LECTURES

ON

THE FORMATION AND EARLY GROWTH
OF THE BRAIN OF MAN.*Delivered at the Royal College of Surgeons of England.*

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LECTURE II.

FROM the examination of the case which contains the brain, it appears that its anterior limits at the earliest stage of its formation are measured by the ring of tissue forming eventually the basal cartilage; that at the inferior extremity of this is found the pituitary body; at the superior, the pineal gland; and that the anterior dilatation of the brain-case is developed in connection with the superior closure of the dorsal or axial arches. By the growth forward of the trabeculae, and by the occipital deflection, the antero-posterior length of the basal tissue is increased. By the membranous connection which follows the line of constriction between the first and second vesicles, the pineal body retains its relations with the pituitary (Fig. 8, M); a band of membrane gradually forming between it and the occipital plate as the latter deflects backwards.

Having referred to the formation of the case, we come to the consideration of that of its contents; and, first, the chief parts of which these consist, and their general arrangement at an early period of development, may be briefly noticed.

In a foetus six-tenths of an inch long, one in which the dorsal and yet lower axial arches are incomplete, the part of the cerebro-spinal axis which lies above the proto-vertebrae is marked by four constrictions, one separating it from the cervico-vertebral region, another terminal, and two intermediate between these. These constrictions give the appearance of slight dilatations to the intermediate portions of the cranium. These are the anterior, middle, and posterior primary vesicles, as they are commonly called; and they contain respectively the fore-brain, the mid-brain, and the hind-brain.

When the membranous portion of the brain-case is removed, the nerve-tissue is seen to be arranged, not in vesicles, but as an elongated tube, which rapidly becomes solid except at certain points, and which is flexed and twisted after a definite fashion. It may be true that the primary bend is due to the cranial flexure of the notochord; but this is not the only flexure at this stage of development. The fore portion of the brain is turned down at a sharp angle, and its middle part is thrown up so as to form the highest part; and this is what is named the mesocephalic flexure. The lowest, originally the most anterior, portion of the fore brain, is attached to the pituitary fossa immediately in front of the termination of the notochord; and the attaching structures in a foetus 1.5 inches long have the ordinary characters of the infundibulum and pituitary body. Reichert thought that this body might be the end of the notochord, the invariable termination of which immediately beneath the pituitary fossa has been dwelt upon as a notable fact by Professor Huxley.

If we bring together the facts which bear upon the nature of the infundibulum and of the pituitary body, we learn that, by the projection and subsequent junction of the trabeculae, a fossa is provided for the reception of the body (Fig. 8, Pt); and this is deepened by the raising up of the clinoid processes. Over the termination of the axis-tissue is the anterior, and, as flexion occurs, the inferior extremity of the fore-brain. (Fig. 8, Cr.) A portion of this fore-brain is enclosed by the trabeculae as they grow forward; and this portion continues to retain its connection on the one side with the tissue in front of the notochord; on the other side, with the fore-brain, of which, indeed, it is a part. It is also held in place by the development around it of the brain-membranes which are fixed to the clinoid processes. There can be no doubt but that this is the origin of the pituitary body, and of its infundibulum, which, in the adult, represent structures which played their parts during foetal life; and it is easy to see that their purpose was to anchor the fore-brain to the fossa (sella Turcica), forming a fixed point, from which, as from a centre, the further steps in the development of the cerebrum might be controlled. The relations between the fore-brain and the pituitary body never vary during all the changes which occur in

other parts of the cerebrum during the progress of their development. It is, in fact, the inferior ligament of the brain.

There is a second fixed point which also holds its position unaltered during the development of the cerebrum; and this is the pineal gland, the superior ligament of the brain. Its position corresponds with that of the second cranial constriction (Fig. 8, P); and from it two bands (the crura) pass forward along the upper and inner margin of the optic thalami, in which they are gradually lost; the reason for this not being traceable to the infundibulum being evident when the structure of the thalami is examined. Whilst examining a foetus 1.2 inch long, I observed that this gland had another attachment—viz., to the upper centre of that portion of the occipital bone which is formed in cartilage. It is, as has been already mentioned, only during the early stages of development that this relation of the supraoccipital cartilage with the pineal centre can be recognised; for the growth of the periotic cartilage forces the occipital backwards, the pineal centre remaining fixed by its membranous connections with the base of the skull. (Fig. 8, M.) A prolongation of membrane, however, always connects it with the internal occipital prominence, and marks the line of junction in the adult between the falx cerebri and the tentorium.

