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BRAIN.

PART IV., 1907.

Original Articles and Clinical Cases.

THE CEREBRAL ARTERIAL SUPPLY.

BY CHARLES E. BEEVOR, M.D., F.R.C.P.,

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FOR the last seven years I have been engaged in working out the distribution of the different arteries to the human brain, and during this time I have injected nearly a hundred brains; but as some of these were necessarily failures, I propose to give you the results of the injection of eighty-seven different brains.

The arteries which I separately injected were the posterior communicating and the anterior choroid—branches of the internal carotid—the anterior, middle, and posterior cerebral arteries. I would here remark that in some text-books the anterior choroid is figured as coming off from the middle cerebral in place of from the internal carotid, and although this may occasionally occur, I do not remember to have met with this distribution in any of my cases.

I must first refer to the work of previous observers, and especially to those of Duret [2], Heubner [3], and Kolisko [4].

As far as I can ascertain, these observers all injected the arteries by means of a syringe, using insoluble particulate

colours or an oil emulsion mass. Duret speaks about using gelatine coloured with carmine, but whether this means soluble carmine I am unable to say, as he does not give any details of the injection he used.

The arterial distribution is divided into basal and cortical, and I will take first the basal supply. The posterior communicating artery, according to Duret, supplies the optic chiasma, the tuber cinereum and pituitary body, the corpus mammillare, two branches to the optic thalamus—especially to the wall of the infundibulum in the most anterior part of the third ventricle and the grey commissure—the optic tract and the cerebral peduncles. According to Heubner this artery supplies the posterior part of the lateral wall of the infundibulum, the inner and anterior part, and sometimes the outer anterior part, of the thalamus opticus, the posterior and the ascending pillars of the fornix, the commissura mollis, the corpus mammillare, and the tegmentum of the crus cerebri. Kolisko makes the posterior communicating artery supply the anterior outer part of the optic thalamus, the anterior quarter of the posterior limb of the internal capsule, the anterior part of the crus cerebri, and sometimes part of the internal segment of the lenticular nucleus.

The anterior choroid artery, according to all observers, supplies the uncinate gyrus and enters the anterior end of the descending cornu of the lateral ventricle, to end in the choroid plexus. On its way to the ventricle it sends in basal branches, which, according to Heubner, supply the highest part of the crus cerebri, the posterior limb of the internal capsule and the anterior external part of the optic thalamus. According to Kolisko these branches supply only the posterior two-thirds of the posterior limb below the level of the second lenticular segment, and, in addition, the white matter behind the internal capsule, the lamina medullaris of the optic thalamus, the internal segment of the lenticular nucleus, the tail of the caudate nucleus, the optic tract, and exceptionally the external superior part of the optic thalamus.

The middle cerebral artery, according to Duret, supplies internal branches to the first and second segments of the

lenticular nucleus and external branches, lenticulo-striate, to the third segment of the lenticular nucleus, and to the tail of the caudate nucleus; and lenticulo-optic branches to the lenticular nucleus and the optic thalamus. Heubner gives the same distribution, but he makes the middle cerebral supply the middle part of the corpus striatum, and branches from the fork between the anterior and middle cerebral arteries supply the first and second segments of the lenticular nucleus and the anterior limb of the internal capsule, while the third or outer segment of the lenticular nucleus is supplied by the middle cerebral. According to Kolisko, the middle cerebral supplies the lenticular nucleus—second and third segments—the upper one-third of the caudate nucleus, and the part of the posterior limb of the internal capsule which lies above the horizontal level of the superior angle of the second lenticular segment.

The anterior cerebral artery, according to all three authors, supplies the head of the caudate nucleus.

The posterior cerebral artery, according to Duret, supplies the crus cerebri, the optic thalamus in its posterior parts, the corpora quadrigemina, the corpora geniculata, the choroid plexus and membrane by the postero-lateral and median choroid arteries, and the cornu ammonis. Heubner, in addition, gives the red nucleus.

