. The bottom edge of the towel and the bottom row of clips were tucked under the animal. The rat was placed on its side diagonally across the table and tied down again. The top row of clips was suspended from the bar of a separate stand (see Fig. 1). An incision of the abdominal wall was then made along the linea alba and one of the cornua of the uterus was brought out. The abdomen and uterus were irrigated with physiological saline containing Rivanol*. The fetuses could be seen clearly through the transparent wall of the uterus. If necessary they could easily be turned inside the fetal membranes to obtained a better view of the umbilical vessels.

Metal hooks (Fig. 2) were used to compress the umbilical vessels. By means of the hook, held in a needle holder and passed through the wall of the uterus, all the umbilical vessels were seized and the point

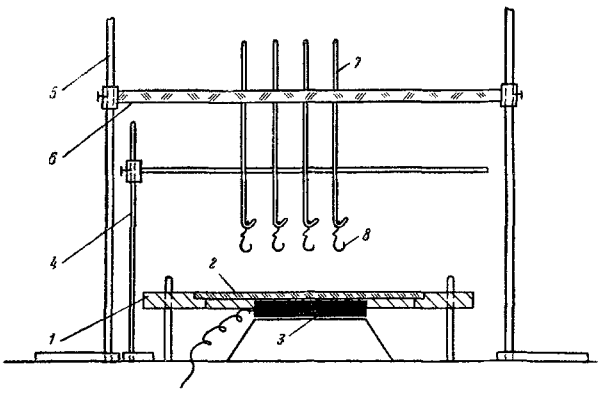

Fig. 1. Diagram of operating table and apparatus for applying traction to the hooks during the experiment. 1) Operating table (40_1 25 cm); 2) glass plate (25 × 20 cm); 3) STN-1 heating table; 4) stand with horizontal bar for hanging clips; 5) stands for fixing hooks with rods; 6) wooden laths between which rods are held; 7) rods (glass) for attachment of hooks; 8) hooks for compressing umbilicus.

* 2-Ethoxy-6,9-diaminoacridine lactate.

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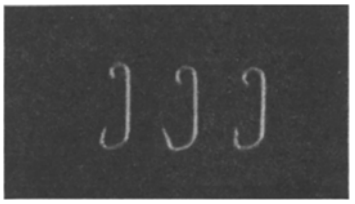

Fig. 2. Hooks for compressing the umbilical vessels.

of the hook was brought out again 3-5 mm from the first puncture. The hook was suspended by a piece of thin rubber band from a rod which could be moved up and down. Glass rods were used for this purpose. By pulling on the hooks the umbilicus was compressed and the blood flow in it was stopped, as was clearly visible with the naked eye and better still with a long-focus binocular loupe. In this way the degree of compression and the umbilicus could easily be regulated, without the risk of trauma and without causing spasm of its vessels, which is unavoidable when other methods of compression (forceps, clips, ligatures) are used.

The condition of the fetus was checked by recording the ECG from needle electrodes (Fig. 3).

To prevent the eventrated uterus from drying, the organ together with the parts drawn up by the hooks was covered with strips of transparent polyethylene film, through which the fetal movements could be observed. An important point to note is that the depth of anesthesia must be minimal during the experiment.

At the end of the experiment, the traction rods were lowered and the blood flow in the umbilical vessels restored. The hooks and electrodes were then carefully removed. As a result of displacement of the amnion relative to the wall of the uterus the puncture holes were closed and no amniotic fluid escaped. After the observations had ended the fetuses were marked by the authors' method, the uterus was replaced in the abdomen, 2 or 3 drops of penicillin solution (2000-3000 units) were instilled, and the muscles and skin were sutured. Usually the rat began to drink water and sometimes to eat 30-40 min later.

Operations were performed as described above on 54 pregnant rats. In every case, asphyxia was produced in 3 or 4 fetusus and the rest were used as controls. Parturition began at term in all the rats. The weight of the newborn rats not subjected to asphyxia was normal (4.2-6.2 g). The mortality among the control fetuses during birth did not exceed 4%.

The results of these experiments showed that the maximal duration of asphyxia after which the heart beat could be restored in at least $^2/_3$ of the fetuses was 30 min for fetuses of 20-21 days, and 60 min for fetuses of 17-18 days of development. In the experiments on animals on the 20-21st day of pregnancy, 15-18 min after compressing the umbilicus the skin of the fetus, not yet covered with hair, which is normally

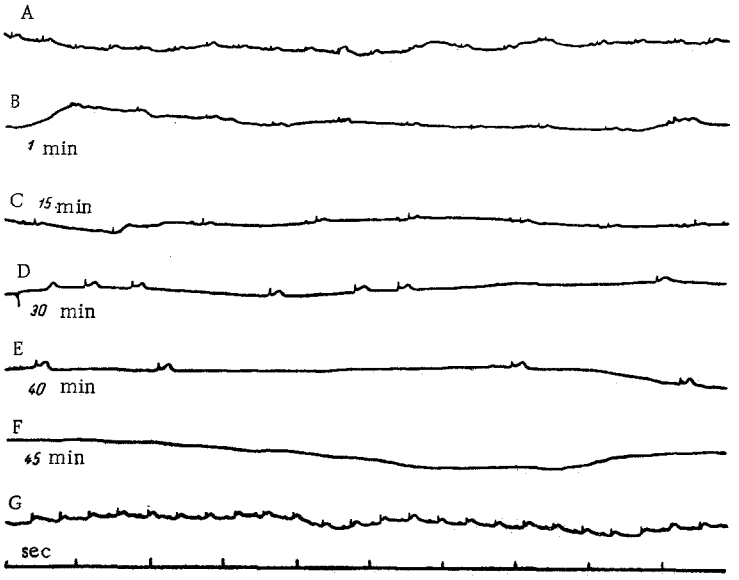

Fig. 3. ECG of a rat fetus on the 19th day of development before (A), during (B-F) and 5 min after (G) asphyxia caused by compression of the umbilical vessels. Recorded by a type EKPSCh-3 electrocardiograph.

pink in color with a slightly livid hue, became almost white (white asphyxia). These experiments also showed that tolerance to asphyxia cannot be judged purely by restoration of the heart beat immediately after the end of asphyxia. When asphyxia lasted 30-60 min (depending on the age of the fetus), of the 93 fetuses exposed and in which the heart beat was restored, 13 (14%) died in utero and underwent maceration, while 17 (18.31) died at birth. Some of the young rats also proved nonviable and died at various times after birth. Intrauterine death of the fetuses at birth and death of the young rats after birth were undoubtedly the result of asphyxia.

Hence, the suggested method is suitable for use in studying the late sequelae of isolated asphyxia of the fetus.

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