The pineal body is the centre of attachment for the membranes of the brain; and, through these, it assists in determining the form of the hemispheres. In a foetus 1.5 inches long, it is a mere thickening of tissue; it only acquires comparatively considerable size as the corpus callosum is formed, and brings to this centre an accession of membrane-tissue.

It is at least a remarkable fact that, as the pituitary centre fixes the fore-brain to the end of the axis-cartilage, and the pineal centre attaches it posteriorly to the first axial arch, so there is found at the lower end of the cerebro-spinal axis a body fixed in a cleft at the end of the coccyx, between the ligaments attached to that bone. This is the coccygeal gland, or gland of Luschka—a structure to which, in the adult, no possible purpose has been assigned, but which, like the two centres at the opposite end of the canal, is not improbably the remains of some tissue connected with the closure of the spine. Formed, as it is said to be, of a confused mass of tortuous, dilated, and thick-walled vessels, forming lobules, with nerve-cells scattered in its substance, its likeness to the pituitary body is best expressed by the fact that both are compared by all observers to the suprarenal capsules.

The membranes of the brain are formed in the tissue intermediate between the cartilaginous and membranous cranium on the one hand and the nerve-tissue on the other. The inner portion of this tissue (Fig. 9, dotted line) is closely applied to the brain, and no doubt assists in its growth, just as the periosteum does in that of the bones. It follows its various outgrowths, and dips in between its fissures; but, as the folds within these deepen, the opposed surfaces of the arachnoid adhere and lose their distinctive characters, and the vascular portion of the tunic alone remains in the recesses of the fissures. The arachnoid and the pia mater, being developed in the same tissue, and being at first equally spread over the nerve-centres, are virtually parts of one membrane; and although, in the way referred to, the arachnoid in the completed brain fails to pass in between the convolutions, and so far appears to be distinct from the pia mater, yet their mode of development gives good ground for objecting to regard these as distinct membranes, and for preferring to consider them but as one investing tunic, which may be named the perineural. (Fig. 9, P N.)

Fig. 8.

Fig. 9.

The endocranial (Fig. 9, E C) membrane (dura mater) is a continuation of the perineural reflected over the cranial cavity. It has its arachnoid surface, and its vascular layer (Fig. 9, dotted line), which, besides giving a strong nutrient coat to the bones, forms the various processes which project into the cranial cavity, and the passages for the veins. All these processes converge towards the pineal centre. In a foetus 1.7 inches long, they cover the rudimentary cerebellum and the site of the corpora quadrigemina (tentorium), and ascend from this layer to form the falx, which is a mere ridge in the middle line. From the tentorium, the endocranium is prolonged forwards and downwards on each side of the mid-brain, which it encloses, and then extends to

the pituitary fossa; and this portion is at this period the chief and strongest part of the membrane, and serves evidently to fix the pineal centre to the basal structures. In a foetus five inches long, the falx is still a narrow band; and it is only as the hemispheres rise up above the fore-brain, that it slowly deepens into the fissure between these structures.

As the hemispheres of the cerebrum and of the cerebellum are developed, they raise before them the arachnoid and pia mater (perineural tunic); and, by the mode of growth of the mantles, this tunic is thrown into duplicate folds, in most of which the arachnoid is obliterated; but one of them on each side, where the mantle rises at an angle from the side of the optic thalamus, persists (Fig. 10, between S and Op), and the roll thus formed eventually constitutes the choroid plexus. It may be traced over the upper surface of the optic thalamus to its posterior border; then over its lower surface, where the peduncle of the mantle passes through its tissue, just above the track of the optic nerve; it then turns up above that nerve and around the front border of the thalamus, anterior to the infundibulum. Thus it constitutes a vascular ring around the peduncle. It may be followed in precisely the same course in the adult brain, forming a continuous band with the relations as in the foetus.

The formation of the velum interpositum, and the provision for the lining of the lateral ventricles (which, it must be remembered, are only parts of the surface of the brain), may be explained by the aid of this diagram. As the corpus callosum grows backwards, opposite sides uniting in the middle line, it pushes before it the perineural tunic (Fig. 10, c c), which is fixed below by its connections around the pituitary centre (Fig. 10, Pt). The investment it thus acquires it carries to the pineal centre (Fig. 10, at P), where this callosal process of membrane blends with that extending from this centre over adjacent portions of the brain. By this means, the upper surface of the

Fig. 10.