With regard to the choroid plexus and membrane, according to Duret the choroid plexus is supplied by the anterior choroid artery in its posterior inferior two-thirds, and by the postero-lateral choroid artery in its anterior superior one-third, *i.e.*, the part above the optic thalamus; the choroid membrane is supplied by the postero-lateral choroid branch of the posterior cerebral artery, while the choroid plexus and membrane of the third ventricle are supplied by the posterior median choroid branch of the posterior cerebral artery. Also, according to Duret, the posterior choroid arteries supply the head of the caudate nucleus, and anastomose with the anterior cerebral artery there.

Heubner also finds that the anterior choroid artery supplies the choroid plexus in the descending cornu of the lateral ventricle, while branches from the posterior cerebral pass to the plexus through the posterior cerebral fissure, and supply

the part of the plexus in the posterior cornu and in the central part of the lateral ventricle.

Taking next the cortical surface, Duret's description is that which is usually adopted, and it is so well known to all that I need not describe it, but later I will point out where my results differ from those of Duret. He also states that the anterior choroid supplies the uncinate convolution, though he does not figure it in his diagrams, and this supply was also found by both Heubner and Kolisko.

METHOD OF INVESTIGATION.

The method which I employ, and which, I believe, has not been used before, is to inject simultaneously by means of the same pressure three, four, or five arteries with liquid gelatine containing different soluble colours. The pressure is produced by using two large pressure bottles, connected at their lower openings by a long indiarubber tube, and by raising one of them gradually to from 3 to 6 ft. The other bottle is connected at its upper opening with the upper openings of the three, four, or five smaller pressure bottles, which contain the different coloured gelatines. The smaller bottles are connected at their lower openings by means of fine indiarubber tubes and glass cannulæ with the different arteries, and together with the brain, they are immersed in a basin of water at 40° to 50° C. The brain, after careful removal from the cranial cavity, is injected with water at 50° C. to wash out the blood from the vessels, and it is then injected with gelatine, to which various colours have been added.

After trying, without good results, various oil masses and gelatine containing insoluble powders, I now use entirely soluble colours in gelatine, made in the following way:—

Two ounces by weight [56 grms.] of gelatine are soaked in cold water for half an hour, and then melted in a water bath; to the gelatine the different colours made according to the formulæ given below are added; hot water to make up the quantity to one pint [568 c.c.] is added, and the mass is strained through flannel.

For red, the formula is :—

Carmine	...	...	...	$\frac{1}{2}$ drachm [2 grms.].
Ammonia	...	...	...	$\frac{1}{2}$ fluid drachm [1·8 c.c.].
Glycerine	..	...	...	$\frac{1}{2}$ fluid oz. [14·3 c.c.].

Dissolve and add to the gelatine.

For blue :—

Nicholson's blue	...	...	...	15 grains [1 grm.].
Alcohol (90 per cent.)	...	...	...	$\frac{1}{2}$ oz. [14·3 c.c.].

Dissolve and add as above.

For green :—

Naphthol green	...	...	...	$\frac{1}{2}$ drachm [2 grms.].
Glycerine	...	...	...	2 fluid drachms [7·2 c.c.].

Rub into a smooth paste, and add as above.

For brown :—

Bismarck brown	...	...	...	1 to 4 drachms [4 to 16 grms.].
Methylated spirit	...	...	...	3 fluid oz. [85 c.c.].
Glycerine	...	...	...	1 fluid oz. [3·6 c.c.].

Dissolve and add as above.

For yellow :

Acridine yellow	...	...	...	2 drachms [8 grms.].
Glycerine	...	...	...	1 fluid oz. [28·4 c.c.].

Dissolve and add as above.

