CHANGES IN PERMEABILITY OF THE PLACENTA TO I^{131} DURING PREGNANCY

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Experiments on albino rats receiving I^{131} at various times of pregnancy showed that the isotope passes readily through the placenta and collects in the fetuses in proportion to their age. The time of pregnancy had no significant effect on accumulation of I^{131} in the placenta. The relationship between I^{131} accumulation in the fetuses and the dose given to the mother is reciprocal: with an increase in dose the content of isotope in the fetuses falls relatively.

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The study of the biological action of radioactive I^{131}, especially its effection on the progeny, is an important topic in modern radiobiology.

Investigations on rabbits and guinea pigs have shown that radioactive iodine passes rapidly through the placenta after administration to pregnant animals, and indeed, the concentration of activity in the fetal plasma was much higher (up to 5 times) than in the maternal plasma.

Passage of I^{131} through the placenta was determined at various periods of pregnancy in relation to the dose of isotope administered.

EXPERIMENTAL METHOD

Experiments were performed on 63 female albino rats weighing 150-170 g. I^{131} (without vehicle) was injected into the stomach in doses of 10, 1, and 0.1 μCi per animal. The chosen times of pregnancy were 9, 11, 13, 15, 17, 19, and 21 days, i.e., from the beginning of formation of the placenta until the last day of pregnancy. The animals were sacrificed 24 h after administration of isotope. The I^{131} content was determined in the fetuses, placenta, and maternal thyroid, using a counter. The content of activity in the tissues was expressed in percentages of the dose of I^{131} given to the mother per gram tissue, and also per body weight of the litter, or weight of the placenta and maternal thyroid.

EXPERIMENTAL RESULTS

The experimental results are given in Figs. 1 and 2. They show that even after administration of the smallest chosen dose (0.1 μCi per animal) to the mother iodine was found in the fetuses at all times of pregnancy investigated.* After administration of the largest chosen dose (10 μCi per animal) to the mother the relative iodine content in the fetuses showed a decrease of 16 times

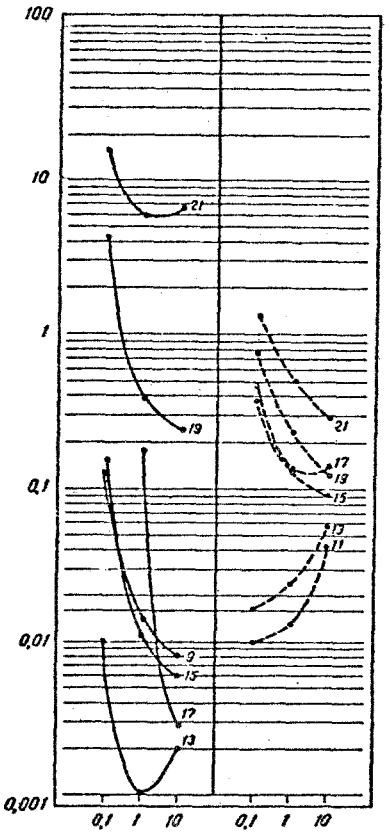

Fig. 1. Content of I^{131} in all fetuses and placenta. On the left, content in fetuses; on the right, in placenta. Here and in Fig. 2, numbers on curves denote times of pregnancy (in days). Ordinate: I^{131} content (in percent of dose administered to mother); abscissa: dose (in μCi).

*On the 9th and 11th days of pregnancy the placenta and fetus were not separated, i.e., tissue activity was the combined activity of fetus and placenta.

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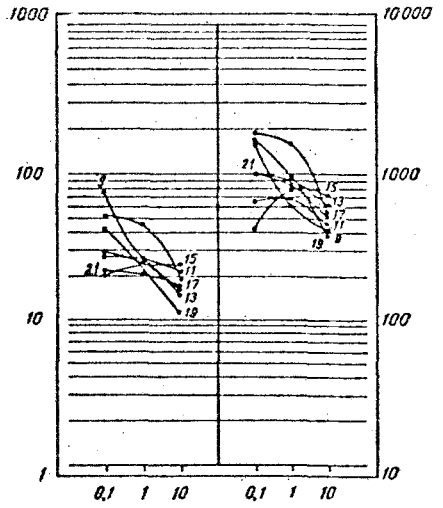

