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COMPARATIVE STUDIES ON THE BRAINSTEM OF SOME DOMESTIC ANIMALS
I- Medulla oblongata and Pons
(With 8 Tables and 4 Figures)

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دراسات مقارنة لساق الدماغ لبعض الحيوانات المستأنسة
١- الجسر والنخاع المستطيل

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تم في هذا البحث دراسة أهم الاختلافات التشريحية للنخاع المستطيل والجسر كجزء من ساق الدماغ في كل من الحمير والأغنام والخنازير والكلاب والقطط. وقد أوضحت نتائج الدراسة ما يلي: أن الشكل العام للدماغ مستدير في القطط ومخروطي في الكلاب وبيضاوي في كل من الحمير والأغنام والخنازير. يظهر ساق الدماغ للخنازير في مستويين مختلفين. أن أطول ساق دماغ بالنسبة لطول الدماغ الكلى قد شوهد في الكلاب(٦٥%) بينما أقصرها في الخنازير(٤٦,٣%). وأثقل ساق دماغ بالنسبة لوزن الدماغ الكلى قد سجل في الخنازير(٢١,٢%) وأقلها وزنا في الحمير(١٠,٧%). أن نسبة طول النخاع المستطيل والجسر للطول الكلى لساق الدماغ سجل أعلى نسبة له في الخنازير(٧٨,٤%) وأقلها في الأغنام (٥٣,٣%). كما أن أعلى نسبة لوزن النخاع المستطيل والجسر قد شوهدت في الحمير(٥٢,٨%)وأن أقلها وزنا في الخنازير (١٧,٩%). أن نسبة طول الجسر لساق الدماغ كان أعلاها في القطط(٢٨,١%) بين الحيوانات تحت الدراسة بينما أقلها قد شوهد في الأغنام(١٦,٧%). النخاع المستطيل هو أخر جزء من ساق الدماغ. وهو رباعي الشكل نهايته الأمامية عريضة ونهايته الخلفية ضيقة هذا وقد لوحظ أن النهاية العريضة تمثل حوالي ثلاث أمثال النهاية الضيقة في الكلاب وهو أعرض نخاع مستطيل بين الحيوانات تحت الدراسة بينما أضيقها في القطط حيث تمثل النهاية العريضة أكثر من مرة ونصف المرة نهايته الخلفية الضيقة. أن نسبة طول النخاع المستطيل لساق الدماغ كان أعلاها في الخنازير (٥١,٤%) بينما أقلها قد شوهد في الحمير (٣٤,٦%). أن السطح الظهري للنخاع المستطيل والجسر يكونا معا البطين الرابع والذي يكون شكله رباعي طويل في الحمير والأغنام والكلاب وسداسي مستطيل في القطط ومعين في الخنازير.

SUMMARY

In this work the main anatomical differences of the myelencephalon (Medulla oblongata) and metencephalon (pons) as parts of the brainstem of the donkey, sheep, pig, dog and cat were studied. Apparently the brain as a whole is rounded in cat, cone shape in dog, ovoid in donkey, ovoid with truncated rostral end in sheep and ovoid but little bit wide caudally in pig. The brainstem of pig appears to lie in two different levels. The longest brainstem was observed in dog (65%), while the shortest one was in pig (46.3%). The heaviest brainstem was recorded in pig (21.2%)and the lightest ones was in donkey (10.7%). The length of the medulla oblongata and pons to the total length of the brainstem recorded its highest value in pig (78.4%)and its lowest value in sheep (53.3%). The heaviest medulla and pons were observed in donkey (52.8%) while the lightest ones were in pig (17.9%). The longest pons to the total length of the brainstem was observed in cat (28.1%) while the shortest one was observed in sheep (16.7%). The medulla oblongata is quadrilateral in shape, broader rostrally and narrow caudally. The wide rostral part equals about three times the narrow caudal one in dog. This represents the widest medulla. In cat it represents the narrowest one, where it equals more than one and half. The longest medulla oblongata to the total length of the brainstem was observed in pig (51.4%) and the shortest one was in donkey (34.6%). The dorsal surface of the medulla oblongata and pons forms the 4^{th} ventricle.The shape of the 4^{th}ventricle is elongated quadrilateral in donkey, sheep and dog; elongated hexagonal in cat and diamond in pig.