Just before using, the melted gelatine mass is filtered through a double layer of filter paper. On an average 2 ozs. [56·8 c.c.] of the gelatine mass are injected into each large artery, and at the end of the experiment the arteries are ligatured off after the brain has been put into cold water for a few minutes. It is then hardened in the following solution of formalin, to fix the colours—

Formaldehyde	...	...	...	1 pint [568 c.c.].
Potassic nitrate	...	...	...	2 ozs. [56 grms.].
Potassic acetate	...	...	...	1 oz. [28 grms.].
Water	...	...	...	4 pints [2,272 c.c.].
Saturated aqueous solution of alum	...	...	...	10 fluid ozs. [284 c.c.],

for one month or longer, after which it is cut into sections in the horizontal, sagittal, or coronal planes.

The experiments consist (a) in injecting simultaneously three arteries, the anterior, middle, and posterior cerebrals,

with different colours after ligaturing the posterior communicating artery at one or both ends, and in some cases ligaturing also the anterior choroid artery; (b) in injecting four arteries, the three mentioned above and the anterior choroid; (c) in injecting five arteries, the posterior communicating along with the anterior, middle and posterior cerebrals and the anterior choroid, all on the same side; (d) in injecting either the basal or the cortical branches of the chief arteries alone.

I think that I may claim for this method that it would not be possible to inject the finest capillaries without using soluble colours; and owing to the communication in the cortex between the different areas, it would not be possible to keep the injections to their proper areas unless the same pressure was applied simultaneously to all the arteries. I found it possible to inject so small a body as the corpus subthalamicum with two colours, and to show that in some brains its two halves had a separate blood supply. All the colours were completely fixed by the formalin solution except the yellow, which washed out to some extent.

BASAL DISTRIBUTION.

I will now give the result of my injections, and will describe the various parts supplied by each of the arteries.

Taking the internal carotid first, and the supply of its branches in the order in which they are given off, the first artery is:—

The *posterior communicating* (fig. 11) which supplies the *optic chiasma*, the *tuber Cinereum* and the *regio subthalamica*, the part which is below the optic thalamus and is bounded ventrally by the posterior perforated space or the corpus mamillare and by the locus niger and pes pedunculi, medially by the third ventricle and the anterior pillar of the fornix, externo-laterally by the internal capsule and the reticular zone of the thalamus, and posteriorly by the nucleus ruber, while anteriorly it is continuous with the substantia innominata;

The *pes pedunculi* or crusta in its anterior one-third;

The *corpus subthamicum* or Luys' body;

The part known as *Forel's field*;

The *anterior one-third* of the *posterior limb* of the *internal capsule*, below the level of the upper angle of the middle lenticular segment (figs. 4-6);

The *anterior external part* of the *external nucleus* of the *optic thalamus*, and sometimes the *anterior half* of the *internal nucleus*.

The next branch of the internal carotid is:—

The *anterior choroid artery* (fig. 12), which passes backwards and outwards to enter the anterior extremity of the descending cornu of the lateral ventricle, where the artery ends in the choroid plexus. On its way to the lateral ventricle it sends branches into the base of the brain to

The *optic tract*, which it supplies as far as its entry into the corpus geniculatum externum;

The *anterior one-third* of the *pes pedunculi* or *crusta*, sometimes, but less frequently than the posterior communicating artery; its *posterior two-thirds*, but less frequently than the posterior cerebral artery (*q.v.*).

Of the *internal capsule*, the *posterior two-thirds* of the *posterior limb*, as high as the superior angle of the second or middle lenticular segment (figs. 5 and 6);

Of the *lenticular nucleus*, the *first* or *internal segment*, the *third* or *external segment*, its posterior inferior part (sometimes);

The *nucleus amygdalæ* (fig. 11), within the hippocampal lobule;

The *anterior commissure*, in its extreme outer part;

The *choroid plexus*, the part in the descending cornu and the posterior cornu of the lateral ventricle;

The *choroid membrane*, the part in the descending cornu, anterior to the level of the coronal section through the posterior surface of the crus cerebri.

From these ventricular arteries of the descending cornu the roof of the lateral ventricle is probably supplied, and

The *retrolenticular fibres* (figs. 6 and 14), posterior to the internal capsule, including

The *optic radiations* at their origin (fig. 7);

The *tail* of the *caudate nucleus* or *surcingle*, in its inferior horizontal part.

