ON THE PROBLEM OF THE EXCRETORY FUNCTION OF THE PLACENTAL EPITHELIUM

M. Ya. Subbotin

From the Chair of Histology and Embryology (Head—M. Ya. Subbotin) of the Novosibirsk Medical Institute

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The problem of the excretory paths of the embryo's metabolic products, as also the problem of the role of the placental epithelium in this process, has not been decided finally until the present time. The experiments of A. Gusserow [3] and the observations of other authors [2] indicated the participation of the Wolffian bodies in the excretory process. On the other hand, quite conclusive data in favor of the acknowledgment of the function of the placenta as the basic excretory organ were obtained on administering various substances into the blood of the embryo [4,5]. The authors invariably found true solutions of dyes injected into the blood of the embryo in the blood of the mother. A substantial insufficiency of these works is, however, the fact that the dye can only be compared approximately with the excretory products of the embryo. The authors also do not indicate in which exact sections of the placenta the excretion of dye occurred.

We undertook an attempt to determine histochemically a basic excretory product—urea—in the tissues of the placenta and embryo, along with the excretory paths of the dye.

EXPERIMENTAL METHODS

The experiments were carried out on rodents—rabbits and white rats which have the same hemochorial type of placentation as man. In distinction to man, a labyrinthine, not a villous, placenta is formed in rodents. At the same time, the extraplacental trophoblast of the rat completely, and of the rabbit almost completely, disintegrates and is replaced by yolk-sac entoderm. Thus, a smooth chorion is absent in the rat, in place of which a yolk-sac placenta is formed. In the rabbit, a small area of extraplacental trophoblast is preserved in the periplacental area. In the allantoic placenta of rodents, the mother's blood washes the cytotrophoblast and chorionic syncytium (syncytiotrophoblast). The yolk-sac epithelium touches the maternal tissues in the region of the antimesometrial folds. In rabbits, in addition, the cytotrophoblast and giant, usually spherical, syncytiotrophoblasts touch the maternal mucosa in the narrow periplacental zone.

In the first series of experiments, we studied the distribution of a dye administered into the blood of the embryo, in the placental epithelium of the rabbit at various stages of pregnancy, but always after the allantoic and yolk-sac placentas had formed. The dye was a 1% solution of indigo carmine injected into the tissues of the embryo; immediately after, the animal was killed and the uterus opened, while the connection between the placenta and uterus still remained. A number of other experiments were set up on embryos removed from the uterus and surviving (L. L. Vannikov's method). In all the experiments, the embryonic membranes and the embryo's kidneys were fixed in absolute alcohol 20 minutes after injection of the dye.

EXPERIMENTAL RESULTS

The results of all the experiments at all the stages of prenancy studied proved to be the same, so we are summarizing them.

In the allantoic placenta of the rabbit, very fine granules of dye were found only in the chorionic syncytiotrophoblast. Indigo carmine proved to be equally distributed throughout the cytoplasm of the synctiotrophoblast, but sometimes small accumulations of dye granules could be found in the upper layer, which is washed by the maternal blood. All the above pertains to the central lobes of the placentas; on the periphery of the placentas, where there are no embryonic blood vessels, the dye was not found. In no case did we succeed in observing granules of indigo carmine in the cellular trophoblast.

In the periplacental trophoblast, there was considerably less indigo carmine. Dust-like granules of indigo carmine appeared in very insignificant numbers in the spherical syncytiotrophoblasts. The deposition of dye was so insignificant, that it is difficult to discuss its excretion by the periplacental trophoblast. Keeping in mind the tremendous resorptive power of the preiplacental syncytiotrophoblasts, it can be assumed that reverse absorption of the dye, which always occurred in small quantities in the subembryonic cavity, took place here. Like the placenta, the cellular trophoblast of the periplacental area did not contain dye granules.

In the yolk-sac epithelium, slight diffuse staining was observed. Large light vacuoles, which we observed in some cells of the yolk-sac entoderm, stained especially intensively.

