THE PRACTICABILITY OF THYROID TRANSPLANTATION INTO THE ANTERIOR CHAMBER OF THE EYE IN FROGS

(UDC 612.44:612.6.02)

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(Presented by Acting Member of the USSR Acad. Med. Sci. V. V. Parin)
Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 61, No. 4,
pp. 101-105, April, 1966
Original article submitted July 9, 1964

The transplantation of endocrine organs into the anterior chamber of the eye has been shown to be highly effective [7, 11]. In this laboratory a series of successful auto- and homotransplantations of the thyroid gland into the anterior chamber of the eye have been carried out with the rabbit as experimental animal [1, 2]. The anterior chamber of the eye represents a good nutritive environment for the transplant and is particularly suitable for carrying out continuous visual observations on the latter through the transparent cornea.

Recently, experiments have been carried out on frogs involving the joint transplantation of the hypophysis together with neurosecretory nervous tissue. These experiments have given positive results and the transplanted hypophysis remained in a functional condition [10].

The aim of the research described in this paper was to carry out a combined transfer of thyroid gland and hypophysis with the preoptic (neurosecretory) region of the midbrain. It is well known that the function of the thyroid gland lies under the hormone control of the hypophysis [3, 5, 15] and the activity of the latter depends, in turn, on the hormonal effect of neurosecretory substances from the preoptic nucleus of the midbrain [4, 8]. Sexually mature frogs, in which the survivability of the selected tissues after transplantation is very similar to that in other animals, were chosen as experimental animals.

EXPERIMENTAL METHOD

The anterior chambers of one eye of marsh frogs Rana ridibunda, weighing from 60-120 g, received homografts consisting of one lobe of thyroid gland, the hypophysis, and part of the preoptic region in various combinations. The thyroid glands of the frogs receiving these grafts were not removed. The experiments involved 120 adult frogs of both sexes. They were carried out in the summer, autumn, and winter of 1963. The mean weight of the donor animals was 75 g and that of the recipients 96 g. The recipient animals were divided into 4 groups: group I animals received thyroid glands only; group II thyroid glands together with hypophysis; group III, thyroid gland, hypophysis, and part of the hypothalamus, all taken from the same donor; group IV, thyroid gland and hypothalamic region. Of the 120 transplantations attempted, 92 were successful, i.e., the grafts survived for various periods after the operation. In order to determine the microstructure of the hypophysis, thyroid glands, and hypothalamus, examples of these organs were fixed in their original condition before the commencement of the experiment and were then subjected to the usual histological treatment.

Group I and group II animals were killed after 3, 10, 15, 20, 30, and 60 days and some after 90 days. Group III and group IV animals were killed 10 days after transplantation had taken place. The eyeball with the transplants, the brain, and both lobes of the thyroid gland were fixed in Bouin's fluid. Paraffin wax sections, thickness 5-6 μ, were stained with hematoxylin-eosin and Heidenhain's Azan stain. The presence of polysaccharide was demonstrated by means of the PAS-reaction. The height of the thyroid epithelium and the internal diameter of the follicles was measured by means of a micrometer.

EXPERIMENTAL RESULTS

Homografts of thyroid gland tissue can survive for 90 days in R. ridibunda, retaining their typical structure and functional ability. A study of histological sections has shown that on the 3rd day after the operation, the transplants

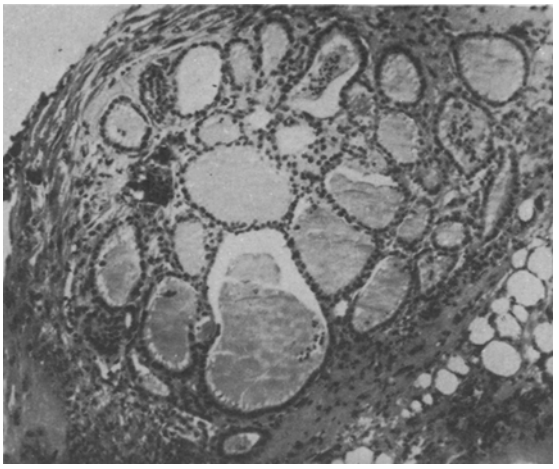

Fig. 1. Transplant of the thyroid gland, inserted together with the hypophysis and preoptic region of the hypothalamus into the anterior chamber. Peripheral follicles more active (vacuolation of colloid). Period of time 35 days. Stained hematoxylin-eosin. Magnif. 100×.

have become overgrown with the richly vascularized tissue of the iridial wall. Some swelling takes place, thus increasing the volume of the transplant. Blood vessels from the iris undergo an intensive penetration into the transplant. In those places, where these blood vessels do not penetrate, some necrosis of the thyroid tissue is clearly visible. The initial height of the thyroid epithelium would average about 6.6 μ and the dimensions of the follicles would be of the order of 95.7 μ, but as a result of swelling, the thyroid epithelium increases to 9.1 μ, and the follicles are reduced to 89 μ in the transplant.

