
QUANTITATIVE MORPHOLOGICAL CHARACTERISTICS OF DEVELOPING NEURONS
OF THE BRAIN-STEM RETICULAR FORMATION

N. G. Gladkovich, T. A. Leontovich, and K. V. Shuleikina

Two types of neurons — reticular (with few branches) and multipolar giant (densely ramified) were distinguished in the brain-stem reticular nuclei of the brain in Golgi preparations from cat fetuses aged 45-55 days and kittens aged 1-5 and 30 days. The quantitative morphological characteristics of these neurons at different stages of development were determined from the dimensions of their bodies, the number, length, and ramification of their dendrites, and the overall ramification of the cell. The types of neurons described above differed in both qualitative and quantitative indices and in the character of their maturation. Maximal ramification of dendrites of giant multipolar neurons was observed in the embryonic period. Foci of maximal ramification in reticular neurons were close to the cell bodies. In giant multipolar neurons in fetuses and 30-day-old kittens foci of maximal ramification were located on the proximal and distal portions of the dendrites, but in the newborn kittens on the proximal segments only. These facts are examined in connection with differences in the spike activity of the growing neuron.

INTRODUCTION

The electrical activity of the developing nerve cell has many features which distinguish it from that of the mature neuron [8]. To a large extent these differences can be due to morphological immaturity of the cell body, its processes, afferents approaching it, and a combination of these factors. The problem of interconnection of morphological and electrophysiological phenomena characterizing development of the cell can be solved only by determining the quantitative characteristics of its geometry. However, there is virtually no information on this matter. The object of the present investigation was accordingly to determine the quantitative morphological characteristics of neurons of reticular nuclei in the lower part of the brain stem — the gigantocellular nucleus of the medulla and the caudal and oral reticular nuclei of the pons — during their ontogeny. These structures were chosen because it is in this region in the embryonic stages that the earliest appearance of electrical activity has been observed, that neurons with sufficiently stable discharge activity are found, and that giant cells developing earlier than the other neurons of the brain-stem reticular nuclei can be detected morphologically. According to the earlier hypothesis [7], the function of supraspinal monitoring and control of the first fetal movements may be connected with these cells.
EXPERIMENTAL METHOD

The experimental material consisted of cat fetuses weighing between 50 and 60 g (five fetuses, 45th-55th days of intrauterine life) and kittens aged 1-5 and 30 days (six and five animals, respectively). The brain stem was treated by Golgi's method and serial sections cut to a thickness of 100-120 μ. Frontal sections were investigated, for the branches of most cells of these reticular nuclei form a layer the height of which is perpendicular to the frontal plane. Leontovich's method [4] was used to characterize the processes and bodies of the neurons quantitatively. At all stages of development groups of 11-12 cells were chosen for each of the types of neurons to be studied. To reduce the percentage error in the values measured, cells in which the overwhelming majority of dendrites were contained within the volume of the section were chosen. The maximal length and width of the cell body, the total number of primary dendrites and of dendrites divided before the first branching, the number of free ends of dendrites, and the maximal radius of the dendritic field were measured on drawings made by means of a drawing apparatus (×400). The linear dimensions of the cell body (half the sum of the length and width), the relative length of the dendrites (the ratio of the maximal radius of the dendritic field to the linear dimension of the body), the degree of ramification of the dendrites (the mean number of free ends of dendrites per dendrite, deducting dendrites divided before the first branching), and the overall ramification of the cell (the product of ramification of the dendrites and their number) were calculated by the appropriate equations. The number of foci of maximal ramification (FMR) of the dendrites also was counted, i.e., the number of regions where the dendrite divides into more than two branches over a distance not exceeding 1/20 of the length of the maximal radius of the dendritic field. To determine the location of FMR on the axis of the dendrite, their distance from the center of the cell body was measured and the ratio of that distance to the linear dimension of the body calculated. To characterize the orientation of dendrites with an FMR, rectangular coordinates in which the ordinate was the true midline of the brain and the abscissa a line perpendicular to it, were applied to all drawings of neurons. The point of intersection of these axes was then adjusted to coincide with the center of the cell body, and the angles of inclination of dendrites with an FMR were measured relative to the abscissa. For the left half of the brain the angle was measured clockwise from the segment of the abscissa on the left, whereas for the right half of the brain it was measured anticlockwise from the segment of the abscissa to the right of the ordinate. Values of the angles of inclination of dendrites with an FMR thus obtained were drawn as radii on diagrams, each of which corresponded to cells of a definite age and type (Fig. 5a, b).