MORPHOGENESIS OF NEURAL DERIVATIVES AFTER TRANSPLANTATION OF THE RAT EMBRYONIC TELENCEPHALON INTO THE TESTIS OF SEXUALLY MATURE ANIMALS

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Transplantation of parts of the embryonic mammalian brain into the brain, anterior chamber of the eye, or nerve is used at the present time to study not only the possibility of correcting certain diseases, but also the principles governing histogenesis of neural tissues [1, 2, 6, 7, 10, 12].

The aim of this investigation was to study the characteristics of morphogenesis of the embryonic rat telencephalon in the testis and to compare the results with data in the literature on histogenesis of the brain in other ectopic sites in order to elucidate the role of the recipient's surrounding tissues in realization of the mode of differentiation of neural derivatives in the graft. The reasons for the choice of the site of transplantation were, first, the presence of a protective barrier in the testis against immune reactions of the body, and second, data on the successful realization of histogenesis and organogenesis in fragments of an embryo transplanted into the testes: the genital ridges and embryonic ganglia [5, 9]. Unlike traditional transplantation sites, the testis has virtually no neural derivatives, and the graft is in contact with other tissues.

EXPERIMENTAL METHOD

Mechanically dissected chambers of the anterior cerebral vesicles (telencephalon) of Wistar rat embryos at 14.5 days of development (the stage of pregnancy was determined by the usual method [4]) were transplanted one into each testis of sexually mature animals of the same line, which were killed 3, 4, 5, 7, 10, 12, 14, 20, 35, and 90 days after the operation. To study the number of DNA-synthesizing cells, 1 h before sacrifice the recipient rats received an injection of ^{3}H-thymidine (molar activity 1880 TBq/mole) in a dose of 0.04 mBq/g body weight. Morphological analysis of the grafts was carried out on histological sections stained with toluidine blue by Nissl's method. Some of the graphs were used to reveal fibers, by the Bielschowsky–Gros method. The volume both of the graft as a whole and of the cells composing it also was determined.

EXPERIMENTAL RESULTS

The number of DNA-synthesizing cells in the original material obtained from a 14.5-day embryo, in the telencephalon (volume 15 mm^3) whose walls consist of a well-developed ventricular zone (neuroepithelium) and a poorly developed intermediate and peripheral zone, was 45%, in agreement with the results of other investigations [3, 8, 13].

Virtually all the grafts (37 of 39) preserved their viability. Morphogenetic transformations of the graft took place in two stages. In the first stage the neuroepithelial cells, which proliferated intensively, formed wedges of growth, filling the space between the seminiferous tubules. As early as 5 days after the operation two types of cells could be detected in such a graft: 1) dark, intensively proliferating, and 2) paler, differentiated cells, differing from the first type in the larger size of their nucleus and cytoplasm. In all grafts, cysts lined with ependymal cells were seen, very similar in structure in some areas to the choroid plexus. The graft 12 days after the operation consisted of both neuroblasts

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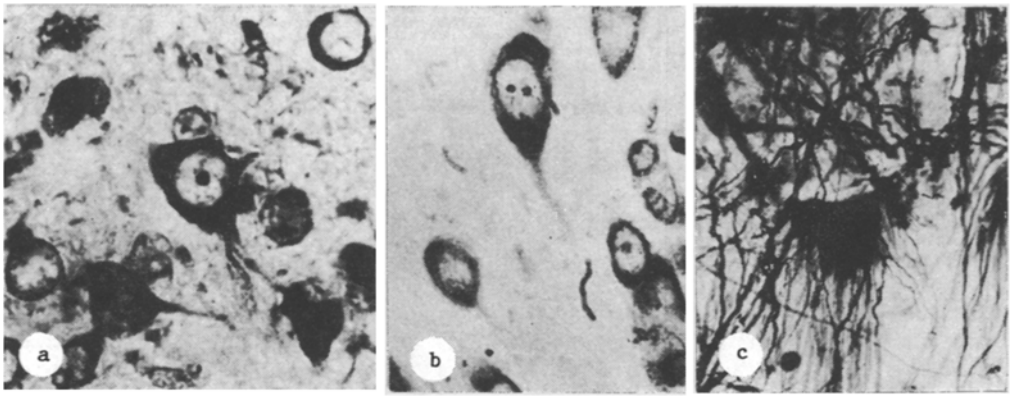

