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COMPARATIVE STUDIES ON THE BRAINSTEM OF SOME DOMESTIC ANIMALS

II- Mesencephalon

(With 4 Tables and 6 Figures)

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(Received at 31/3/2002)

دراسات مقارنة لساق الدماغ لبعض الحيوانات المستأنسة
٢- الدماغ الأوسط

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وجد في هذا البحث أن الدماغ الأوسط هو أصغر أجزاء ساق الدماغ في كل الحيوانات تحت الدراسة. وفيما بينها فهو أصغرها في الخنازير. وقد لوحظ أن الدماغ الأوسط لهذا الحيوان يأخذ وضع مائل في اتجاه الأمام بين الدماغ الأمامي المرتفع والدماغ الخلفي المنخفض. يتكون الدماغ الأوسط من جزء ظهري (السقف) ويتمثل في الأجسام التوأمية الأربعة وجزء بطني يتمثل في سويقتا المخ وغطاء المخ. ويعبر الدماغ الأوسط قناة الدماغ. أن أطول نسبة لطول الدماغ الأوسط بالنسبة للطول الكلى للدماغ وساق الدماغ قد شوهدت في الأغنام (١٢,٤ %٢١,٧,%) بينما أقصرها قد شوهدت في الخنازير (٥%,٨,١٠%).أن حجم الأجسام التوأمية الأمامية يكون أكبر من الخلفية في الحمير والأغنام ومتساويين في الحجم تقريبا في القطط بينما في الكلاب والخنازير فأن حجم الأجسام التوأمية الخلفية يكون أكبر من الأمامية. أن مثلث الدماغ الأوسط يكون رباعي الشكل في كل من الحمير والكلاب والقطط ، مثلث في الأغنام بينما في الخنازير فيظهر على شكل شق ويمثل عضد الأجسام التوأمية الخلفية.أن سويقتا المخ تكونا بارزتان في الحمير، طويلتان نسبيا في الأغنام ، قصيرتان في الخنازير وسميكتان متماثلتان في العرض على أمتداد طولهما في الكلاب والقطط وأن النواة بين سويقتا المخ تكون مرئية عيانيا في القطط والخنازير والأغنام. أن شكل واتجاه قناة الدماغ يختلف بين الحيوانات تحت الدراسة بناء على شكل ووضع سقف الدماغ. أن الحفرة السويقتية تكون سداسية الشكل في الأغنام ومستطيلة في الحمير وكاسية في الخنازير بينما في القطط والكلاب فهى على شكل شبة منحرف. أن غطاء المخ يكون نامي جدا في الكلاب حيث يشكل أعلى نسبة له بالنسبة للارتفاع الكلـي للدمـاغ الأوسـط (٥٧,١%) يعقبه القطط, الأغنام ثم الخنازير وأخيرا في الحمير حيث أنها تمثل أصغر نسبة له (٥٠%) فقط. أن المادة السوداء والنواة الحمراء كانتا ناميتان جدا في الكلاب والخنازير.

SUMMARY

The mesencephalon was the smallest part of the brainstem in all examined animals. In pig it was the smallest and takes an oblique position rostrodorsally between the rostral higher forebrain and the caudal lower hindbrain. The mesencephalon composed of dorsal tectum, ventral tegmentum, crura cerebri and traversed centerally by mesencephalic aqueduct. The longest mesencephalon to the total length of the brain and also to the brainstem was observed in sheep (12.4%, 21.7%) while the shortest one was in pig (5%, 10.8%). The rostral colliculi were larger than the caudal ones in donkey and sheep, nearly of the same size in cat but in dog and pig the caudal ones were the larger. The lemniscal trigone was rectangular in donkey, dog and cat; triangular in sheep and groove like space in pig and represented by the brachium of the caudal colliculi. The cerebral crura were thick and well prominent in donkey, relatively long in sheep, short and fan shaped in pig and in the form of thick column nearly with the same caliber along its length in dog and cat. The intercrural nucleus was visible in cat, pig and sheep. The shape and orientation of the mesencephalic aqueduct differed between the examined animals in accordance to the shape and position of the mesencephalic tectum. The intercrural fossa was elongated hexagonal in shape in sheep, rectangular in donkey, cup shaped in pig and trapezoid in dog and cat. The mesencephalic tegmentum was well developed in dog where it formed the highest percentage to the total mesencephalic height (57.1%) followed by cat, sheep and pig. The lowest value (50%) was recorded in donkey. The substantia nigra was well developed in dog, pig and sheep, while the red nucleus was well developed in dog and pig.

Key words: *ComparativeBrainstem, Domestic animals, Mesencephalon*

INTRODUCTION

The mesencephalon was the most important part of the brainstem, as it links between the forebrain rostrally and the hindbrain caudally. The dorsal aspect of the mesencephalic tectum was a large center for correlation of the optic, visual and auditory impulses with the exteroceptive impulses from the face and the trunk [Ariens Kappers, Huber and Crosby (1965); Gray (1973); Nickel, Schummer and Seiferle (1984); Dyce, Sack and Wensing (1987); Seeley, Stephens and Philip Tate (1992)]. In the ventral portion of the mesencephalon (tegmentum) the entire efferent component was situated and include the nuclei of the occulomotor and trochlear nerves; mesencephalic reticular nuclei which are involved in behavioural arousal, regulation of muscle reflexes and modulation of pain sensation (Ariens Kappers *et al.*1965; Kotchabhakdi, Hoddevik and Walberg, 1980; Kelly, 1985 and Seeley *et al.*, 1992). In addition the reticular formation and other mesencephalic nuclei form the promotor networks that organize several complex behaviours such as; control of posture, orientation of the head and body towards external stimuli, control of eye movements and coordination of the activity of visceral organs (Mussen, 1927; Hinsey, Ranson and Dixon, 1930; Kelly, 1985 and Brodal, 1998). Moreover the fibers pathways through the mesencephalon (basis peduncle) to and from the higher centers take place (Ariens Kappers *et al.*, 1965; Nickel *et al.*, 1984; Dyce *et al.* 1987 and Seeley *et al.*, 1992).

MATERIAL and METHODS

In the present work heads of adult clinically healthy donkeys, sheep, pigs, dogs and cats of both sexes (10 each) were used. Injected with 10% formalin solution through the common carotid artery and immersed in the same fixative for sufficient time. The cranial cavity was opened and the brain with its meninges was extracted. The meninges were removed carefully. Different measurements of the brain, brainstem, mesencephalon and its structures were recorded in (Fig. 1). Cross and sagittal sections of the mesencephalon at specific levels were made to examine some of its internal structures.

