

## DESCRIPTION OF THE MOTOR AREA OF THE CORTEX CEREBRI OF AN INFANT.

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I lately had the opportunity of examining sections from the brain of a child *æt.* 18 hours precisely. It died in consequence of an accident; the autopsy showed all the viscera to be healthy. The case is of interest partly on account of the early age of the child, but mainly because the examination was made after the fresh method, which has not, so far as I know, been employed in a similar instance. It is now widely admitted that sections obtained from the fresh brain (ether-frozen) and stained with aniline blue-black, which has an extraordinary affinity for nerve structures proper, present unrivalled pictures of the cerebral cortex. The detrimental (corrugating) effects of the chrome salts can immediately be appreciated by comparison of sections obtained from tissues hardened in them with others made after the fresh method. I refer exclusively to brain tissue.

The brain in the present case was exceedingly soft, and suitable sections were obtained with much difficulty. Unfortunately those made from the upper end of the ascending frontal gyrus (a site at which the cell groups of Betz are peculiarly large and numerous) underwent partial dissolution in the staining fluid, so soft were they. However, sections made at the junction of the upper and middle thirds of this gyrus proved complete at the end of the staining process, and as at this site the motor cortex is sufficiently typical they were selected for description.

*Description of Cortex and Subjacent White Matter*—The outermost layer is very well defined. Under a low power it is obvious that this layer contains many more elements than are present in the similar region of the adult cortex. Under a high power these are found to be mainly round, but also angular, oblong, oval, and pear shaped, and to have taken the stain very deeply. They can scarcely be other than connective tissue nuclei. Besides free nuclei, others occur which have an incom-

plete investment of faintly stained protoplasm, but these are in a decided minority. The delicate spider cells with vascular processes, which can be seen (on careful examination) in this layer in the adult cortex, are completely absent in the present specimen; but it is interesting to note that some of the nucleated clumps of protoplasm are in apposition with blood capillaries; possibly they and the other irregular protoplasmic masses mentioned above represent a very early stage of the spider cell. Blood capillaries are present in far greater numbers than in the fully formed outermost layer, their longitudinally placed nuclei being also peculiarly numerous and well marked. The diameter of the capillaries ranges between 2  $\mu$  and 4  $\mu$  (in the adult cortex it is often 4  $\mu$ ).

The neuroglia-matrix is pellucid and homogeneous. As regards the size of the connective tissue nuclei, the round ones are from 4  $\mu$  to 6  $\mu$  across, the others (oval, oblong, etc.,) from 6  $\mu$  to 10  $\mu$  in greatest diameter. At the junction of cortex and pia the usual felt work of fibres connecting these two structures can be seen, though it is more delicate and less dense than in the adult.

Beneath the outermost layer is a belt of tissue, deep-blue in color, nearly 150  $\mu$  broad, marked off sharply from the superjacent layer, but passing rather gradually into that beneath. This is a very prominent feature of the specimen. Under a low power it appears to be composed of deeply-stained nuclei, very closely set, an appearance verified on further magnification. Most of these nuclei have no covering. They measure from 6  $\mu$  to 9  $\mu$  at greatest diameter. Others appear partially surrounded by lightly stained protoplasm, and in such cases the structure presented may be termed a rudimentary cell. Very rarely such rudimentary cells present a slightly pyramidal form, the small amount of protoplasm outside the nucleus being in contact with the part of the latter nearest the outermost layer, the resulting shape being that of a short, blunt cone. But even in such rare instances of pyramidal type no trace of a process is visible. Many of these nuclei and young cells are irregularly angular; frequently they consist of mere lumps of protoplasm, without particular shape. Some of them are clearly nerve cells, and most can doubtless be placed correctly in the same category. But the ordinary criteria for distinguishing between nerve cells and connective tissue cells do not invariably furnish positive conclusions in the present specimen.

In this connection it may be noted that the nerve cells of the second layer in the adult cortex are closely aggregated in comparison with those of other layers, though far less so than are the protoplasmic masses of the present specimen. The average size of the nucleus in this (second) layer in the adult is given as 6  $\mu$ , (Bevan Lewis,) the length of the nerve cell varying from 11  $\mu$  to 23  $\mu$ . The nuclei of the second layer of the present specimen would therefore appear to be, proportionately to the size of the rudimentary cells, decidedly large. This layer, like the first, is rich in blood capillaries.

The portion of cortex beneath the second layer—out of which one must suppose that the third layer (or a portion of it, at any rate,) and the fourth and fifth layers of the fully formed cortex develop—does not, in the present case, permit of division into strata. Had specimens been obtained from the upper end of the ascending frontal gyrus, it is probable that “motor” (giant) cells in an early stage would have been seen, of sufficient prominence to constitute a layer. In the present specimen, though these are distinguishable with a high power, they are few and scattered and cannot be employed for the purpose of differentiation.

