NEW METHODS

DATA ON THE TOPOGRAPHY OF SUBCORTICAL FORMATIONS IN THE DOG BRAIN IN RELATION TO EXPERIMENTAL INTERFERENCES IN THEM

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A number of questions in the study of higher nervous activity and the morphology of the brain necessitate experiments on the subcortical formations in the animal brain. Such experiments, presupposing penetration in the subcortical nuclei without destruction of more than superficially located cortical and subcortical structures, are not possible without knowledge of the precise topography of the subcortical formations in the brain of the experimental animal. In the literature there are papers enabling one to calculate the coordinates of the subcortical formations of the brain of a monkey [3], cat [2, 4, 6] and rat [5].

However, such findings are absent for the brain of one of the most widely used experimental animals – the dog.

The purpose of the present work was to determine in the brain of the dog the location of the most important subcortical formations in relation to the external orientating points on the skull.

EXPERIMENTAL METHODS

The heads of 18 dogs of different dimensions served as material for the investigation. The following measurements of the head of the dog were carried out: length (from the rear point of the occipital protuberance to the hind-upper edge of the eye socket and to the tip of the nose), width (between the internal auditory ducts), height (distance between two planes, passing horizontally through the external auditory ducts and through the upper surface of the skull), and the length of the occipital protuberance (at its lower surface – from the hindmost point up to the base).

Fixation of the brain within the skull was achieved by introduction of a 10% formalin solution in the large cervical vessels. After this, the soft integuments were removed from the head, and again we conducted the same measurements as with measurement of the whole head. Lines of basic planes were marked on the skull (frontal and horizontal) and also lines of the future cuts, then it was then photographed.

With a sharp surgical saw, the skull together with the brain was sawed in fine lamina in a frontal or sagittal direction. The thickness of the shearings on the average was 4 mm, 1mm being lost to the saw. On each shearing, measurements were conducted of the hemispheres of the brain, the sulcuses and subcortical formations, after which laminate preparations were prepared according to Talalaev [1], which enabled the sections to be stored for a number of years.

EXPERIMENTAL RESULTS

The system of calculation was arranged in such a way that one can use our findings both in the presence of a special stereotropic apparatus for the operation on the subcortex and in its absence. For those cases where