Kery words:*Comparative Brainstem,Domestic animals,Medulla & Pons,*

INTRODUCTION

The medulla oblongata and pons act as the major fiber pathway to transmit signal up and down the brainstem. They also play a vital physiological role as they contain the very important centers and nuclei of many cranial nerves concerned with the regulation and controlling most of the physiological functions of the body [Beitz and Fletcher (1993); Seeley, Stephens and Tate (1992); Arthur and Guyton (1987) as well as Dyce, Sack and Wensing (1987)]. Damage of small area of the brainstem causes death although damage of large area of the cerebrum or the cerebellum passes without permanent symptoms (Seeley *et al.*, 1992). Lack of information about the anatomical features of these parts of the brainstem particularly that of the donkey, sheep, pig, dog and cat attracts our attention to throwgh light on their main anatomical differences.

MATERIAL and METHODS

The present work was carried out on the heads of adult clinically healthy donkeys, sheep, pigs, dogs, and cats of both sexes (10 each). The heads 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 isolated carefully. Ways of measurements of the brain, brainstem, medulla oblongata and pons were illustrated in Fig. (1).

RESULTS

The shape of the brain is very irregular. Apparently the brain as a whole is rounded in cat, cone shape in dog, ovoid in donkey, ovoid with truncated rostral end in sheep and ovoid but little bit wide caudally in pig (Figs. 2/A-E). The brainstem is formed by the medulla oblongata, pons, mesencephalon and the diencephalon. The anatomical structure of the brainstem varies among the examined animals. The brainstem of pig appears to lie in two different levels (Fig. 1). The longest brainstem was observed in dog (65%), while the shortest one was in pig (46.3%). The heaviest brainstem was recorded in pig (21.2%)and the lightest one was in donkey (10.7%) (Table1). The medulla oblongata and pons form the caudal part of the brainstem. Their length forms about half the total length of the brainstem in donkey, sheep and dog while it forms about three fourth in pig and cat (Table 2).

The pons:

The pons occupies nearly the central part of the brainstem. Its rostral and caudal edges can be easily demarcated from the medulla oblongata caudally and the mesencephalon rostrally. The ventral aspect of the pons appears as white transverse fibrous band convex in both directions with a central basilar projection and is marked centrally by the basilar sulcus. The dorsal aspect of the pons is completely obscured by the cerebellum and it constitutes the rostral part of the rhomboid fossa. The trigeminal nerve originates from the caudal border of the pons in sheep, pig and from the caudolateral side in donkey, dog and cat. It appears as a broad band which measured about 1.1cm at its origin in donkey, 0.7cm in sheep, 0.5cm in pig, 0.4cm in dog and 0.3cm in cat (Figs. 3'/A-E). The length and width of the pons vary among the different examined species of animals (Table 3). In donkey the pons appeared as a thick prominent, well distinct transverse fibrous band with central basilar projection. The rostral border is concave at both sides and convex at the center with slightly central dentation, while the caudal one is convex in both sides and concave at the center. The basilar sulcus is unclear (Figs. 2,3,3′/A). In sheep it represents the shortest pons among the examined animals. It appeared as two well prominent rounded parts separated from each other by a deep basilar sulcus which diverges towards the caudal border of the pons enclosing a small triangular area. Its rostral border overlaps the cerebral crura. The rostral border is slightly convex with shallow central dentation and caudal border appeared straight and well marked from the corpus trapezoideum.(Figs. 2,3,3′/B). In pig the pons was represented by a short wide somewhat prominent transverse fibrous band without clear ventral basilar projection. The basilar sulcus was faint. The rostral border was set off from the origin of the cerebral crura and convex from side to side with faint central dentation, while the caudal border is straight with small central projection and well marked from the medulla oblongata (Figs.2,3,3′/C). In dog the pons was long, broad with a well prominent basilar projection; which appeared as the direct continuation of the medullary pyramids. The rostral border of the pons was too convex from side to side, so the length of the pons at the edges (0.5cm) was shorter than that at the midline (1.2cm); it overlaps the cerebral crura. The caudal border is somewhat straight. Both the rostral and caudal borders contains shallow central dentation, the rostral one was shallower. The basilar sulcus is not clear (Figs. 2,3,3′/D). In cat the pons was apparently well distinct quadrilateral mass representing the longest among the examined animals. It was flattened in rostrocaudal direction with a less prominent basilar projection. The basilar sulcus was clear and well distinct. The rostral border overlapped the cerebral crura and was convex at its sides. The caudal border was rather straight. Both the rostral and caudal borders contain central dentation. The rostral dentation was deeper (Figs. 2,3, 3′/E).