Fig. 11.

corpus callosum is covered with arachnoid and pia mater, like other parts of the cerebrum (Fig. 10, dotted and inner lines); and from it these membranes pass to the hemispheres. The under surface of the corpus callosum is also lined, the vascular tunic being next to the brain-tissue; next to this is the arachnoid; then follows the arachnoid lining the optic thalamus and the ventricular part of the corpus striatum; and beneath this is the pia mater, which, where rolled up to form the choroid plexus, is covered with arachnoid (Fig. 10, between P and S). The arachnoid and pia mater which cover the bourrelet, or pad, adhere to the corresponding tunics, here passing to the posterior surface of the thalamus of each side; and consequently there is, at a later period, no communication between the general sac (so called) of the arachnoid and the cavity of the third ventricle. The vessels of the pia mater, however, pass freely from the pineal centre to the surface of the thalami.

In the development of the cerebellum, a fold of arachnoid and of pia mater (perineural tunic) is raised on each side from the ascending columns; and the two, coming into relation in the middle line, unite, and shut off the cavity of the future fourth ventricle from the sac of the arachnoid. The line of reflection is marked by a vascular fringe on each side (choroid plexus), which reaches, in the adult brain, from the inferior vermiform process to the restiform track.

The endocranial membrane is adherent to the margins of the foramen magnum.

The tissue enclosed by these membranes, and in which the brain-centres and the cerebral nerves are developed, consists, in a foetus one inch long, of two elongated tracks, which ascend through the foramen magnum; then bend forward at an acute angle; then backwards, and again forwards and downwards. Two curves are thus formed; the higher being the superior cerebral (mesocephalic) (Fig. 11, at Q); the lower, the inferior cerebral (Fig. 11, at O). On the higher curve is placed the pineal centre (Fig. 11, at P). The end of the tortuous tube is fixed to the pituitary fossa (Fig. 11, Pt).

In front of the superior cerebral curve, the brain-tissue, having be-

come solid, expands and ends by throwing out a number of processes which overlap the anterior lateral and superior surfaces of the mesial tissue (Fig. 11, M), and are connected, or rather held down to the pineal centre, by means of their investing membrane; whilst below they are fixed to the pituitary centre (Fig. 11, P). These processes are the rudiments of the mantles (surface-parts of the hemispheres). The peduncles of the pineal centre, marginating the optic thalami, are of great comparative size, and are lost gradually as they pass forward. Each thalamus has a smooth upper surface, but is nearly overgrown by the mantle. On its inner surface are several marks, the nature of which will require subsequent consideration.

Behind the thalami is the elevation for the corpora quadrigemina (Fig. 11, Q), corresponding to the bulging portion of the primitive brain-case, between the second and third constrictions. The two side-pieces unite by interdigitating; and the superior layer of its tissue seems folded on each side, as in Fig. 11, Q.

Beneath the buds of each mantle, the optic nerve forms a distinct band, with two bulging portions (Fig. 11, at O), and then ascends by the side of the corpora quadrigemina, where it makes a series of folds, and ends close to the upper portion of the cerebellum. It would seem from this, that the mode of development of this nerve indicates a connection with the optic thalamus, the corpora quadrigemina, and the deeper and central (vermiform) process of the cerebellum.

Below the corpora quadrigemina, the curve forward of the tissue represents the cerebellum (hinder brain); and, at the most posterior portion of this, there is a thickening of tissue in the middle line, which is the vermiform process (Figs. 11 and 12, Cb). The rest of the cerebellum is a mere track of tissue; but, just behind the inferior cerebral curve, three buds project, and indicate its laminated structure. This lifting up of the tissue is continued backwards until the central thickening or vermiform process is reached, and at a later period the buds begin to overlap it.

These parts must now be referred to in relation with the tissue ascending from the cord. This tissue, just at the level of the foramen magnum, is divided on either side into two distinct tracks. Of these, the two which at first are partly lateral and anterior are curved backwards (see Fig. 11, T); whilst those which are partly lateral and posterior, curve forward beneath them (centrally) (Fig. 11, Ti). The tracks again cross a little higher up; but now the posterior are external, and the anterior are central; the curve of the former, posterior, bearing the rudiments of the cerebellum, then pass through, or rather form the upper portion of the corpora quadrigemina (the mesial fissure, Sylvian, is at this period closed), and are then continued to the optic thalami. The anterior tracks pass along the base of the corpora quadrigemina, throwing up some tissue to join the posterior tracks through the upper portion of the mid-brain; then skirt that of each thalamus, and, following its floor, surround the infundibulum; those of opposite sides being at this stage united in the middle line from the point at which they open to give passage to the posterior tracks, to their anterior relations about the infundibulum. The fissure above these and below the cerebellum is the site of the fourth ventricle. The continuation of the median fissure is closed through the corpora quadrigemina as a canal; but, by separating the optic thalami, it is exposed to its front termination, being here closed below by the union between the two anterior tracks. There is no fifth ventricle.