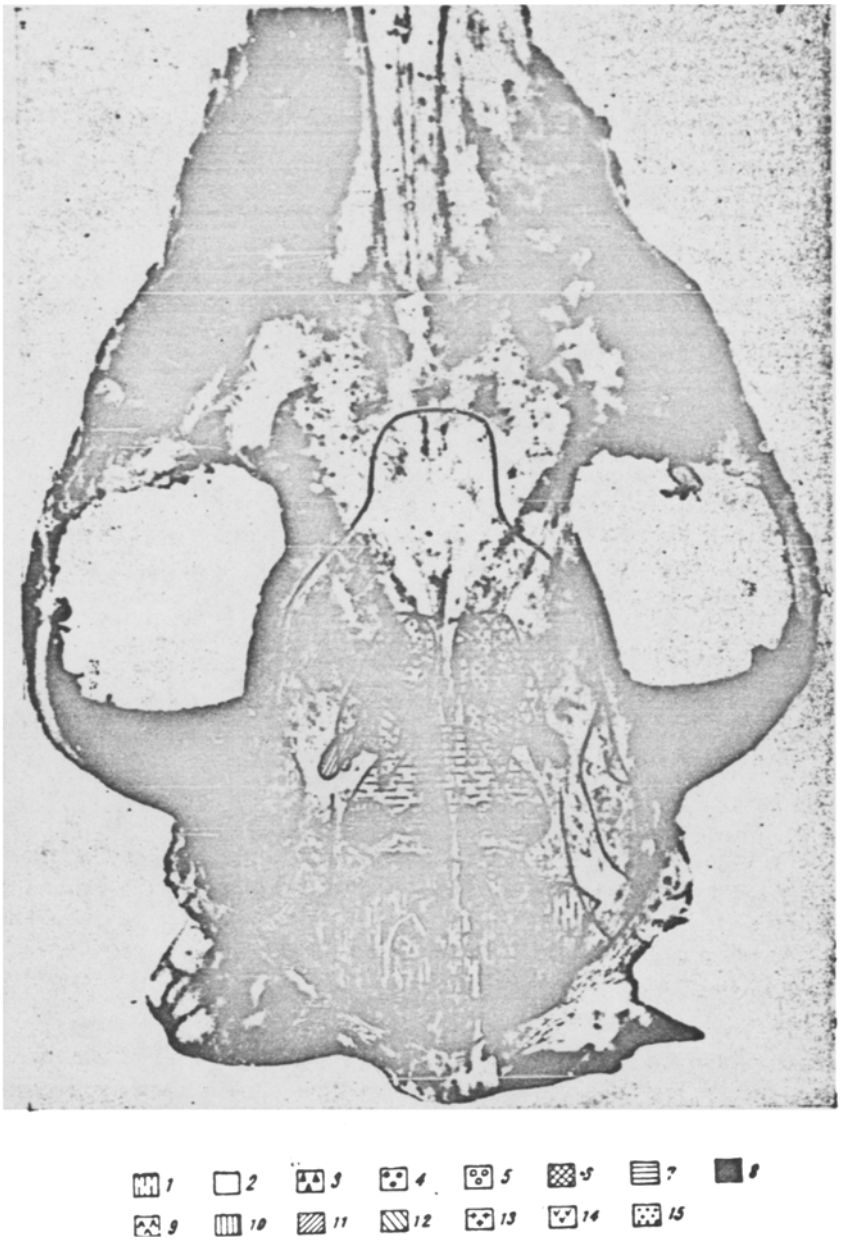

Fig. 1. Projection of cerebral hemispheres and subcortical formations on upper surface of skull of dog No. 9.
1) Cerebellum, 2) Nucleus Fatigii, 3) Nucleus dentatus, 4) Oliva superior, 5) Corpus bigenium posterior, 6) Corpus bigenium anterior, 7) Corpus geniculatum mediale, 8) Red nucleus, 9) Substantia nigra, 10) Corpus geniculatum laterale, 11) Amygdala, 12) Pale sphere (external member), 13) Putamen, 14) Claustrum, 15) Nucleus caudatus.

TABLE 1

Dimensions of Skull of Dogs and Distance to Subcortical Formations

Name of subcortical formations	Dog No. 8					Dog No. 15				
	Dimension of skull									
	From the term. of occip. proturb. to near edge of socket	Length of occipal proturberance	From the term. of the occip. proturb. to the transv. commiss.	Height of skull	Width of skull	From the term. of occip. proturb. to near edge of socket	Length of occipal proturberance	From the term. of the occip. proturb. to the transv. commiss.	Height of skull	Width of skull
	97	7	62	52	62	87	4	52	44	52
	Distance to the midpoint of each formation									
	From the terminus of the occipital proturberance	From the base of the occipital proturberance	From the upper surface of the skull	From the sagittal plane	From the transv. commissure	From the terminus of the occipital proturberance	From the base of the occipital proturberance	From the upper surface of the skull	From the sagittal plane	From the transv commissure.
Nucleus fastigii	22	15	35	2	40	18	14	31	2	34
Nucleus dentatus	22	15	31	6	40	18	14	29	6	34
Oliva Superior	38	21	45	4	34	23	19	43	4	29
Corpus bigeminum posterior	30	23	35	6	32	27	23	31	5	25
Corpus bigeminum anterior	33	26	36	3	29	30	26	31	3	22
Corpus geniculatum mediale	38	31	36	9	24	35	31	32	9	17
Corpus geniculatum laterale	39	31	31	9	23	36	32	27	9	16
Pulvinar						39	35	26	5	13
Internal nucleus of thalamus	45	38	33	2	17	42	38	32	2	10
External nucleus of thalamus	45	38	30	7	17	42	38	30	7	10
Ventral nucleus of thalamus	45	38	36	3	17	42	38	34	3	10
Frontal nucleus of thalamus	51	44	31	3	11	47	43	31	3	5
Red Nucleus	40	33	42	2	22	36	32	40	3	16
Substantia nigra	40	33	42	5	22	36	32	40	5	16
Claustrum	57	50	27	12	5	53	49	25	14	1
Body of nucleus caudatus	51	44	25	7	11	47	43	24	8	5
Tip of nucleus caudatus	57	50	27	6	5	53	49	28	6	1
Pale sphere (external member)	56	49	36	8	6	52	48	32	8	0
Putamen	56	49	32	10	6	52	48	30	10	0
Amygdala	49	42	38	14	13	46	42	38	13	6