RESULTS

The mesencephalon was completely hidden from view by the cerebral and cerebellar hemispheres. It was the smallest part of the brainstem in all examined animals and in pig it was the smallest at all (Table 1). It was situated between the medulla oblongata and pons caudally and the diencephalon rostrally. In all studied animals except pig, it appeared horizontal (Figs. 2/A,B,D,E). In pig it lay in an oblique position (rostrodorsal) between the lower hindbrain caudally and the higher forebrain rostrally (Fig. 2/C). The width of the mesencephalon varied along its length in accordance to the divergence of the cerebral crura rostrolaterally to end caudal to the optic tract where it reaches its maximum width (Table 2).

The mesencephalon composed of *dorsal tectum mesencephali, ventral crura cerebri and tegmentum mesencephali*. It was traversed centrally by the mesencephalic aqueduct which continue rostrally with the cavity of the 3rd ventricle and caudally with that of the 4th one (Figs. 3,3'/A-E).The occulomotor and trochlear nerves originate from the mesencephalon.

The dorsal mesencephalic tectum was represented by the lamina tecte and two pairs of eminences. The rostral pair was the rostral colliculi and the caudal one was the caudal colliculi. They were connected with the geniculate bodies by the brachium colliculorum caudalis et rostralis. In all examined animals the tectum took an oblique direction where the caudal eminence lay caudolateral to the rostral one (Figs. 2,4/A,B,D,E) In pig the rostral eminence lay above the caudal one and the tectum took a vertical position (Figs. 2,4/C). In donkey the larger rostral colliculi were hemispherical in shape (Figs. 2,4/A and Table 3) and located rostrolateral to the caudal ones. In sheep (Figs. 2,4/B and Table 3)) they were rectangular of grayish color and located rostrodorsal to the caudal ones. In sheep also they were thick at the midline (0.9cm) and became thin laterally (0.2cm). The long axis of the rostral colliculus was straight in donkey, where it directs rostrally and oblique in a rostrolateral direction in sheep. The rostral transverse groove which separate them from the lateral geniculate body was wide and deep while the caudal one which separates them from the caudal colliculi was shallow and narrow. The longitudinal groove which separate the right from the left one was deeper. Rostrally this groove formed a deep fossa for the lodgment of the pineal gland in sheep (Fig. 4/B).The smaller caudal colliculi were ovoid in shape and of white color. They continued in the midline by an isthmus which was very thin in donkey and thick in sheep. The trochlear nerve originated caudal to the brachium of the caudal colliculi. In cat the rostral and caudal colliculi were nearly of the same size (Fig. 4/E, Table 3) but in dog the caudal colliculi were the larger (Fig. 4/D, Table 3). It was observed that in the before mentioned animals the rostral colliculi were triangular in shape, with rounded angles and of grayish color. The base of this triangle was at the midline while the apex was directed laterally. The rostral colliculi in dog were located more ventral to the caudal ones than that in cat (Figs. 2,4/D,E). The long axis of each colliculus was straight in a rostral direction in dog and oblique in a rostrolateral direction in cat. The longitudinal groove between the rostral colliculi was well distinct. It was deeper in dog but in cat rostrally it forms with the thalamus a deep fossa for the lodgment of the pineal gland. In dog and cat the rostral colliculi were separated from the caudal ones by a deep transverse groove and from the thalamus and medial geniculate body rostrally by a deeper one.

The caudal colliculi were ovoid in shape in dog and spherical in cat. Its long axis directed caudolaterally in dog and dorsolaterally in cat (Figs. 4/D,E and Table 3). They connected with each other by an isthmus, which was thin and very long in dog and thick in cat (Figs. 4D,E and Table3).

In the two cases of dogs that have recorded in the previous paper, the caudal colliculi formed one band that continued at the midline and directed dorso-laterally to connect with the cerebral crura and enclose the rostral ones (Fig. 4").

In pig the large rostral colliculi appeared as cone shaped structure (Fig. 4′ and Table3) and were located above the caudal ones (Figs. 2,4/C); in dorsal view they appeared triangular (Fig. 4/C). They were separated rostrally from the thalami and caudally from the caudal colliculi (Fig. 4′) by a deep transverse groove and from each other by a deeper longitudinal one. The groove formed with the thalami and the caudal commissure a deep triangular fossa for the epiphysis cerebri (Figs. 4′,4/C). The large caudal colliculus appeared as a cup shaped structure above it lay the rostral ones like a basket net and ball (Fig. 2/C). The caudal colliculi were connected with each other by a long narrow isthmus (Fig.4′).

The rootlets of the delicate trochlear nerve originated from the caudomedial aspect of the caudal colliculi (Fig. 4′).

The cavity of the mesencephalon (Table 4, Figs.3,3′/A-E) was represented by the cerebral aqueduct, which was a channel between the cavity of the 4th ventricle and that of the 3rd one. Its roof was formed by the tectum and its floor was formed by the tegmentum (Figs. 3,3′/ A-E) It was slightly dilated at its middle (at the level of the rostral colliculi) and narrow at both ends. In donkey and sheep the duct was somewhat crescentic in shape wide at its middle, narrow at its ends. The rostral opening appeared nearly at the same level with the caudal one, where the long axis of the duct was longitudinal in a rostrocaudal direction (Figs. 3,3′/A,B and Table 4). In dog and cat the duct appears wide at both ends and narrow at the middle. The rostral opening (at the 3rd ventricle) was ventral to the caudal one; so the long axis of the duct was oblique rostroventrally. This may be attributed to the normal position of the tectum where the rostral colliculi were somewhat ventral to the caudal ones, (Figs. 3,3'/D,E and Table 4). In Pig, the duct was slightly wide caudally otherwise it had the same caliber. The caudal opening appeared higher than the rostral one and the long axis of the duct was oblique in a rostr-odorsal then ventral direction where the rostral colliculi lay above the ventral ones (Figs. 3,3'/Cand Table 4).

The cerebral crura (Table 1,2) form the base of the mesencephalon. They appeared as two prominent white fibrous bands which diverge from the rostral border of the pons and course rostrolaterally to disappear in the substance of the cerebral hemisphere caudal to the optic tract (Figs. 2,5,5"/A-E) forming the intercrural fossa. The length of the cerebral crura (Figs. 1,5,5"/A-E) was equal to the actual length of the mesencephalon (caudal limit of the mammillary body), in addition to a great part of the diencephalic length (from the caudal limit of the mammillary body till the rostral end of the optic chiasma). Rostral to the occulomotor rootlets each cerebral crus was pierced by the transverse crural tract (basal optic tract) which was a narrow fibrous band directed towards the brachium of the caudal colliculi. The crural surface was indented by the crural sulcus (Figs. 2,5/A-E).