Fig. 1. Fragments of graft 90 days after intratesticular transplantation of anterior cerebral vesicle. a, b) Bodies of neurons. Stained with toluidine blue. 625 ×; c) Network of fibers. Stained by Bielschowsky–Gros method. 500 ×.

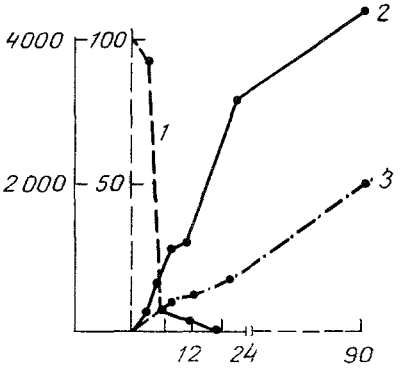

Fig. 2. Changes in number of DNA-synthesizing cells (1), and volume of graft (2) and its component cells (3) at various times after intratesticular transplantation of anterior cerebral vesicle. Abscissa, time after transplantation (in days); ordinate, data relative to control (14.5-day embryo; in %): I) volume of graft (2) and cells (3); II) DNA-synthesizing cells (1).

and grouped glial cells. Newly formed capillaries were found among the neural derivatives. Thus the first stage, lasting 12 days, was characterized by migration and proliferation of cells, and also by the initial processes of cytodifferentiation, with the formation of neuroblasts and glial cells. An increase in volume of the graft at this stage took place chiefly on account of an increase in the number of cells and, to some extent, to the increase in size of the cells during initial differentiation.

The second stage of morphogenetic transformations in the graft (after 12 days) was characterized by absence of proliferation of precursors of neurons, with a sharp increase in the intensity of cell differentiation. The graft 20 days after the operation consisted not only of glial cells and neuroblasts, but also of neural cells, whose shape and size, the presence of processes, and the distribution of their Nissl's substance indicated a definite degree of differentiation. Whereas 20 days after transplantation very few fibers could be detected at the light-optical level, by 3 months a very well developed network had formed, further evidence of a high degree of differentiation of the neural cells. The most highly differentiated cells were similar in structure to pyramidal, stellate, and spindle-shaped cells (Fig. 1). In grafts of this sort, definitively formed capillaries and glial cells were present in quite large numbers. The increase in volume of the graft (45 times larger than the volume of the original material) at this stage took place mainly on account of differentiation of

neurons, i.e., of an increase in their size and the formation of a widely branching fibrous network (Fig. 2).

Thus the neuroepithelial cells of the anterior cervical vesicle of the rat embryo at 14.5 days of development, transplanted into the testis, proliferated intensively and then differentiated, to form cells characteristic of the definitive brain. However, the regular organization of cells with the formation of all the cortical layers did not take place in the graft, i.e., the typical cytoarchitectonics, so characteristic of the definitive cortex, was absent. It must be emphasized that after transplantation of fragments of embryonic brain into the definitive brain [1, 6, 7], nerve [11], or testis (results of the present investigation) the morphogenetic potential was realized in a similar manner irrespective of their interaction with the recipient's tissues. External factors evidently do not play a decisive role in the realization of the mode of differentiation of neural derivatives, as shown by the presence of cells characteristic of the definitive brain in the grafts. Evidence of the autonomous character of development of neural derivatives may be given by data in [2]. Meanwhile external factors can influence only the rates of proliferation and differentiation of cells in the graft. Thus on transplantation of a graft into the brain the cells cease to synthesize DNA 5 days earlier [12], and the volume of the conglomerate of neural derivatives [10] is only half of that in the testis.

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