TABLE 1 (continued)

Dimensions of Skull of Dogs and Distance to Subcortical Formations

Name of subcortical formations	Dog No. 10					Dog.No. 9				
	Dimension of skull									
	From the term. of occip. proturb. to near edge of socket	Length of occipal troturberance	From the term. of the occip. proturb. to the transv. commiss.	Height of skull	Width of skull	From the term. of occip. proturb. to near edge of socket	Length of occipal proturberance	From the term. of the occip. proturb. to the transv. commiss.	Height of skull	Width of skull
	81	1	50	43	5	85	5	54	50	65
	Distance to the midpoint of each formation									
	From the terminus of the occipital proturberance	From the base of the occipital proturberance	From the upper surface of the skull	From the sagittal plane	From the transv. commissure.	From the terminus of the occipital proturberance	From the base of the occipital proturberance	From the upper surface of the skull	From the sagittal plane	From the transv. commissure.
Nucleus fastigii	15	14	32	2	35	18	13	34	2	36
Nucleus dentatus	15	14	30	6	35	18	13	30	6	36
Oliva Superior	20	19	43	4	30	22	17	43	4	32
Corpus bigeminum posterior	23	22	31	6	27	27	22	33	5	27
Corpus bigeminum anterior	27	26	31	2	23	31	26	33	2	23
Corpus geniculatum mediale	30	29	32	9	20	35	30	33	9	19
Corpus geniculatum laterale	31	30	27	9	19	36	31	28	9	18
Pulvinar	34	33	26	5	16	38	33	27	5	16
Internal nucleus of thalamus	36	35	32	2	14	40	35	31	2	14
External nucleus of thalamus	36	35	30	6	14	40	35	29	6	14
Ventral nucleus of thalamus	36	35	35	3	14	40	35	34	3	14
Frontal nucleus of thalamus	42	41	28	3	8	45	40	28	3	9
Red Nucleus	31	30	37	3	19	35	30	39	3	19
Substantia nigra	31	30	39	5	19	35	30	40	5	19
Claustrum	48	47	24	12	2	52	47	24	12	2
Body of nucleus caudatus	42	41	23	7	8	46	41	23	7	8
Tip of nucleus caudatus	48	47	25	5	2	52	47	25	5	2
Pale sphere (external member)	46	45	31	7	4	49	44	31	8	5
Putamen	46	45	29	10	4	49	44	29	11	5
Amygdala	40	39	35	13	10	46	41	35	12	8