In donkey (Figs.5,5"/A) the cerebral crus was wide with a convex ventral surface. The intercrural fossa was shallow, narrow and rectangular in shape. The rootlets of the occulomotor nerve originated about 0.8cm from the origin of the cerebral crura. The fine striations on the crural surface caused by the longitudinal fibrous bundles, which demarcated into three groups by a medial and a lateral crural sulcus (Fig. 2/A). The well distinct transverse crural tract (basal optic tract) crosses the ventral surface of the cerebral crura and directed dorsally to contact with the brachium of the caudal colliculus a level of the medial geniculate body (Fig. 2/A). In dog the cerebral crura were too thick quadrilateral columns symmetrical along their length, but in cat they were short, wide fibrous bands with rounded striated ventral surface. The intercrural fossa was trapezoid in shape, it was wider in cat where the cerebral crura diverge more laterally; deeper in dog where it contains deep intercrural sulcus (Figs. 5,5"/D,E). The rootlets of the occulomotor nerve originated nearly at the beginning of the middle third in dog and at the middle of the crural length in cat. The intercrural nucleus was visible and occupied the intercrural fossa in cat (Fig. 5'). The transverse crural tract well distinct in dog but in cat it was faint and demarcated between the well- prominent rounded smooth caudal part and flattened striated rostral part of the crural surface. (Figs. 2,5/D,E). In sheep the cerebral crura were too long and representd the longest ones to the total length of the brain and brainstem among the examined animals (Figs. 5, 5"/B and Table 1). The crural tract divided the ventral crural surface into a large rounded well prominent rostral part and a narrow well distinct smooth triangular caudal one. The medial side of the rostral part slightly flattened and smooth while the lateral one has many longitudinal striations. The medial and lateral crural sulci divide it into three bands. The origin of the occulomotor rootlets was nearly at the caudal third of the crural length. The elongated hexagonal intercrural fossa was wide and shallow (Figs. 5,5"/B). The intercrural nucleus can easly observed at its caudal part near the pons. In pig the cerebral crura were very short, wide and well prominent. It represented the shortest ones among the examined animals (Table 1). The faint crural tract divided it into two parts; a small caudal wide triangular part with smooth ventral surface and a well prominent fan shaped rostral part with striated ventral surface (Fig. 5,5"/C). The faint crural tract traversed the ventral surface of the cerebral crura towards the caudal colliculus a level of the medial geniculate body (Fig.2/C). The occulomotor nerve originated at the junction of the caudal and the rostral parts (0.3cm from the origin of the cerebral crura). The intercrural fossa was wider and cup shaped. It occupied by the intercrural nucleus caudally (Figs. 5,5"/C) and contained deep intercrural sulcus at its rostral part.

In donkey *The lemniscal trigone* (Fig. 2/A) was quadrilateral in shape and included between the caudal colliculi and its brachium rostrodorsally (1.3cm), the cerebral crus rostroventrally (1.3cm), the prepontine sulcus ventrocaudally (0.9cm) and the rostral cerebellar peduncle dorso-caudally (0.4cm in length). Its surface was smooth and slightly curved by the superficial fibers of the lateral lemniscal. In dog and cat (Figs. 2/D, E) the lemniscal trigone was quadrangular area lay between the cerebral crus rostroventrally (where its length measured about 0.4cm in dog, 0.3cm in cat), the brachium of the caudal colliculi and medial geniculate body rostro-dorsally (about 0.7cm in dog and 0.5cm in cat), the prepontine sulcus caudoventrally (about 0.8cm in dog and 0.6cm in cat) and the rostral cerebellar peduncle caudodorsally (about 0.2cm in dog and 0.15cm in cat). The lemniscal fibers can not be detected from the surface; however the furrows on the trigoneal surface which gave it a very irregular appearance indicate their existence and direction. In sheep the lemniscal trigone was isosceles triangular area (Fig.2/C) included between the cerebral crura and the crural sulcus rostroventrally, the brachium of the caudal colliculi rostrodorsally and the prepontine sulcus caudally and each measured about 0.7cm in length. The fibers of the lateral lemniscal can be seen clearly. In pig the trigone was invisible as it appeared as a wide shallow fissure lay ventral to the brachium of the caudal colliculi and caudodorsal to the cerebral crura, caudal to the medial geniculate body and rostral to the prepontine sulcus (Fig. 2/C) and measured about 0.8cm in length.

The internal structure of the mesencephalic tegmentum and crura cerebri were studied in sagittal section through the brainstem and cross-section at the level of the occulomotor rootlets. In sagittal sections (Figs.3',3/A-E). The mesencephalon ventral to the aqueduct was very thick in dog and constitute about (57.1%) from the total mesencephalic thickness. However in donkey it was thiner and formed the lowest value among the examined animals (50%). In cat, sheep and pig its thickness occupied an intermediate position between these two values respectively (Table 4). In cross-sections (Figs. 6/A-E) the substantia nigra (which was a thin lamina of gray matter) occupied the dorsal concavity of the cerebral crura and formed its core. It was well developed in dog, pig and sheep. Dorsomedial to the substantia nigra and ventral to the motor nucleus of the occulomotor nerve the red nucleus (nucleus ruber) was located. It was somewhat large ovoid mass of gray matter which was well developed in dog and pig. The occulomotor nucleus lay ventral to the aqueduct in a paramedian position. The medial longitudinal fascicle which was represented by myelinated tract occupied the ventrolateral position of the occulomotor nucleus (Figs. 6/A-E).

DISCUSSION

The mesencephalon was the smallest part of the brainstem. a result which was in agreement with that mentioned by Dyce *et al.* (1987) and Nickel *et al.* (1984) in domestic animals, Amin (1984) in goat, Mansour (1983) and El-Khaligi (1977) in camel as well as El-Nahla (1982) in water buffalo.

In the present study the breadth of the mesencephalon at the origin of the cerebral crura was 1.8cm in donkey, 1.5cm in sheep and dog, 1.4cm in pig and 1.2cm in cat. While, the breadth at the roots of the occulomotor nerve was 2.8cm in donkey, 2.1cm in sheep, 1.9cm in pig, 1.8cm in dog and 1.3cm in cat. El- Nahla (1982) in water buffalo recorded 4.5cm for the breadth and Mansour (1983) in camel gave 0.4cm for the diameter.

Our study declared that, the mesencephalon was composed of dorsal tectum, mesencephalic tegmentum and cerebral crura which was in agreement with that described by House and Panisky (1960), Gray (1973) as well as Seeley *et al.* (1992) in man, Jenkins (1972) in dog and Mansour (1983). However Ariens Kappers *et al.* (1965) in mammals; El-Nahla (1982) in water buffalo, Dyce *et al.* (1987) in domestic animals as well as Beitz and Fletcher (1993) in dog mentioned that the mesencephalon was formed from the tectum, cerebral peduncles which composed of crura cerebri, tegmentum and substantia nigra. On the other hand, May (1970) in sheep, Dellmann and McClure (1975) in domestic animals and Amin (1984) in goat recorded that the mesencephalon consisted of tectum or corpora quadrigemina, crura cerebri, the tegmentum and the substantia nigra.