The internal carotid divides into the middle and anterior cerebrals. I will take first the *anterior cerebral artery*, which supplies (fig. 10) :—

The *lamina terminalis vel cinerea*, forming the floor of the third ventricle ;

The *internal capsule*, anterior limb, the inferior half ;

The *head of the caudate nucleus*, inferior half ;

The *lenticular nucleus*, external or third segment, the anterior inferior part ;

The *lenticular nucleus*, second segment (fig. 9), the anterior inferior part, in about half the cases ;

The *septum lucidum* ;

The *anterior commissure*, median part ;

The *anterior pillar of the fornix*, upper part.

The other branch into which the internal carotid divides is :—

The *middle cerebral* (fig. 11), which passes outwards along the fissure of Sylvius giving basal branches at the anterior perforated spot, which supply

The *anterior commissure*, its outer part ;

The *lenticular nucleus*, the middle and the external segments ;

The *internal capsule*, the posterior limb above the horizontal level of the upper angle of the middle lenticular segment ;

The *internal capsule* (figs. 9 and 10), the anterior limb in its superior half (horizontally) ;

The *caudate nucleus*, the horizontal part posterior to its head ;

The *caudate nucleus*, head, superior half.

The two vertebral arteries join together to form the basilar, which divides into the two posterior cerebral arteries, each of which courses round outside the crus cerebri to the median surface of the temporal and occipital lobes, to end in the extremity of the calcarine fissure

The *posterior cerebral artery* supplies :—

The *corpus mamillare* ;

The *pes pedunculi* or *crusta* in its posterior two-thirds (fig. 12) ;

The *nucleus ruber* ;

The *internal nucleus* of the *optic thalamus*, in its posterior half (fig. 14) ;

The *external nucleus* in its posterior half (fig. 14) ;

The *pulvinar* (fig. 14) ;

The *choroid arteries*, postero-lateral to the choroid plexus in the central lateral ventricle, and to the choroid membrane as far inferiorly in cornu descendens as the posterior surface of crus ; postero-median to choroid plexus and membrane of third ventricle ;

The *optic thalamus*, anterior superior part of the external nucleus (? from choroid membrane in central lateral ventricle) ; anterior nucleus (fig. 11) (? from choroid membrane in central lateral ventricle) ;

The *fornix*, body and crura posteriora ; anterior pillar, inferior part ;

The *corpora quadrigemina* ;

The *corpus geniculatum internum* ;

The *corpus geniculatum externum* (nineteen times in twenty-three cases).

CORTICAL DISTRIBUTION.

According to my observations the most frequent distribution of the *anterior cerebral artery* along the median surface of the hemisphere is, that it extends posteriorly to about 1 in. anterior to the internal parieto-occipital fissure (fig. 16), and less frequently it extends as far back as this fissure, which is the extent given by Duret. Along the outer surface the area of the anterior cerebral artery extends posteriorly in most cases to half way along the parietal lobule (fig. 17), in place of the upper end of the fissure of Rolando as figured by Duret. Outwards and downwards on the external surface, anteriorly this area reaches to from $\frac{3}{4}$ to 1 in. from the median edge of the hemisphere and more posteriorly to the superior frontal sulcus (fig. 15) ; this is less extensive than according to Duret's description, which includes the middle frontal gyrus in the area of the anterior cerebral artery.