TABLE 1

Dimensions of Skull of Dogs and Distance to Subcortical Formations

Name of subcortical formations	Dog.No. 17					Dog No. 11				
	Dimension of skull									
	From the term. of occip. proturb. to near edge of socket	Length of occipal proturberance	From the term. of the occip. proturb. to the transv. commiss.	Height of skull	Width of skull	From the term. of occip. proturb. to near edge of socket	Length of occipal proturberance	From the term. of the occip. proturb. to the transv. commiss.	Height of skull	Width of skull
	78	1	48	43	65	74	1	44	42	57
	Distance to the midpoint of each formation									
	From the terminus of the occipital proturberance	From the base of the occipital proturberance	From the upper surface of the skull	From the sagittal plane	From the transv. commissure.	From the terminus of the occipital proturberance	From the base of the occipital proturberance	From the upper surface of the skull	From the sagittal plane	From the transv. commissure.
Nucleus fastigii	12	11	31	2	36	12	11	30	1	32
Nucleus dentatus	12	11	30	6	36	12	11	26	4	32
Oliva Superior	17	16	42	4	31	15	14	40	4	29
Corpus bigeminum posterior	22	21	32	5	26	20	19	31	5	24
Corpus bigeminum anterior	26	25	33	2	22	24	23	31	2	20
Corpus geniculatum mediale	30	29	35	9	18	29	28	32	9	15
Corpus geniculatum laterale	31	30	30	9	17	30	29	27	9	14
Pulvinar	33	32	29	5	15	31	30	28	5	13
Internal nucleus of thalamus	35	34	33	2	13	34	33	31	2	10
External nucleus of thalamus	35	34	32	6	13	34	33	28	6	10
Ventral nucleus of thalamus	35	34	37	3	13	34	33	34	3	10
Frontal nucleus of thalamus	40	39	30	3	8	38	37	28	2	6
Red Nucleus	30	29	40	2	18	29	28	37	2	15
Substantia nigra	30	29	42	5	18	29	28	39	3	15
Claustrum	46	45	26	13	2	45	44	24	11	−1
Body of nucleus caudatus	40	39	26	8	8	39	38	24	6	5
Tip of nucleus caudatus	46	45	28	6	2	45	44	25	5	1
Pale spher (external member)	43	42	33	9	5	41	40	31	8	3
Putamen	43	42	31	12	5	41	40	30	10	3
Amygdala	40	39	39	13	8	38	37	35	11	6

TABLE 2

Name of subcortical formations	Dog No. 4						Dog No. 18				
	Dimensions of skull						Dimensions of skull				
	From the term. of occip. proturb. to near edge of socket	Length of occipal proturberance	From the term. of the occip. proturb. to the transverse commissure	From the terminus of the occipital proturb. to the frontal plane	Height of skull	Width of skull	From the term. of occip. proturb. to near edge of socket	Length of occipal proturberance	From the term. of the occip. proturb. to the transverse commissure	From the term. of the occipital proturb. to the frontal plane	Height of skull
	96	8	61	26	54		93	7	62	22	57
	Distance to middle point of each formation										
	From frontal plane	From horizontal plane	From upper surface of skull	From sagittal plane	From transverse commissure		From frontal plane	From horizontal plane	From upper surface of skull	From sagittal plane	From transverse commissure
Corpus bigeminum posterior	8	13	36	5	27		8	13	35	5	31
Corpus bigeminum anterior	12	15	36	3	23		12	15	35	3	28
Corpus geniculatum mediale	18	12	35	9	17		18	11	35	9	22
Corpus geniculatum laterale	19	18	30	9	16		19	17	29	9	21
Thalamus	23	16	34	5	12		23	15	33	5	17
Substantia nigra	18	5	43	5	17		18	4	42	4	22
Body of nucleus caudatus	30	18	28	7	5		30	17	25	7	10
Tip of nucleus caudatus	36	15	32	5	—1		36	14	30	5	4
Pale sphere (External member)	30	10	38	8	5		30	9	33	8	10
Putamen	34	10	36	7	1		34	9	32	8	6
Amygdala	24	4	41	14	11		24	3	38	12	16

TABLE 2 (Continued)