The result of the present work in donkey was in agreement with that described by Dellmann and McClure (1975) in horse that the rostral colliculi were larger, hemispherical in shape and much higher than the caudal ones. The smaller caudal ones were ovoid in shape and wider than longer. Sisson and Grossman (1969) in horse mentioned that the caudal colliculi were rounded. Our study in dog was in accordance with that of Dellmann and McClure (1975) in the same animal, that the rostral colliculi were smaller than the caudal ones. Contrary to that was described by Evan's and Delahunta (1996) that the caudal pair was smaller. Also our investigation observed that the rostral colliculi were triangular in shape while the caudal ones were ovoid. According to the affore mentioned authors the rostral colliculi were circular in outline and the caudal ones were oval and pointed. The result of the present study revealed that the rostral colliculi in dog were located rostroventral to the caudal ones. On the other hand Dellmann and McClure (1975)in the same animal recorded that; these colliculi were located rostrodorsally and slightly medial to the caudal ones. In sheep the rostral colliculi were rectangular in shape while the caudal ones were ovoid. Dellmann and McClure (1975) stated that the rostral colliculi of sheep were spherical and the caudal ones were rounded, the rostral colliculi of ox were spherical and the caudal ones were ovoid; El-Nahla (1982)in water buffalo described the rostral colliculi as globular in shape. The present study in sheep observed that the isthmus between the caudal colliculi was very thick; while Amin (1984) in goat recorded that the caudal colliculi connected with each other by a narrow strip (isthmus).

The caudal colliculi of pig were larger than the rostral ones, this was in agreement with that described by Dellmann and McClure (1975) in the same animal, but they described the rostral colliculi as triangular in outline. They were cone shaped in our investigation, but when they observed dorsally; appeared triangular in outline. The present study observed that, the rostral colliculi lie above the caudal ones and appeared as basket net and ball; similar also to that mentioned by the same author. In cat the present result was similar to that described by Gray (1973) in man where the rostral and caudal colliculi were of the same size.

The trochlear nerve originated from the mesencephalic tectum caudal to the brachium of the caudal colliculi in donkey; similar to that mentioned by El-Nahla (1982) in water buffalo. El-Khaligi (1977) in camel mentioned that the trochlear nerve emerged caudal to the brachium congunctivum lateral to the caudal medullary vellum. Amin (1984) in goat mentioned that the trochlear nerve was originated from the caudal aspect of the caudal colliculi immediately rostral to the rostral cerebellar peduncles. In pig the delicate trochlear nerve originated caudomedial to the brachium of the caudal colliculi however Dellmann and McClure (1975) in the same animal mentioned that the slender fibers of the trochlear nerve emerged from the rostral cerebellar peduncle close to the caudal colliculi.

The present study mentioned that the mesencephalic aqueduct was narrow at its ends and wide at its middle and the widest part lie at the level of the rostral colliculi, similar to that was mentioned by Mansour (1983) in camel, Nickel *et al.* (1984)in domestic animals, however El-Nahla (1982) in water buffalo mentioned that the widest part of the channel lie at the level of the caudal colliculi.The present study described the aqueduct as crescentic in shape however El-Nahla (1982) in water buffalo mentioned that the canal was oval in shape at its beginning and lozenge in outline at the level of the caudal colliculi.

Concerning the cerebral crura the present observation was in agreement with that described by Bradley and Graham (1948). Dellmann and McClure in dog that the cerebral crura represented by thick symetrical rounded column with striated ventral surface. In pig; our investigation showed that the cerebral crura were wide, thick fibrous bands divided into caudal triangular part and rostral rounded one by a faint crural tract, but in the same animal and according to Dellmann and McClure (1975) the cerebral crura were formed by large convex lateral portion and narrow flattened concave medial one. In sheep the present work illustrated that the longer cerebral crus was divided by a faint crural tract into a rounded rostral part and a narrow triangular smooth caudal one which was in agreement with that recorded by Dellmann and McClure (1975) in ruminant, Amin (1984) in goat and was in contrary with El-Nahla (1982) in water buffalo who mentioned that the cerebral crus was irregular fold with a slight rostral convexity. In sheep the intercrural fossa was elongated hexagonal in shape but Ganguli and Singh (1977) in Indian sheep mentioned that the intercrural fossa was triangular in shape. In pig the intercrural fossa was cup shaped with deep intercrural sulcus in its rostral part while Dellmann and McClure (1975) in the same animal mentioned that the two cerebral crura separated by the intercrural sulcus. The intercrural nucleus was observed in the caudal part of the intercrural fossa of pig and sheep; Dellmann and McClure (1975) described small gray elevation rostral to the pons in pig. In cat the intercrural nucleus appeared as two small rounded nuclei. Dellmann and McClure (1975) who was in the same animal mentioned that it can not be observed macroscopically. Ramony cajal (1911) and Ganser (1882) mentioned that the intercrural nucleus was well developed in macrosomatic animals.

The rootlets of the occulomotor nerve originated from the medial surface of the cerebral crura nearly at about the distal fourth of the crural length in donkey and sheep; at the distal third in dog and pig which was similar to that described by Amin (1984) in goat and at the middle of the crural length in cat which was similar to that described by Mansour (1983) in camel.

The present study showed that the lemniscal trigone is quadrilateral in outline in donkey, dog and cat. This was in accordance with that mentioned by Dellmann and McClure (1975) in dog and horse, however Mansour (1983) in camel, Nickel *et al.* (1984) in domestic animals declared it triangular in shape. Our result in sheep was in accordance with that mentioned by Dellmann and McClure (1975), El Nahla (1982) that the trigone was triangular in shape. In this study the trigone was bounded by the cerebral crura rostroventrally, the brachium of the caudal colliculi and the medial geniculate body rostrodorsally, the prepontine sulcus caudoventrally and the rostral cerebellar peduncle caudodorsally. Nickel *et al.* (1984) mentioned that the trigone was bounded by the brachium of the caudal colliculi rostrodorsally, the cerebral crura rostroventrally and the rostral cerebellar peduncle caudally.In pig the trigone was invisible as it appeared as a wide shallow fissure ventral to the brachium of the caudal colliculi and cando dorsal to the cerebral crura and the prepontine sulcus caudoventrally. Dellmann and McClure (1975) in the same animal mentioned that the trigone was situated ventral to the brachium of the caudal colliculi and separated by shallow sulcus from the just mentioned brachium, rostral cerebellar peduncle, cerebral crura and deep prepontine sulcus.

The mesencephalic tegmentum was very thick in dog, thin in donkey. Areins Kappers *et al.*(1965) pointed that the tegmental portion has increased in size in mammals, this increase was not to the size of its nuclear masses but to the increase in its fiber passage. He also added that the cerebral crura occupied large portion of the mesencephalic field, as these crura carry the greater fibers pathways between the motor centers of the cortex and those of the brainstem and spinal cord. Consequently their size varies in the different species in proportion to the development of the neopallial cortical area.