The medulla oblongata:

The different measurements of the medulla oblongata in examined animals are shown in Tables (4-6).

The wall and floor of the medulla oblongata are massive consisting of fiber bundles and nuclear centers; macroscopically they show many differences among the examined species.

The ventral median fissure which continuous caudally with the same fissure of the spinal cord; is well visible and deep in dog, cat, sheep and pig (Figs. 3/D, E, B and C) and it ends rostrally in a foramen coecum. In pig the foramen coecum is represented by a shallow fossa. In donkey (Fig. 3/A), the ventral median fissure is shallow and wide in the rostral two thirds and ends caudal to the trapezoid body by a shallow depression.

The medullary pyramids in dog and cat are thick and well prominent (Figs. 3/D, E and Table 7). In donkey they are narrow and well distinct along the rostral two thirds of the medulla oblongata (Fig. 3/A and Table 7), then they become less prominent and continue till they disappear in the substance of the medulla oblongata caudally. In sheep and pig the medullary pyramids are represented by a wide flat fibrous bands which are less prominent from the ventral surface(Fig.3/B and Table 7).In sheep the pyramids are wider caudally (Fig.3/C and Table 7).

In donkey the **pyramidal decussation** starts to appear at the beginning of the distal third of the medullary pyramids. For this reason the ventral median fissure is interrupted and the size of the medullary pyramids decrease until they disappear at the end of the medulla in its substance (Fig. 3/A). In dog and cat the decussation are not distinct, consequently the ventral median fissure continuous with its homologous fissure of the spinal cord (Figs.3/D,E). In sheep and pig the fibers of the medullary pyramids intersect at the caudal end of the medulla oblongata (Figs. 3/B, C).

The corpus trapezoideum is well developed in dog and cat, it protruded from the ventral surface of the medulla (Figs. 3/D,E and Table 7).It is crossed at the midline by the passage of the medullary pyramids. In donkey the corpus trapezoideum is represented by a narrow well prominent transverse band, continuous at the midline rostral to the pyramids (Figs. 2,3/A and Table 7).In sheep the corpus trapezoideum is represented by wide, well distinct flattened band of transverse fibers (Figs. 2,3/B and Table 7). In pig the corpus trapezoideum is represented by a broad, faint transverse fibrous band with clear rostral demarcation from the pons. The caudal one is ill distinct from the medulla oblongata (Figs. 2,3/C and Table 7). In all examined animals except donkey the corpus trapezoideum is interrupted at the midline by the passage of the medullary pyramids.

The facial tubercle (Figs. 2,3/A-E and Table 7) in pig is represented by a well distinct rounded area, partially on the medial part of the corpus trapezoideum and partially on the medulla oblongata lateral to the pyramids. In donkey, sheep and dog it is represented by a faint circular area which can be demarcated on the ventral surface caudal to the corpus trapezoideum and lateral to the pyramids. In cat the facial tubercle is visible hardly caudolateral to the trapezoid body but can not be demarcated from the ventral surface.

The olivary eminence (Figs. 2,3/A-E and Table 7) is represented by a bulging circular area at the caudolateral part of the medulla oblongata in pig and sheep. Well distinct semicircular area at the caudolateral end of the pyramids in cat. In dog and donkey it is represented by a less prominent oval area lies rostral to the roots of the hypoglossal nerve.