In the *middle cerebral area* the superior border at the anterior part is the same as that for the anterior cerebral as far posteriorly as the middle of the parietal lobule; posteriorly to this point the middle cerebral area either reaches the edge of the median surface of the hemisphere (fig. 15), or is bounded by the posterior cerebral area (fig 17), and this depends on whether the posterior cerebral area extends forwards anteriorly to the external parieto-occipital fissure (*vide infra*). The posterior limit of the middle cerebral artery on the outer surface, taken along a horizontal line, drawn from the fissura extrema of the calcarine fissure to the posterior angle of the parallel sulcus, is most frequently between the intraparietal sulcus at its posterior part, where it is continued into the anterior occipital sulcus, and the occipital pole. Nearly half the cases extend to the occipital pole, or to $\frac{1}{2}$ in. anterior to it (fig. 15), in place of to just posteriorly to the upturned end of the parallel sulcus (Duret). The extension downwards of the middle cerebral area is to the middle of the inferior temporal convolution (fig. 18), or to the lower border of the middle or second temporal convolution, in place of to the middle of the second temporal convolution, as given by Duret.

The *posterior cerebral artery* supplies the whole of the median surface of the temporal lobe, and of the occipital lobe as far anteriorly as the internal parieto-occipital fissure, or to a point an inch anterior to this, except the most anterior part of the temporal lobe, which is supplied by the middle cerebral, and the anterior end of the gyrus uncinatus including the uncus, which is supplied by the anterior choroid artery, which anastomoses freely with the branches of the posterior cerebral artery to the rest of the uncinate gyrus (fig. 16). The posterior cerebral area extends round the occipital pole to the external surface for about $\frac{1}{2}$ in., corresponding to the limit of the extension posteriorly of the middle cerebral area. More superiorly the posterior cerebral area extends across the median line on to the *outer surface*. In most cases it extends as far anteriorly as the external parieto-occipital fissure, which corresponds to Duret's description, or in some cases to half way along

the parietal lobule (fig. 17). The width of the area on the external surface is from $\frac{3}{4}$ to 1 in.

In relation to the extent to which the posterior cerebral artery reaches forwards on the external surface, is the area of extension of the anterior cerebral backwards and of the middle cerebral area towards the middle line. Out of fifty-one cases where it was observed, the middle cerebral area reached the middle line in thirty cases, and it failed to do so in twenty-one cases, so that the areas of the anterior and posterior cerebral arteries joined in these twenty-one cases, owing to the extension forwards of the posterior cerebral area.

The arterial supply to the corpus callosum (fig. 16) is from the cortical branches. The genu, rostrum and body are supplied by the anterior cerebral artery. The tapetum is supplied successively from before back by the anterior or middle cerebral, by the middle cerebral, and outside the cornu of the lateral ventricle by the posterior cerebral. The splenium and the forceps major by the posterior cerebral.

The supply of the centrum ovale (figs. 1-14) is from the medullary arteries of Duret, and the distribution of the arteries corresponds to that of the cortex external to it, so that the line of demarcation between the areas of distribution of any two arteries is quite hard and fast. I can corroborate by experiments Duret's statement that there is no connection between the cortical distribution and that of the basal arteries. I also agree with Duret that there is no anastomotic network in the pia mater, but that there is an anastomosis between the systems of the three chief arteries at the confines of their areas. This is shown by an experiment which I have made, and which consisted in ligaturing the third cortical branch of the middle cerebral artery, viz., that to the ascending parietal convolution, and then injecting the three chief arteries with separate colours with the same pressure. It was then found that the area supplied by the ligatured branch of the middle cerebral was injected from the anterior cerebral artery at its periphery rather than from the contiguous branches of its own artery, the middle cerebral. It is therefore difficult to understand why, when thrombosis occurs, the circulation in any branch is suffi-

ently interfered with to produce softening, unless very fine emboli block the capillaries of the cortex. I hold with Duret that the arteries which penetrate and supply the cortex are end arteries, and do not anastomose with their contiguous branches; and I have found that, if the pia mater be carefully removed, or a circular cut be made in it, the subjacent cortex is not injected by the vessels in the surrounding cortex.