Concerning the cerebral crura, the present study described its ventral surface striated in most examined animals which indicates the course of the fibers tracts. Ariens Kappers *et al.*(1965) mentioned that the fiber paths which form the most superficial portion of the cerebral peduncle vary in size in different domestic animals. Gierlich (1916) mentioned that the basal portion constitutes 5.4% of the whole peduncle in carnivore, 11% in apes and 20% in man.

The present study was in agreement with that described by Dellmann and McClure (1975) and Nickel *et al.* (1984) in domestic animals, Ariens Kappers *et al.* (1965) in mammals, and Seeley *et al.* (1992)in man that the substantia nigra was gray plate of dark color located dorsal to the cerebral peduncule and form its internal structure. Dellmann and McClure (1975) as well as Dyce *et al.* (1987) recorded that in domestic animals the substantia nigra was only revealed at the microscopic level .

The result of the present study was in accordance with that described by Dellmann and McClure (1975) in domestic animals, Ariens Kappers *et al.* (1965) that the nucleus ruber can easily recognized in all mammalian forms. It was located ventral to the occulomotor nucleus. Davenport and Ranson (1930) mentioned that the red nucleus appeared to extend further forward in cat than in rabbit.

Our study was in accordance with that mentioned by Ariens Kappers *et al.*(1965) that the longitudinal fascicle was myelinated fibers located ventrolateral to the occulomotor nucleus, extend caudalward and occupying a portion near the midline through out the pons and the medulla oblongata.

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LEGENDS

Fig. 1: A diagram showing the methods of measurements of the: brain, A; brainstem, B mesencephalon, C in examined animals.

Fig. 2A-E: Photographs of the lateral aspect of the brainstem in: Donkey, A; Sheep, B; Pig, C; Dog, D and Cat, E showing: *-Lemniscal trigone →-Transverse crural tract ●-Pons ➢ -Rostral and caudal transverse grooves 1-Rostral colliculi 2-Caudal colliculi 3-Brachium of the caudal colliculus 4-Medial geniculate body 5-Lateral geniculate body 6-Optic tract 7-Prepontine sulcus 8-Crura cerebri 9-Rostral cerebellar peduncle.

Fig. 3A-E: Photographs of sagittal sections of the brainstem in: Donkey, A; Sheep, B; Pig, C; Dog, D and Cat, E showing: *-Mesencephalic tectum ➢-Cerebral aqueduct ●- Mesencephalic tegmentum T-Thalamus ■-Third ventricle Δ-fourth ventricle M-Medulla oblongata P-Pons.

Fig. 3'A-E: Diagram of the sagittal sections of the brainstem in: Donkey, A; Sheep, B; Pig, C; Dog, D and Cat, E showing: ▨-Thalamus ▩-tectum ▦ Mesencephalic tegmentum.

Fig. (4A-E): Photographs of the dorsal aspect of the mesencephalon in: Donkey, A; Sheep, B; Pig, C; Dog, D and Cat, E showing: □Thalamus *-Pineal body °-Habenula ■-Rostral colliculi Δ-Caudal colliculi ➢-Rostral and caudal transverse groove R-Longitudinal groove S-Isthmus between two caudal colliculi. → -Occulomotor nerve.

Fig. 4': A photograph of the dorsal aspect of the brainstem in pig viewed caudodorsally showing the normal position of the caudal colliculi which was under covered by the rostral ones in dorsal view. □Thalamus *-Pineal body °-Habenula ■-Rostral colliculi Δ-Caudal colliculi ➢ -Rostral and caudal transverse groove R-Longitudinal groove S-Isthmus between two caudal colliculi. → -Occulomotor nerve.

Fig. 4": A photograph of the dorsal aspect of the brainstem in recorded two cases of dogs showing the shape of the mesencephalic tectum. □Thalamus ■-Rostral colliculi Δ-Caudal colliculi ➢ -Rostral and caudal transverse groove .

Fig. 5A-E: Photographs of the ventral aspect of the mesencephalon in: Donkey, A; Sheep, B; Pig, C; Dog, D and Cat, E showing: ■-Crura cerebri ●- Intercrual fossa Δ- Occulomotor rootlets · Ttransverse crural tract (Basal optic tract) 6- Intercrural sulcus °-Intercrual nucleus.

Fig. 5′: A photograph of the brain of cat showing the intercrural nucleus (arrow).

Fig. 5″A-E: Diagran of the ventral aspect of the mesencephalon in: Donkey, A; Sheep, B; Pig, C; Dog, D and Cat, E showing: ⁘-Intercrual fossa ▦-Mammillary body ▬-Occulomotor rootlets

Fig. 6A-E: Photographs of Cross sections of the mesencephalon at the level of the occulomotor rootlets in Donkey, A; Sheep, B; Pig, C; Dog, D and Cat, E showing: 2-Hypocampus 3- Septum pelucidum 4-Lateral ventricle 5-Thalamus 6-Habenula 7-Third ventricle 9-Crura cerebri 10-Piriform lobe 11-Optic tract 12-Mammillary body 13-Ventral end of the Hypocampus 14-Amygdaloid body 16-Medial geniculate body 17-Rostral colliculus C-Corpus callosum →-Pineal body o-Nuclei of III nerve r-Red Nucleus n-Substantia nigra f-medial longitudinal fascicle.

Table (1): Showing the mean length of the brain(B), brainstem (S),mesencephalon (M), M/B, M/S, cerebral crura (C), C/B, C/S and position of the III from crural origin(III), (III)/C, (III)/M in examined animals.

Animal	(B)	(S)	M			(III)			(C)		
	cm	cm	cm	M/B	M/S	cm	III/C	III/M	cm	C/B	C/S
Donkey	12.5	7.8	1.5	12.0	19.2%	0.8	35%	53%	2.3	18.4%	29.5%
Sheep	10.5	6.0	1.3	12.4%	21.7%	0.7	33%	56%	2.1	20.0%	35.0%
Pig	08.0	3.7	0.4	05.0%	10.8%	0.3	27%	75%	0.8	10.0%	21.6%
Dog	09.7	6.3	0.9	09.3%	14.3%	0.5	33%	56%	1.5	15.5%	23.8%
Cat	05.3	3.2	0.4	07.5%	12.5%	0.3	43%	75%	0.7	13.2%	21.9%

Table 2: Showing the mean Width of the mesencephalon (M), Cerebral crus(C), intercrural fossa (I) at the level of pons(P), occulomotor nerve,(III) and optic tract,(T) and C/M, I/M in examined animals.