The ventrolateral sulcus (Figs. 2,3/A-E) is deep and well visible on both sides of the medullary pyramids in donkey, dog and cat; faint in pig while in sheep it is represented by a visible groove separated a clear ridge on its lateral side.

The facial nerve (Figs. 2,3/A-E) originates from the lateral side of the rostral border of the corpus trapezoideum in sheep and pig. In dog and cat it is originated with the vestibulo-cochlear nerve from the lateral side of the corpus trapezoideum immediately caudal to the origin of the trigeminal nerve. In donkey, the facial nerve originates from the lateral side of the ventral surface of the corpus trapezoideum.

The abducent nerve (Figs. 2,3/A-E) originates from the lateral side of the pyramid rostral to the corpus trapezoideum in all examined animals except in donkey where its roots originated from the lateral side of the pyramids across the whole length of the corpus trapezoideum.

The dorsal aspect of the medulla oblongata can be divided by the presence of the 4^{th} ventricle into two parts; rostral opened part and a caudal closed one (Figs. 4/A-E and Table 8).

The rostral opened part of the medulla oblongata is represented by the 4^{th} ventricle. The shape of the **4^{th} ventricle** (Figs. 4/A-E and Table 8) differs in examined animals. It is elongated quadrilateral in shape in donkey, sheep and dog, the broader rostral end is rounded while the narrow caudal one is pointed. In cat it is hexagonal with pointed caudal end. In pig, due to the normal orientation of the brainstem (Fig. 1`), the $4^{th}$ ventricle is divided into two parts; ventral medullary part (0.9cm) and rostrodorsal pontine part (0.6cm). Generally, the $4^{th}$ ventricle of pig is diamond in shape with rounded rostral end and pointed caudal one (Fig. 4/C`). The cavity of the 4^{th} ventricle is deeper in donkey, sheep, pig, dog and cat, wider in pig, sheep, cat, dog and donkey.

The rostral end of the 4^{th} ventricle is extends rostral to the rostral border of the pons in dog and cat. The rostral cerebellar peduncle is nearly at the same level with the caudal border of the corpus trapezoideum. In donkey the rostral limit of the 4th ventricle lay at the same level with the rostral border of the pons. The rostral cerebellar peduncle lay nearly at the same level with the caudal border of the pons. In sheep the rostral end of the 4th ventricle is slightly caudal to the rostral border of the pons and the middle cerebellar peduncle is nearly at the level of the caudal border of the pons. In pig the caudal border of the pons and the rostral cerebellar peduncle are at the same level with the rostral limit of the caudal ventral medullary part of the 4th ventricle.

The ventral median fissure (Figs. 4/A-E and Table 8) is deep and well distinct along the whole length of the rhomboid fossa in sheep and only along its rostral half in donkey. In pig the pontine part of the ventral median fissure is deep, narrow and curved while the medullary part is shallow and wide (Fig. 4/C`). In dog and cat the ventral median fissure is faint and invisible.

The sulcus limitanse is represented by a ridge like elevation, which is well prominent in donkey, sheep and dog while in pig and cat it is invisible.

The vestibular eminence is well prominent in cat, dog, donkey, sheep and pig, while the facial one is more prominent in donkey, sheep, dog and pig.

The caudal closed part (Figs. 4A-E)**:** of the dorsal surface of the medulla oblongata is subdivided into two symmetrical haves by the dorsal median septum which continuous caudally with that part of the spinal cord. It is deep in dog, cat and sheep while wide and narrow in donkey and faint in pig. Lateral to it, is the dorsal funiculi, which is limited by the dorsolateral sulcus. It is well distinct in donkey and dog, faint in cat and pig and ill-distinct in sheep. The fasciculus gracilis is longer in dog, cat, pig and donkey. In cat it is well prominent and bulges into the cavity of the 4th ventricle. The cuneate fasciculus is well prominent in dog, cat, pig and donkey (Figs. 4/A-E). Ventrolateral to the cuneate tubercle presents the spinal tract of the trigeminal nerve which is well developed in donkey, cat, dog than in sheep and pig.