By the 10th day after transplantation, there is considerable intensification of overgrowth and vascularization of the transplant on the part of the iridial wall. Infiltration of the former by connective tissue cells is clearly discernible. In addition to the old follicles in the center of the transplant, islets of undifferentiated thyroid tissue, in which new and very small follicles may be seen, are making their appearance at the periphery of the transplant. The thyroid epithelium is cubical and in some places prismatic, the height of its cells averages 10.5 μ and the diameter of the older, surviving follicles is 90.6 μ. The picture is preserved almost unchanged until the 15th day. By that time the height of the epithelium is 9.3 μ and the diameter of the follicles is somewhat reduced (69.1 μ).

By the 20th day the transplants have become even more strongly overgrown by the highly vascularized tissue of the iris. The epithelium of the old follicles now consists of almost cubical cells (6.7 μ in height). The diameter of the follicles is 70.1 μ. Colloid is absent from many of them. Formed elements of the blood and exfoliated epithelial cells are frequently encountered in the lumina of individual follicles. The main mass of thyroid tissue is represented by poorly differentiated cells and small follicles.

By the 30th day there has been even greater increase in the amount of undifferentiated thyroid tissue. Further small follicles have formed at the points of contact between the transplant and the iris. The walls of the various follicles are of unequal thickness, and the epithelial cells are always somewhat taller in those places lying near to the source of vascularization. The height of the epithelium averages 6.9 μ and the diameter of the follicles 73.8 μ. The structure of the thyroid gland transplant is still very similar to the above condition even after 60 days. By that time, however, the height of the epithelium is only 6.6 μ and the dimensions of the follicles are 94.4 μ.

In the joint transplantation of thyroid gland with midbrain tissue the structure of the thyroid transplant underwent no change in addition to those described above; by contrast, the nervous tissue suffered rapid resorption. Transplants of the hypophysis were relatively well preserved for 20 days. By the 10th day that part of the hypophysial transplant in contact with the iris was more highly vascularized than was the thyroid tissue but its structure had undergone a certain amount of change. Hypophysial transplants showed accumulations of poorly differentiated cells in certain areas, particularly on the periphery of the transplant near the blood vessels. However, 20 days after transplantation the microstructure of the hypophysis had altered significantly. Basophilic cells were infrequent and no regular arrangement of the epithelial cells along the blood vessels was discernible.

In cases of simultaneous transfer of hypophysis and thyroid gland, local destruction of the thyroid tissue on the 1st day after transplantation is prevented, and a high percentage of the transplants survive and new follicles are formed, the colloid of which may be partially vacuolated (Fig. 1).

Vacuolation of the peripheral zone colloid is a well known and characteristic sign of increased thyroid function. The results of simultaneous transplantation of thyroid gland, hypophysis, and neurosecretory tissue in terms of the effect on the thyroid transplants are very similar to those obtained previously for the hypophysis [9].

The phenomenon of ingrowth of the iridial envelope into the transplants in the different variants is worthy of note. Moreover, in certain cases the epithelium of the thyroid grows into the iris and forms typical follicles containing colloid there (Fig. 2). We observed isolated cases of intimate contact between the iris and the cornea, as a result

Fig. 2. Ingrowing of epithelial tissues and formation of new, typical follicles in the iris. Period of time 60 days. Stained hematoxylin-eosin. Magnif. 100x.

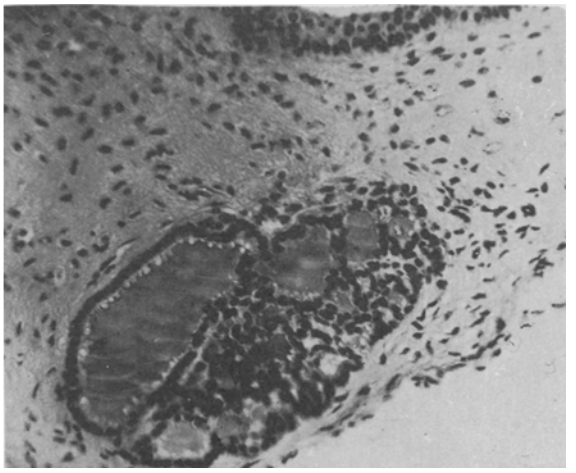

Fig. 3. Formation of islet of thyroid gland tissue with follicles of various sizes in the corneal matrix. Period of time 30 days. Stained hematoxylin-eosin. Magnif. 100x.

of which the cells of the iris would penetrate the cornea to some extent. Such examples were associated with the accumulation of undifferentiated cells as islets in the thyroid tissue and the presence of partially differentiated and small follicles. In certain cases, ingrowths of thyroid gland tissue penetrated the matrix of the cornea, forming there a series of definite islets with follicles of various sizes (Fig. 3). This suggests that thyroid gland transplants possess considerable ability to proliferate and regenerate [compare 6] and still retain their capacity to form follicles with typical colloid.

In this way the results of our studying the dynamics of thyroid gland transplantation show quite conclusively that all the transplants undergo radical changes, which may commence in various parts of the transplant and take place with varying degrees of intensity depending on local conditions of nutrition and vascularization. We have observed the phenomenon of transplantational regeneration which has previously been described in relation to the thyroid gland [1, 2], and we have shown that under certain conditions the formation of thyroid tissue may occur at some considerable distance from the original transplant and yet include typical, functional follicles.

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