Animal	M			C						I					
	P	III	T	P		III		T		P		III		T	
				L	C/M	L	C/M	L	C/M	L	I/M	L	I/M	L	I/M
	Cm	Cm	Cm	Cm	%	Cm	%	Cm	%	Cm	%	Cm	%	Cm	%
Donkey	1.8	2.8	4.8	0.7	77.8	0.9	46.3	1.5	62.5	0.4	22.2	1.0	35.7	1.8	37.5
Sheep	1.5	2.1	3.2	0.4	53.3	0.6	57.1	1.3	81.3	0.7	46.7	0.9	42.9	0.6	18.8
Pig	1.4	1.9	2.6	0.5	71.4	0.7	73.7	1.0	76.9	0.4	28.6	0.5	26.3	0.6	23.1
Dog	1.5	1.8	2.1	0.6	80.0	0.7	77.8	0.8	76.2	0.3	20.0	0.4	22.0	0.5	23.8
Cat	1.2	1.3	1.7	0.5	83.0	0.5	76.9	0.6	35.3	0.2	16.7	0.3	23.0	0.5	29.4

Table 3: Showing the mean length(L), width (W)and thickness(T) of the mesencephalic tectum in examined animals.

Animal	Rostral colliculi			Caudal colliculi			Isthmus	
	(L)	(W)	(T)	(L)	(W)	(T)	(L)	(W)
Donkey	1.4	1.4	---	0.7	1.5	-----	0.6	0.3
Sheep	1.1	1.1	0.7	0.6	1.5	-----	0.4	0.7
Pig	0.8	1.1	---	0.5	2.2	1.2	0.8	0.6
Dog	0.7	0.5	---	0.6	0.8	-----	0.6	0.3
Cat	0.5	0.4	---	0.5	0.5	-----	0.4	0.2

Table 4: Showing the mean length(L), width (W) of the cerebral aqueduct, lemnisaci trigone, tegmentum and tegmentum /mesencephalon thickness in examined animals.

Animal	Cerebral aqueduct				Lemniscal trigone	Tegmentum	
	L	Width at				CM	T/M
	cm	3rd	Middle	4th	Cm	cm	%
Donkey	1.7	0.4	0.7	0.3	1.3x1.3x0.9x0.4	0.9	50.0
Sheep	0.8	0.4	0.4	0.2	0.7x0.7x0.7x------	1.0	51.9
Pig	1.1	0.3	0.4	0.3	0.8x----x----x-----	1.0	51.7
Dog	0.9	0.3	0.3	0.2	0.7x0.4x0.8x0.2	0.9	57.1
Cat	0.5	0.3	0.3	0.2	0.5x0.3x0.6x0.15	0.5	52.9

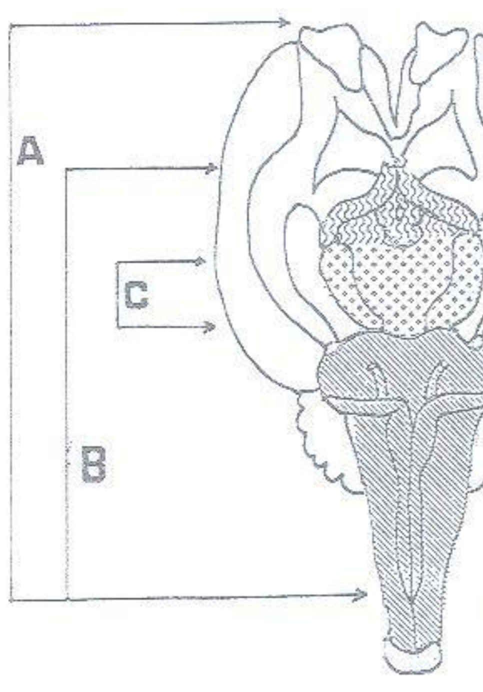
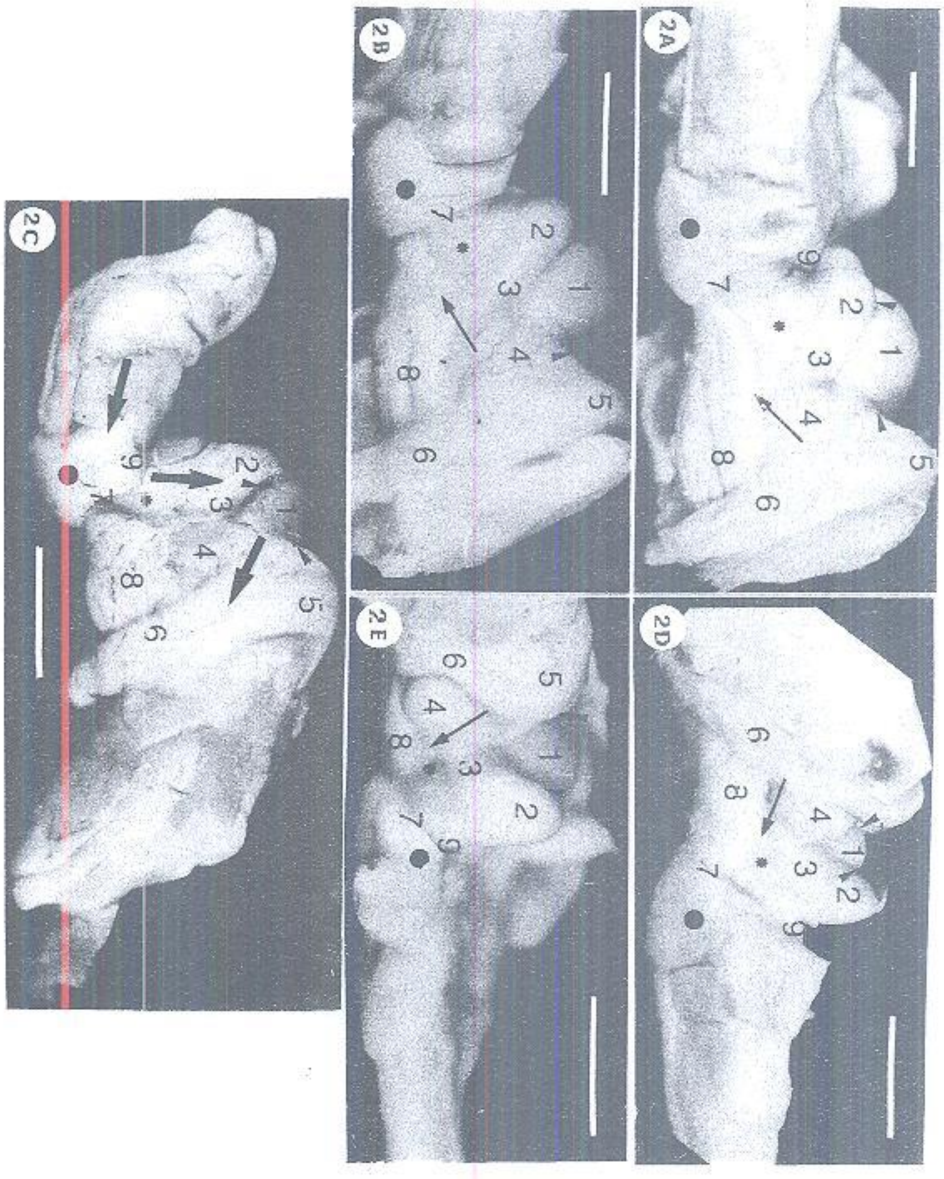