Another point which is of interest is the supply of the middle and posterior cerebral arteries to the occipital white matter, and especially to the fibres of that part of the optic radiations which lie posteriorly to the part which, as we have seen (p. 409), is supplied by the anterior choroid artery. The relative share taken by these two arteries differs according to the distance that the middle cerebral area extends on the outer surface. •

The most frequent distribution is the following:—

Taking a cross section of the optic radiations by making coronal sections of the occipital region, it is found that the superior three-quarter of the fibres, viz.: those fibres which supply the cortex of the cuneus and occupy the superior lip of the calcarine fissure, are supplied by the middle cerebral, with the exception of the posterior 1 in. (2.5 cm.), which is supplied by the posterior cerebral artery; while the whole of the inferior quarter of the radiations, which are considered to terminate in the cortex of the gyrus lingualis, are supplied by the posterior cerebral artery. The above distribution is found in those cases where the middle cerebral area extends to the intraparietal sulcus or to the posterior pole, but in those where the middle cerebral does not extend more posteriorly than the upturned posterior end of the parallel sulcus, all the fibres of the optic radiations in the occipital region are supplied by the posterior cerebral.

As the fasciculus longitudinalis inferior has of late years been regarded as the true course for optic impressions (Flechsig, Redlich [5], Archambault [1]), I have ascertained the arterial supply to these fibres in the occipital region, and I find that it corresponds to that given to the optic radiations, viz., that in most cases the superior part, as seen in coronal sections, is supplied by the middle cerebral, whereas the inferior part is supplied by the posterior cerebral artery.

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FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.

FIG. 9.

FIG. 10.

FIG. 11.

FIG. 12.

FIG. 13.

FIG. 14.

FIG. 15.

FIG. 16.

FIG. 17.

FIG. 18.

DESCRIPTION OF FIGURES.

The figures are outlines of the photographs of the different injected sections and surfaces of the brain of man.

Figs. 1 and 2 are sagittal sections of the hemisphere made $\frac{1}{8}$ and $\frac{6}{16}$ in. respectively from the median surface.

Figs. 3 to 8 are horizontal sections of the brain. Fig. 3 is made through the most superior part of the optic thalamus; fig. 4 through the highest part of the lenticular nucleus; fig. 5 through the superior part of the internal segment of the lenticular nucleus; fig. 6 through the highest point of the anterior commissure; fig. 7 through the highest part of the corpora quadrigemina; and fig. 8 through the nucleus ruber.

Figs. 9 to 14 are coronal sections of the brain. Fig. 9 is made through the superior median part of the anterior commissure; fig. 10 is made just posteriorly to the optic chiasma; fig. 11 is through the tuber cinereum and the genu of the internal capsule; fig. 12 is through the most anterior part of the pons; fig. 13 is made just posteriorly to the lenticular nucleus; and fig. 14 is through the posterior part of the optic thalamus.

Figs. 15 to 18 are the external, median, superior and inferior surfaces respectively of the right human hemisphere.

In figs. 1 to 8 and 15 to 18 the area of the anterior cerebral artery is represented by lines drawn coronally across the long axis of the hemisphere. The area of the middle cerebral artery is represented by lines drawn diagonally. The area of the posterior cerebral artery is represented by lines drawn parallel to the long axis of the hemisphere.

The area of the anterior choroid artery is represented by small rings, and that of the posterior communicating by dotted shading.

In figs. 9 to 14 (coronal sections) the areas of the middle cerebral, anterior choroid and posterior communicating arteries are represented as above, but the area of the anterior cerebral artery is represented by horizontal lines, and that of the posterior cerebral artery by vertical lines.

EXPLANATION OF FIGURES.

(The same letters apply to all the figures).

- A. l., ansa lenticularis.
- C., cuneus.
- C. A., calcar avis.
- C. a., commissura anterior.
- Calc., fissura calcarina.
- Call. Marg., calloso-marginal fissure.
- C. Am., cornu ammonis.
- C. C., corpus callosum.
- C. C. f. m., corpus callosum, forceps major.
- C. C. g., corpus callosum, genu.
- C. E., capsula externa.
- Cer., cerebellum.
- C. g. e., corpus geniculatum externum.
- C. g. i., corpus geniculatum internum.
- Ch., chiasma of optic nerves.
- C. I. a., capsula interna, anterior segment.
- C. I. g., capsula interna, genu.
- C. I. p., capsula interna, posterior segment.
- C. I. p. s., capsula interna, posterior segment, superior part.
- C. I. p. i., capsula interna, posterior segment, inferior part.