In traversing this stretch of cortex, extending between the dense second layer and the white substance, the eye encounters numbers of deeply stained structures, round, oval, angular, irregular. Some of these are doubtless connective tissue nuclei; others—distinguished by the presence outside them of a lightly stained substance, protoplasm, and by their pyramidal shape—appear to be nerve cells. The cell-substance is, however, in very small amount; and placed at one side of the nucleus, rarely, it partially envelopes the latter. An exception must be made in the case of certain nerve cells situated quite near the lower limit of the cortex: the nuclei of these are distinct from all others in that they are completely surrounded by protoplasm. Further, the pyramidal shape in many of them is unequivocal, though—as is the case throughout the cortex—no processes are visible, or at most the commencement of an apex process; lateral and secondary processes are never seen. These cells are the largest in the specimen, many of them measure 12  $\mu$  x 9  $\mu$ , 15  $\mu$  x 9  $\mu$ , 18  $\mu$  x 9  $\mu$  (the length being taken from the base to the extreme upper limit of the rudimentary apex process). They probably represent an early stage of development of the giant (“motor”) cell. Rarely they occur in groups of three and four,

(as in the adult), but are more commonly separate and scattered. The rich staining and comparatively large size of the nucleus in all cases in which cell substance is present and a contrast afforded are remarkable. It may here be mentioned that aniline blue-black, while giving a rich nuclear stain, fails to show the structure of the nucleus.

Distinct from the undoubted connective tissue nuclei on the one hand and the rudimentary nerve cells on the other, are certain large nuclei, often measuring  $9\mu \times 6\mu$ , irregularly oval or pyramidal in shape: these may with much probability be regarded as consisting of nerve tissue proper, though devoid, at present, of cell-substance.

There is a complete absence in this specimen of the striking appearance presented in the adult by the numbers of cell processes streaming upward towards the periphery of the cortex.

Blood capillaries are abundant throughout the portion of cortex just considered, their diameter being the same as that of the vessels of the external layer, which has been given. I have been unable to make out the vascular loop around the nerve cell, described in the adult cortex, and am of opinion that it is by no means so evident in the latter case as descriptions would lead one to suppose.

One especially expected to see the pericellular lymph-sacs in sections taken from cortex at such an early period of life. The fully formed nerve cell of the adult apparently occupies the whole space in which it lies, since nothing can be seen of the space in ordinary fresh specimens, and it would seem that the same would hold good in the cortex of the young; at any rate, I have not succeeded in finding pericellular sacs in the present specimen. It may be that fresh specimens would show these lymph spaces if prepared after a special method: I can not speak definitely upon this point. [Hitherto I have only succeeded in seeing them in the cortex of the cat; the specimen had undergone preliminary hardening, but the pericellular spaces in this instance were obviously natural, and not merely the outcome of retraction of tissue.]

In the lowest part of the cortex, cells with a distinctly spindle shape—such as constitute the characteristic feature of this part of the adult cortex—can be seen scattered about in small numbers. But here, as throughout the grey matter, deeply stained nuclei, naked, or with incomplete protoplasmic investment, form

the most prominent feature. Capillaries in large numbers are again met with.

The state of the central white matter may now be referred to. Connective tissue nuclei are present here in great numbers, and very many have a well marked protoplasmic investment. The contrast with the cortex in this regard is very marked; in the latter the investing sheath, if present, is imperfect. The size and depth of staining of the nuclei also attract attention. The intercellular substance is remarkably clear; the granular, blue-tinted basis-substance seen in adult specimens is represented here by a faint grey mottling. The larger blood-vessels exhibit numerous hair-like processes, passing out to cells or oval nuclei; they are seen with peculiar distinctness. The structures described are the vascular processes of the so-called scavenger cells. It is interesting to note that blood-vessels below the largest in size do not present them.

In contrast to the cortex just described, I may here refer to that of a healthy boy, æt. 2 years, which I lately examined by the fresh method. The specimen was from the motor region. This shows well marked differences between the second, third and fourth layers in regard to the size and shape of the nerve cells, which become larger and more perfectly pyramidal as one proceeds from above downwards. The five layers described in the adult motor cortex can be made out well. Cell processes, —especially apical—are well marked and run a considerable distance; they end, however, abruptly, with a blunt extremity. Connective tissue structures can be readily distinguished from nervous structures.

In the specimen which is the subject of this paper one is struck by the trifling difference apparent between the nerve cells in point of size, shape, and richness of protoplasmic investment, as one proceeds from without inwards. No striking difference is seen until one suddenly encounters the cells in the deepest part, above mentioned. Only three layers can be properly differentiated; of these the third comprises all that portion of cortex subjacent to the belt of deeply stained nuclei. In this layer it must be supposed that differentiation takes place at a later period.

The prominence of the nucleus throughout—whether of nerve or connective tissue cell—and the vascularity of the cortex call for special mention.