Small amounts of indigo carmine could be seen in the epithelium of the uriniferous tubules of the embryo's kidneys under the microscope. The dye accumulation in the embryo's kidneys, however, cannot even be compared with the amount that takes place in the placenta or kidneys of an adult animal when the same indigo carmine is administered to it. If the indigo carmine injection was carried out without injuring the amniotic membrane, an insignificant amount of indigo carmine was only occasionally found in the amniotic cavity. We were convinced that this staining was caused by some errors of injection and not at all by the excretory activity of the embryo's kidneys.

Thus, the excretion of dye occurs in the chorionic syncytiotrophoblast in the central lobes of the placenta and, apparently, to some extent in the yolk-sac epithelium.

The determination of urea in the tissues of the allantoic and yolk-sac placenta which we carried out, showed that the localization of this excretory product differs somewhat from the localization of the granules of indigo carmine.

Urea was found in the placenta and kidneys of the embryo by the xanthydrol reaction (Shtyubel's method), based on the formation of the very typical crystals of dixanthylurea in the tissues in the presence of urea. The observations were carried out on rats and rabbits and, as in the preceding series of experiments, during the second half of pregnancy, when both the yolk-sac and allantoic placentas were functioning. After the animal was killed, a solution of xanthydrol was injected in the blood vessels of the umbilical cord and of the embryo and then small pieces of the extraembryonic organs and the kidneys were immersed in the same fixing fluid. The sections were dyed with Mayer's hematoxylin.

The typical greenish-yellow clumps of dixanthylurea crystals were found only in the chorionic syncytiotrophoblast in the central part of the rat's placenta (in the central parts of the placental lobes in the rabbit). In other sections of the allantoic placenta and in the yolk-sac placenta, urea was not evident. In the chorionic syncytiotrophoblast large clumps of dixanthylurea were localized in various areas of its cytoplasm.

For comparison, we determined urea by the same xanthydrol reaction in the kidneys of an adult animal whose embryos were taken for investigation. Here clumps of dixanthylurea were found as invariably and, in addition, in amounts larger than in the placenta.

Urea in very insignificant amounts was found on the surface (never in the mass) of the amniotic epithelium.

Thus, undoubtedly, urea is contained in the amniotic fluid but, apparently, in much smaller amounts than in the allantoic placenta. In studying serial sections of the embryonic kidneys, prepared according to Shtyubel, under a microscope, we could note only individual, very rare, clumps of dixanthylurea. In the great majority of sections they were not found. It is therefore possible that a small amount of urea is excreted by the kidneys of the embryo into the amniotic fluid. At the same time, it is apparent that this method of excretion has no significance at all and the embryonic kidneys cannot be regarded as an excretory organ of the embryos of animals with hemochorial placentation.

Correlation of the data of histochemical analysis and the results of experiments with the administration of dye into the embryo's blood leaves no doubt that the basic excretory organ of the embryo in the second half of pregnancy is the allantoic hemochorial placenta. To be exact, excretion of the embryo's metabolic products occurs in the chorionic syncytiotrophoblast. Taking into account the fact that, in the chorionic syncytiotrophoblast, treatment and secretion of some nutritive substances occur from mother to embryo at the same time, the conclusion should be made that bilateral secretion is a property of the chorionic syncytiotrophoblast. In this connection, the investigations of Yu. B. Pailodze and B. I. Kopaleishvili [1], who, studying the blood nitrogen of the newborn and of the umbilicus, reached the conclusion that urea is synthesized in the human placenta, should be mentioned in this connection. The problem of the role of the yolk-sac placenta, which functions for a long time in rodents and some other mammals, has special interest. On the basis of our data, the thought can be expressed strictly speculatively that the yolk-sac placenta takes some part in the excretion of nonureal metabolic products.

SUMMARY

In the experiments on rabbits and white rats it has been shown that the dye (indigo carmine injected into the blood of an embryo) is secreted by the syncytiotrophoblast of the chorion of the placenta into the blood of the maternal organism. Indigo carmine has been also found in the epithelium of the vitalline placenta which functions for a long period of time in rodents. By means of the xanthydrol reaction crystals of the dixanthylurea were always found in the chorionic syncitiotrophoblast. The author draws the conclusion that it is chiefly the chorionic syncitiotrophoblast which performs the excretion of the metabolic products of the embryo.

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