Fig. 2. Content and concentration of I^{131} in maternal thyroid. On the left, content; on the right, concentration. Ordinate: percentages (of administered dose of I^{131}); abscissa: dose (in μCi).

on the 9th day, 0.23 times on the 11th day, 5 times on the 13th, 25 times on the 15th, 17 times on the 19th, and 23.6 times on the 21st day (Fig. 1). The indices of I^{131} accumulation for the middle dose were intermediate in position, although (except for the earliest times of pregnancy) closer to the indices obtained after administration of 10 μCi.

This reciprocal relationship between the administered dose of I^{131} and its relative accumulation, was also found with the I^{131} content in the placenta and the maternal thyroid (Figs. 1 and 2). At the earliest times of pregnancy (11th and 13th days) accumulation of iodine in the placenta was proportional to the administered dose.

A distinct relationship was also observed between accumulation of iodine by the maternal thyroid and the dose of I^{131} given: with an increase in administered dose the relative content of isotope in the thyroid fell.

It may be postulated that this relationship between the accumulation of I^{131} in the fetuses, placenta, and maternal thyroid is determined by differences in the physiological reactions of the body to administration of different doses of I^{131}, the largest dose inhibiting and the smallest stimulating certain bodily functions.

Accumulation of radioactive iodine depends on many factors: the amount of stable iodine in the diet, the time between administration of iodine and its determination in the fetus, the external environmental temperature, and, of course, the dose of radioactive iodine given to the mother. All these factors were constant in our experiments. Nevertheless, accumulation of I^{131} by the fetal and placental tissues were significantly affected not only by the dose of iodine given, but also by the time of pregnancy. According to our findings, I^{131} was found in the fetuses by the 9th day of pregnancy, i.e., before the rat fetal thyroid has started to function. The detection of iodine in the fetus at such an early date is probably the result of its entry through the blood stream. The iodine content in the fetus subsequently increases during pregnancy, rising sharply by the 19th day and reaching a maximum on the 21st day, when its concentration in the fetal tissues for a dose of 10 μCi was 68 times higher than on the 13th day, 13 times higher for a dose of 1 μCi, and 28 times higher for a dose of 0.1 μCi. Accumulation of iodine by the fetal thyroid depends on the character of increase in mass of the fetal thyroid and also on changes in its ability to concentrate iodine in the course of pregnancy. According to data in the literature, the rat fetal thyroid begins to absorb I^{131} and to function on the 18th day of pregnancy, and this probably caused the sharp increase in accumulation of I^{131} by the fetuses on the 19th and 21st days.

Accumulation of I^{131} in the placenta, in contrast to that in the fetuses, was not significantly affected by the time of pregnancy, except on the 11th and 13th days, when the iodine content in the placenta was lowest, i.e., at the time of formation of the placenta, which is not completed until the 15th day. At other times, accumulation of iodine in the placenta showed little variation with the time of pregnancy. The iodine content in the placenta for the whole litter increased from the 15th to the 21st days of pregnancy by 3 times for a dose of 10 μCi, by 3.8 times for a dose of 1 μCi, and by 3.5 times for a dose of 0.1 μCi.

Whereas accumulation of iodine in the fetuses and placenta increased until birth, accumulation in the maternal thyroid decreased. Both the absolute content and the concentration of I^{131} in the maternal thyroid remained relatively constant from the 9th until the 15th day of pregnancy, after which they increased until the 17th day, reaching 51.4% of the administered activity for a dose of 0.1 μCi and 48.8% for a dose of 1 μCi, falling again until birth. For the dose of 10 μCi the iodine content in the maternal thyroid reached its maximum of 23.8% on the 15th day of pregnancy. It may be concluded from these results that I^{131} passes readily through the placenta and accumulates in the fetus in proportion to its age, and that the time of pregnancy had no significant effect on accumulation of I^{131} in the placenta, and that a definite relationship exists between accumulation of I^{131} by the fetus and the dose given to the mother. With an increase in the dose of I^{131} administered to the mother, the content of isotope in the fetus decreases.