Name of sub-cortical formations	Dog No. 2						Dog No. 5						Dog No. 19					
	Dimensions of skull																	
	From the term. of occip. proturb. to near edge of socket	Length of occipal proturberance	From the term. of the occip. proturb. to the transverse commissure	From the terminus of the occipital proturb. to the frontal plane	Height of skull	Width of skull	From the term. of occip. proturb. to near edge of socket	Length of occipal proturberance	From the term. of the occip. proturb. to the transverse commissure	From the terminus of the occipital proturb. to the frontal plane	Height of skull	Width of skull	From the term. of occip. proturb. to near edge of socket	Length of occipal proturberance	From the term. of the occip. proturb. to the transverse commissure	From the term. of the occip. proturb. to the frontal plane	Height of skull	Width of skull
	75	3	47	19	42	62	73	1	43	13	40	58	91	7	57	26	65	65
	Distance to middle point of each formation																	
	From frontal plane	From horizontal plane	From upper surface of skull	From sagittal plane	From transverse commissure		From frontal plane	From horizontal plane	From upper surface of skull	From sagittal plane	From transverse commissure		From frontal plane	From horizontal plane	From upper surface of skull	From sagittal plane	From transverse commissure	
Corpus bigeminum posterior	6	13	30	5	24		6	13	29	5	24		6	14	38	5	25	
Corpus bigeminum anterior	10	14	31	2	18		10	14	30	2	20		9	15	38	3	22	
Corpus geniculatum mediale	15	10	31	8	13		15	10	31	8	15		16	11	38	8	15	
Corpus geniculatum laterale	16	16	25	8	12		15	15	25	8	15		17	19	32	8	14	
Thalamus	19	15	29	4	9		18	14	28	5	12		20	16	35	5	11	
Substantia nigra	14	3	39	4	14		14	3	38	4	16		15	5	47	4	16	
Body of nucleus caudatus	26	17	24	6	2		27	17	23	6	3		28	18	29	7	3	
Tip of nucleus caudatus	31	13	28	5	2		30	12	27	4	0		33	15	32	5	—2	
Pale sphere (External member)	25	8	31	8	3		24	8	31	8	6		27	9	38	8	4	
Putamen	30	8	31	8	—2		30	8	30	8	0		32	9	36	8	—1	
Amygdala	23	4	35	12	5		21	3	35	12	9		23	4	42	13	8	