If the basal portion be examined at a somewhat more advanced stage, the thalamus above it is seen to be deeply indented posteriorly. Below it, the thick masses of the anterior tracks pass forward, edged by a slight ridge, easily distinguished by its white colour, which is broken at the pituitary centre, but, on reappearing, ascends in front of the thalamus. In front of this, again, is a considerable mass of a whitish colour. This is the point at which the fore part of each mantle begins to unite with its fellow, forming the corpus callosum. If the brain be turned over, so that its base is exposed, the union of the anterior tracks and their surrounding of the infundibulum are distinct, the infundibulum appearing as a foramen, from being torn from its connections with the pituitary body. At this period, this body is formed, and the pineal centre can be recognised.

In a foetus 1.6 inches long, the origins of the cranial nerves can be examined. The first, or olfactory (Fig. 11, Ol), which can also be traced in a foetus one inch long, consists of a bud growing out with those for each mantle. It is the second in order from the anterior curve of the thalamus, and is the lowest. At first of great proportionate size, it consists of a layer of tissue which soon folds over, closing above, so that the bulb appears hollow. It lies throughout in the fossa formed on the trabecule, with which it is permanently associated. It is in relation with the three anterior inferior folds of the mantle, and immediately behind it is the point at which opposite sides unite to form the corpus callosum. The optic nerves have been

referred to. The tracks are united by commissural fibres in a foetus 1.5 inches long. I have not been able to fix an earlier period for the appearance of this commissure, from the difficulty experienced in dissecting for it. The third, the fifth, and the facial division of the seventh pair, grow out from the anterior columns, where crossed above by the posterior; and the fifth is close to the fissure which serves to divide them (Fig. XI, at X), so that it may be equally connected with either track. The facial is placed higher up (Fig. XI, above X), and curves round the anterior bulge of the cerebellum to reach, and thence to accompany, the auditory nerve. The fourth nerve forms a conspicuous line curving along the upper border of the cerebellum; it comes out just by the side of the vermiform portion (Fig. II, above Cb), and is thus in relation with the groove between the posterior tracks. The auditory nerve is of large size (Fig. II, A), and grows from the open floor of the fourth ventricle by a series of bands which form a thick projection curving below the cerebellum and over the lip of the ventricle formed by the diverging anterior tracks, until, at the anterior curve of the cerebellum, it passes to the periotic cartilage in company with the facial nerve. Although the two nerves pass off from the brain in company, their origins are widely apart and dissimilar. The remaining cerebral nerves have their origins from the side of the decussating fibres below the fourth ventricle—the sides of the future medulla oblongata.

In a foetus 1.8 inches long, it seems as if the change of direction in the tracks passing through the medulla oblongata is also from side to side, as viewed from the posterior surface. The track thus seen is the one spoken of as the anterior; the tissue ascending on the right side lies, as it crosses, behind that of the left. On looking at the front surface between the elevations for the medulla oblongata, no such crossing is indicated.

In a foetus 1.6 inches long (ten to twelve weeks), little change has taken place in the relations of the hinder portions of the brain. The medulla has enlarged considerably, and the auditory nerve on each side forms a thick cord of fibres as it curves out over its upper margin, which margin is nearly horizontal. The cerebellum is little more than a smooth band (posterior column of each side), with slight bud-like projections behind the inferior cerebral flexure. The corpora quadrigemina, somewhat lobed on their surface, but their permanent elevations not yet defined, are still marked with the irregular lines of junction of opposite sides, the most conspicuous being at the lower portion, where the section from the right side (Fig. XI, Q) is prolonged far to the left, forming a superficial elevation. The optic thalami are concealed by the mantles, which are connected with one another above at the site of the pineal centre.

The mantle of each side presents its especial characters; and it may be mentioned that in none of the brains examined have the appearances of the mantles during these early stages been alike to each other in any one, or similar in any two brains. It seems as if the development of the left mantle were throughout somewhat in advance of that of the right; a statement which I make with some hesitation, not only because it is itself a remarkable fact, but because it is quite opposed to the view I had formed from some dissections made a few years ago. Repeated observations lead me to the conclusion that these were made in error, and that some precedence must be allowed to the left side of the mantle portion of the hemispheres.