- Cl.*, claustrum.
C. m., commissura mollis.
C. O., centrum ovale.
C. p., commissura posterior.
C. q. a., corpus quadrigominum anterius.
C. R., corona radiata.
Cr., crusta or pes pedunculi.
C. S., corpus subthalamicum (Luys' body).
F., fornix.
F. a., fornix, anterior pillar.
F. p., fornix, posterior pillar.
F. 1., gyrus frontalis superior.
F. 2., gyrus frontalis medius.
F. 3., gyrus frontalis inferior.
f. 1., superior frontal sulcus.
f. 2., inferior frontal sulcus.
F. a., gyrus frontalis ascendens.
F. C., fissura collateralis.
F. D., fascia dentata.
F. D. a., fascia dentata, anterior end.
F. H., fissura hippocampi.
Fi., fimbria.
F. l. i., fasciculus longitudinalis inferior.
F. M., fissure of Monro.
F. R., fissura Rolandi.
F. S., fissura Sylvii.
Fus., gyrus fusiformis.
G. H., gyrus hippocampi.
G. Hab., ganglion habenulae of optic thalamus.
I., iter a tertio ad quartum ventriculum.
L., gyrus lingualis.
L. c. a., lenticulo-caudate arteries from middle cerebral arteries.
L. m. c., lamina medullaris externa of optic thalamus.
L. N., locus niger.
L. p. a., locus perforatus anticus.
N. A., nucleus amygdalae.
N. C., nucleus caudatus.
N' C', nucleus caudatus, tail or surcingle.
N. C. c., nucleus caudatus, caput.
N. C. h., nucleus caudatus, horizontal part.
N. L. 1., nucleus lenticularis, internal segment.
N. L. 2., nucleus lenticularis, middle segment.
N. L. 3., nucleus lenticularis, external segment.
N. R., nucleus ruber.
O. R., optic radiations.
P., pons varolii.
P. Ch. l., plexus choroideus lateralis.
P. Ch. p., plexus choroideus posterior.
p. c. s., precentral sulcus.
P. O., fissura parieto-occipitalis.
p. s., parallel or first temporal sulcus.
Pulv., pulvinar thalami optici.
Qu., lobulus quadratus.
R. l., retro-lenticular fibres.
R. S., regio subthalamica.
S. g. c., substantia grisea centralis.
s. i. p., sulcus intra-parietalis.
S. L., septum lucidum.
S. M., gyrus supra-marginalis.
Spl., splenium corporis callosi.
T. 1., gyrus temporalis superior.
T. 2., gyrus temporalis medius.

- T. 3*, gyrus temporalis inferior.
- t. 2*, second temporal sulcus.
- t. 3*, third temporal sulcus.
- Tap.*, tapetum corporis callosi.
- T. c.*, tuber cinereum.
- Th.*, thalamus opticus.
- Th. n. a.*, thalamus opticus, nucleus anterior.
- Th. n. e.*, thalamus opticus, nucleus externus.
- Th. n. i.*, thalamus opticus, nucleus internus.
- T. O.*, tractus opticus.
- U.*, uncus.
- U'*, root of uncus where it is joined by fascia dentata.
- V. iii.*, ventriculus tertius.
- V. G.*, vena galeni.
- Vicq.*, tract of Vicq d'Azyr.
- V. L.*, ventriculus lateralis.
- V. L. c. a.*, ventriculus lateralis, cornu anterius.
- V. L. c. d.*, ventriculus lateralis, cornu descendens.
- V. L. c. p.*, ventriculus lateralis, cornu posterius.
- V. s. l.*, ventriculus septi lucidi.