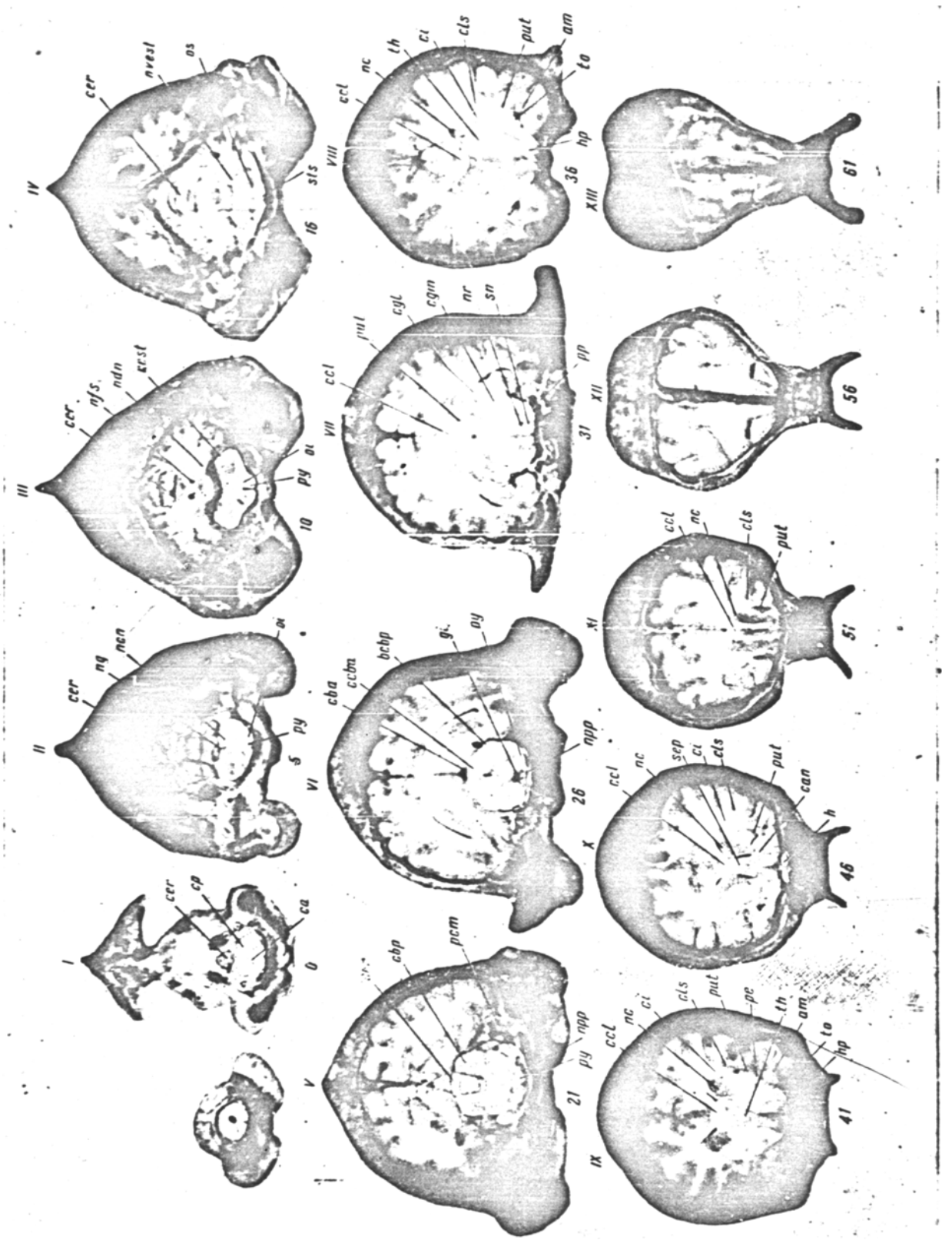
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Fig. 2

Fig. 2. Photographs of Series of Frontal Sections through Skull with Brain of Dog No. 17. Reduction 42 percent. Roman figures under each section indicate ordinal number of sections, considered from hind end of occipital protuberance. Figures under each section indicate distance in mm of a given section from hind end (terminus) of occipital protuberance. Skull dimensions of dog are given in Table 1.

am	– amygdala	ncn	– nucleus cuneatus
bcbp	– brachium corporis bigemini posterior	ndn	– nucleus dentatus
ca	– cornu anterius	nfs	– nucleus fastigii
can	– comissura anterior	ng	– nucleus gracilis
cba	– corpus bigeminum anterior	npp	– nuclei proprii pontis
cbp	– corpus bigeminum posterior	n. vest	– nuclei vestibularis
ccba	– commissura corporis bigemini anterior	oi	– oliva inferior
ccl	– corpus callosum	os	– oliva superior
cer	– cerebellum	pcm	– pedunculus cerebelli medii
cgl	– corpus geniculatum laterale	pp	– pes pedunculi
cgm	– corpus geniculatum mediale	pul	– pulvinar
ci	– capsula interna	put	– putamen
cls	– claustrum	py	– pyramis
cn	– cornu posterius	rest	– corpus restiformis
gi	– ganglion interpedunculare	sep	– septum pellucidum
h	– chiasma	sn	– substantia nigra
hp	– hypothalamus	th	– thalamus
nc	– nucleus caudatus	to	– tractus opticus

there is a stereotropic apparatus, readings are taken in the work from three mutually perpendicular planes: horizontal, taken through the middle of the internal auditory duct and the lower edge of the orbit; frontal, perpendicular-horizontal plane taken through the center of both internal auditory ducts; and the sagittal, taken vertically between both hemispheres. If a stereotropic apparatus is not available, it is more convenient to conduct the readings from other external orientating points: from the rear end of the occipital protuberance and from the upper surface of the skull and from the sagittal plane.