The right mantle, viewed on the outer side, presents a smooth surface, except towards its margins. At these, beginning from below (see Fig. 13), are seen the distinct lobe of the olfactory nerve, then two rather deep fissures, then three notches, then, after an interval, a well defined fissure succeeded by three notches, and then by a long sweep of comparatively smooth border. On the general surface, there is a rising of the fore part of the mantle; the depression behind this, vertical in its direction, is the line of the fissure of Sylvius. The left mantle (see Fig. 14), on its outer surface, has the line of the Sylvian fissure more

Fig. 12.

Fig. 13.

Fig. 14.

distinctly indicated. Below, after a notch on the margin, the olfactory lobe is conspicuous. Then follow four distinct fissures, twice the number of those seen on the right side. Where the notches occupy the right margin, there is, on the left side, a broad fissure with notched margins; this corresponds with the future fissure of Rolando; and, again, there

is a considerable fissure at the superior extremity of the Sylvian line. The fissures on the hinder margin are deeper and more numerous, and the intervening brain-tissue (gyri) is wider than on the opposite side.

To separate the mantles, which lie flat upon the thalami, it is necessary to break through the folds of membrane which unite them at the pineal centre; and, on turning them aside, the membrane can be traced over their outer and inner aspects, dipping in between the fissures wherever these exist. The endocranial membrane forms a ridge of no great depth, projecting from the cranium between the hemispheres, and elsewhere following that disposition of a separating membrane, which it has in the adult brain.

THE HASTINGS PRIZE ESSAY,

1873.

ON THE PATHOLOGY AND TREATMENT OF OVARIAN DISEASES.

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III.

THE remaining affections of the ovary are those which are included in the results of increased growth, taking the form, in the largest number of instances, of cystic degeneration; in some rarer instances, the growth is solid, and may be either fibro-myxomatous or more commonly cancer. So much has been written lately, and so much done for the pathology and treatment of Ovarian Tumours, that I can scarcely hope to add anything new in this essay; but, as I have had a special experience in the investigation and treatment of ovarian tumours, I shall limit myself to the discussion of what I have seen and done myself, in preference to making a mere summary of what is to be found in perfection in the recent publications of Spencer Wells, Atlee, Peaslee, and Gallez.

For this purpose, I shall first discuss the diagnosis of ovarian tumours and their varieties; their therapeutic and surgical treatment. I shall also describe such ovarian tumours as I have met with which have not admitted of surgical treatment; and, finally, I shall give the results of some original investigations in the pathology and method of growth of these tumours.

There are, perhaps, no diseases in the province of surgery where so much caution is necessary in weighing carefully every point in the history, every symptom and every sign, for the purpose of establishing an accurate diagnosis as in those usually classed under the head of ovarian tumours. There are so many conditions which mimic them, and so few facts in connection with them upon which implicit reliance can be placed, that the only safety is to be found in the process of reasoning by exclusion; that is, for a proper diagnosis in the case of an ovarian tumour it will be found the best plan, first of all, to make a mental list of all the conditions that it might be, and exclude them one after another until no alternative is left. Anyone who habitually follows a converse plan will sooner or later be led into some fatal blunder. Our anxiety should always be, not to prove that a given tumour is ovarian, but to show that it cannot by any chance be anything else.

It may be said with perfect certainty that from the history alone no ovarian tumour could be diagnosed, so various are the stories told by the patients about their cases. Thus one patient will present herself totally unaware of the fact that there is any tumour, her only sensation being one of discomfort from the swelling, whilst another may have known for many years of the presence of a small lump which had long remained quiescent and had taken to enlarging only for a few weeks or months. The rate of increase gives no guide, either in unilocular or in multilocular tumours; for I have removed two multilocular tumours which had been in progress respectively seven and eleven years, and I have removed one of great size from a patient aged 66 which had grown in four months. I have removed, on the other hand, a large unilocular tumour which had been in existence for more than ten years, and the structure of which showed that it always had been unilocular; and I have removed two unilocular tumours, one of which grew so as to completely distend the abdomen in seven weeks, and another, almost as large, which had not been noticed for more than five weeks.

The details given by the patients as to the region in which the tumours were first observed are often very misleading, and no dependence whatever