Fig (1)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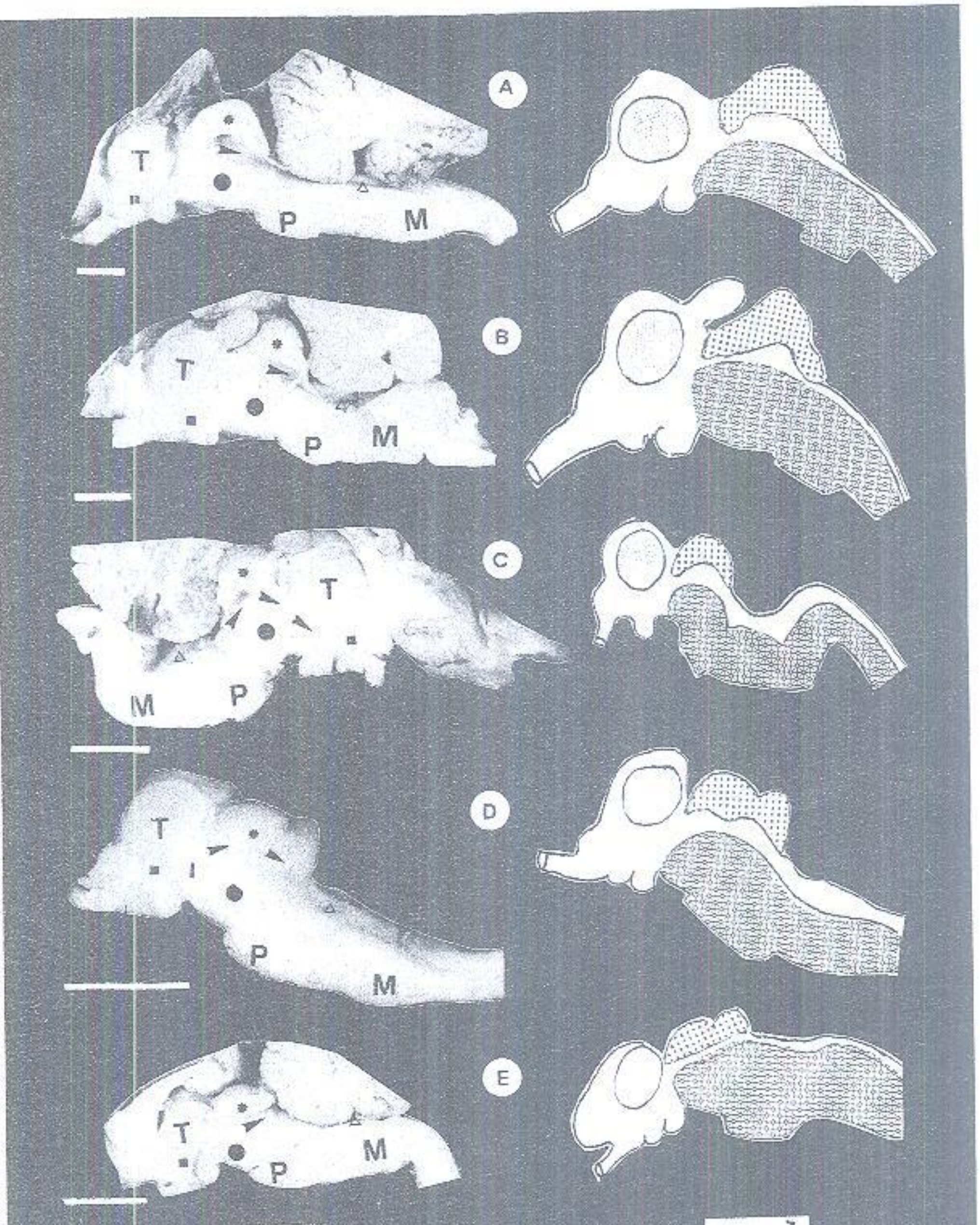
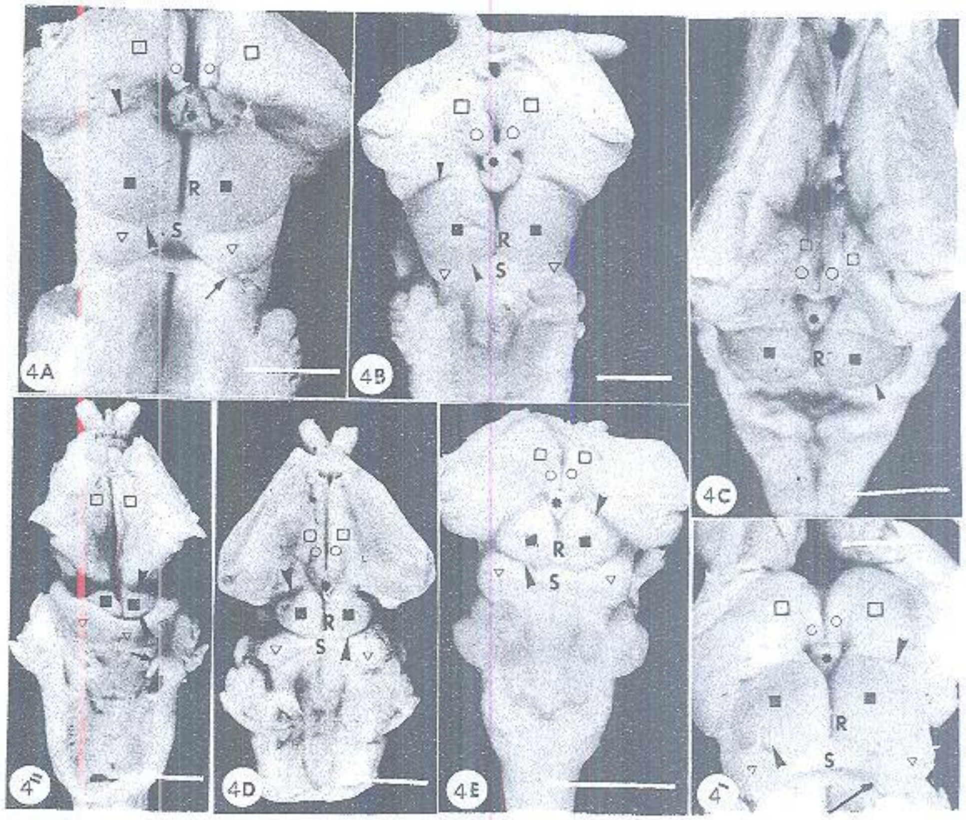


Fig (3)