The above-named lines of the planes were applied on each section and served as guides for calculating the coordinates of each subcortical formation.

Results of the calculations on frontal cuts are presented in Table 1.

It is clear from Table 1 that in the dogs with approximately uniform dimensions of the head, the length of the occipital protuberance may greatly vary (1-5 mm) and it is therefore, better to carry out the calculation from the base of the occipital protuberance than from its terminus. This distance varies significantly less in dogs.

Table 2 gives the figures obtained in calculations on the sagittal cuts.

It is clear from the table that the distance to each formation from the base of the occipital protuberance and from the frontal plane in dogs with different dimensions of head is roughly proportional to the size of the head. The depth of the stratification of the subcortical formations is not always modified in proportion to its dependence on the different thicknesses of the skull bone.

Thus, the greatest deviation was observed in dog No. 19 in which the thickness of the bone was almost twice as large as in the other dogs. In dog No. 17 we noted a certain deviation for the subcortical formations lying in the frontal part of the brain, which is explained by the considerable thickening of the bones in the frontal part of the skull.

The transverse commissure is not a sufficiently accurate guide for the operation on the subcortical formations. Thus, in dogs No. 18 and No. 19 (Table 2) the commissure was far forward in relation to the subcortical formations lying underneath it, and in dogs No. 6 and No. 11, on the other hand, it was far back.

In order to provide the experimentor with better orientating points, we made a projection of the cerebral hemispheres, of the basic sulcuses and subcortical formations on the upper surface of the skull for all dogs. Fig. 1. shows the variant most frequently encountered (dog No. 9).

The tables give the measurements of those subcortical formations most often required in the various operations. The sections maintained in the form of Talalaev preparations enable the experimentor to carry out calculations independently for any formation interesting him along the lines of the planes marked on each section, and by the distance indicated for each section from this or that orientating point (from the hind point of the occipital protuberance for the frontal sections and from the sagittal plane for the sagittal sections). Photographs of such a series of frontal sections are given in Fig. 2.

With the use of the tables, during an operation it is necessary above all to select in the table the skull of approximately the same dimensions as the skull of the dog under operation (length of the skull with this means of measurement roughly corresponds to the length of the head of the dog, since measurement is carried out from the hind edge of the eye socket to the hind point of the occipital protuberance and the thickness of the skin basically does not influence these dimensions). If an electrode is inserted perpendicular to the upper surface of the skull, the figures should be taken from Table 1, if parallel to the frontal plane, then from Table 2. With the use of Table 1, the distance of the given formation from the rear edge of the occipital protuberance is calculated as follows. The distance from the base of the occipital protuberance is taken (column 2) and to it is added the length of the occipital protuberance of the dog under operation plus 2-3 mm for the thickness of the skin. All the remaining measurements are determined according to the figures indicated in both tables.

Using the data from the table, we carried out a number of operations on the subcortex. Thus, for example, with a constant current we destroyed the internal nucleus of the thalamus (length of head of the dog 88 mm, length of occipital protuberance 6 mm, orientating point at which electrode is plunged in 44 mm in front of the terminus of the occipital protuberance, 2 mm from the sagittal plane, 34 mm deep), external nucleus of the thalamus (length of the head of the dog 80 mm, length of occipital protuberance 3 mm, orienting points 40 mm from terminus of occipital protuberance, 6 mm from sagittal plane, 26 mm deep), the body of the nucleus caudatus (length of head of dog 80 mm, length of occipital protuberance 3 mm, orientating points 44 mm from terminus of occipital protuberance, 6 mm from sagittal plane, 26 mm deep), tip of nucleus caudatus (length of head of dog 74 mm, length of occipital protuberance 3 mm, orientating points 47 mm from terminus of occipital protuberance, 4 mm from sagittal plane, 27 mm deep), etc.

Thus, the figures we give in the table have been checked in a number of experiments.

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