Fig (3)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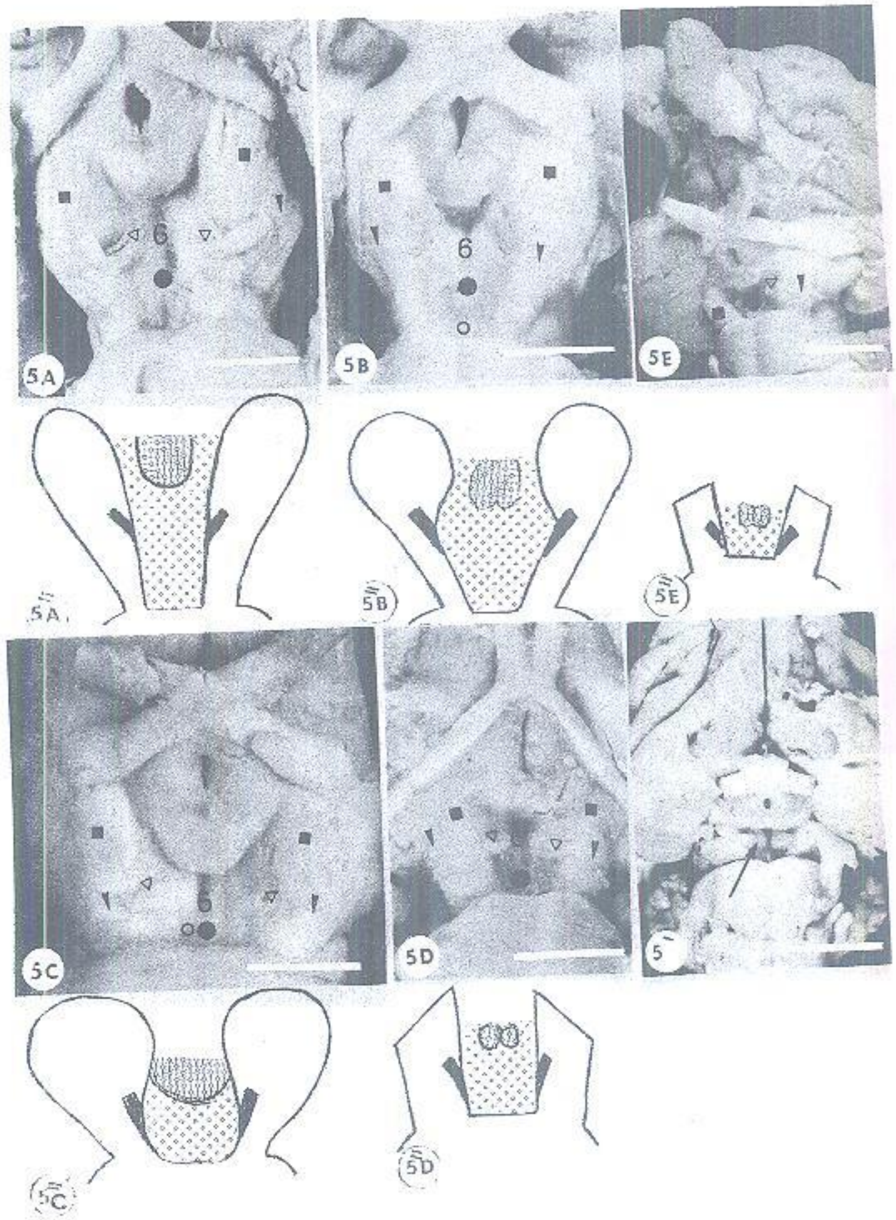
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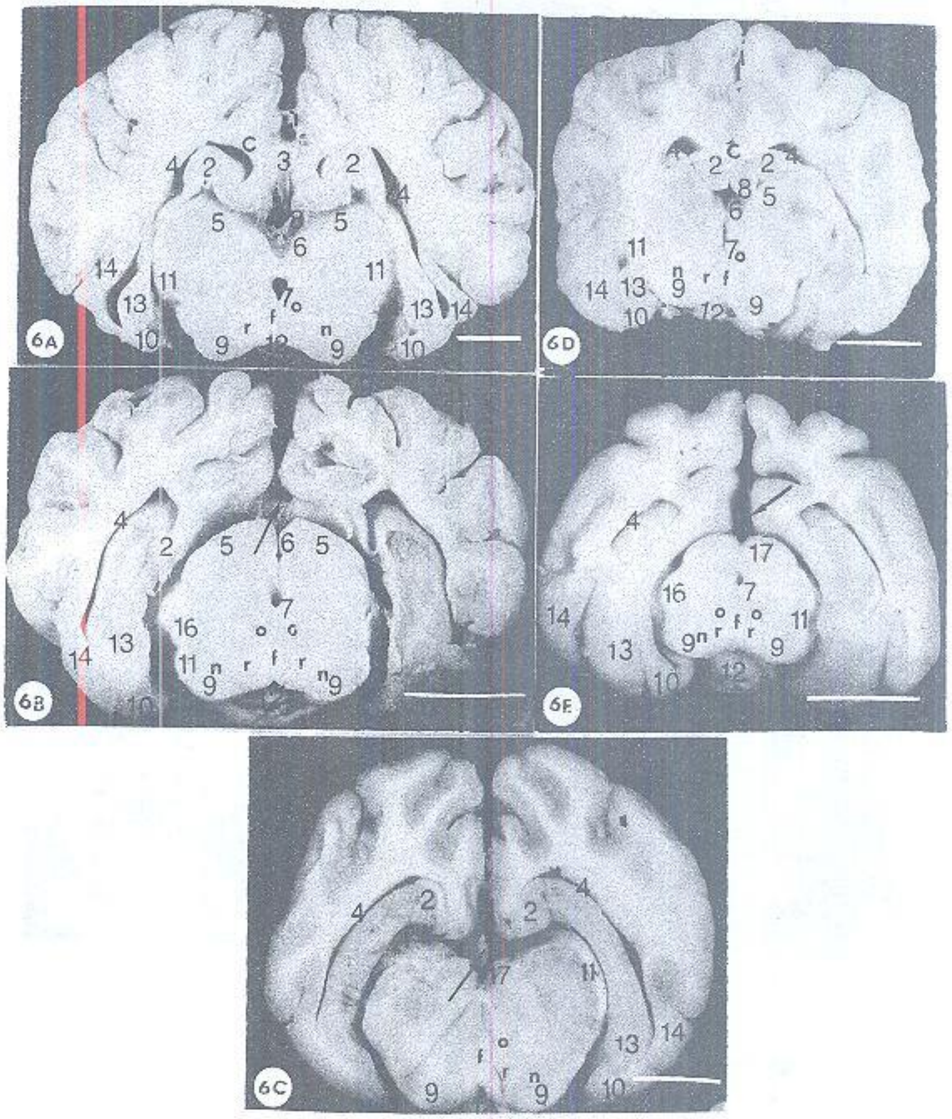
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