In two recorded cases of dogs the rhomboid fossa was wide quadrilateral in shape with its widest part rostrally. It was shallow and appeared to be divided into two parts, rostral and caudal by the rostral cerebellar peduncle. The caudal part was deeper than the rostral one. The cuneate tubercles bounded the lateral and caudal sidets of the caudal part and appeared in a form of two ridges. The rostral part was bounded rostrally by the brachium of the caudal colliculi and the rostral medullary vella, while laterally by the cerebellar peduncles (Fig. 4′)

DISCUSSION

Marsden and Rowland (1965) mentioned that the pons is a structure concerned with the motor function and the control of the motor activity. It is more prominent in animals with large body built the same was observed in the present investigation.

In dog the ventral aspect of the pons appeared long and broad with a prominent basilar tubercle, the same was mentioned by the last mentioned author who added that the ventral prominence of the pons was one of the most important surface elevations of the brainstem which formed on dependence of the close functional integration between the cerebellum and cerebrum through the pons. In pig our result was in agreement with that mentioned by Dellmann and McClure (1975) as well as Marsden and Rowland (1965) in that the ventral aspect of the pons was flattened and less prominent. In donkey the pons is well prominent ventrally this was similar to that described in horse by Dellmann and McClure (1975); in camel by Mansour (1983) and El-khaligi (1977); in water buffalo by El-Nahla (1982), in ox by Raghavan and Kachroo (1964), in bovine by McLeod (1958).

In cat and sheep the well developed basilar sulcus divided the ventral surface of the pons into two prominent parts, this was in agreement with that described by Marsden and Rowland (1965) in cat, Dellmann and McClure (1975) in small ruminant and Amin (1984) in goat. The basilar sulcus was very shallow in pig and invisible in dog, this similar to that described by Marsden and Rowland (1965) as well as Dellmann and McClure (1975) in the same animal. The basilar sulcus was unclear in donkey, similar to that in horse (Bradley and Graham, 1948), El-khaligi (1977) and Mansour (1983) in camel, El-Nahla (1982) in water buffalo. In dog the rostral border of the pons was more convex overlapping the cerebral crura, while the caudal border was straight. It was similar to that described by Marsden and Rowland (1965) as well as by Dellmann and McClure (1975) in the same animal. The present study added that; both the rostral and caudal borders of dog contained shallow dentation the rostral one was shallower; however the latter authors described central dentation for the caudal border only. While in cat both the rostral and the caudal borders contain central dentation, the rostral one was deeper. In pig the rostral border was thick with shallow central dentation. Dellmann and McClure (1975) recorded the same data but without dentation. The present study recorded that there was a small projection opposite to the central dentation of the rostral border of pig.

Our result in sheep indicated that the rostral border was slightly convex with central dentation and the caudal one was straight. This is in consistance with that described by Amin (1984) in goat, Dellmann and McClure (1975) in large ruminant as well as Raghavan and Kachroo (1964) in ox. Amin (1984) in goat mentioned that the caudal border was concave.

The present study described that the trigeminal nerve originates from the caudal border of the pons in sheep, pig and from the caudolateral side in donkey, dog and cat. Godinho and Getty (1975) mentioned that the roots of the trigeminal nerve originated from the lateral aspect of the pons in horse, pig and goat; from the lateral aspect of the brainstem between the pons and the trapezoid body in dog; however in the cat, it originates from the lateroventral aspect of the pons; similar to that was mentioned in goat by Amin (1984). Godinho and Getty (1975) mentioned that the roots of the trigeminal nerve originated from the dorsolateral side of the pons in bovine .On the other hand El-Nahla (1982) in water buffalo as well as Mansour (1983) in camel observed that the superficial origin of the trigeminal nerve from the caudal border of the ventral surface of the pons. Godinho and Getty (1975) described that the trigeminal nerve appears on the caudal aspect of the upper portion of the middle cerebellar peduncle in Ovine.

The shape of the medulla oblongata in examined animals was quadrilateral wider rostrally than caudally, similar to that described in goat by Amin (1984), in camel by El-khaligi (1977) and Mansour (1983), in water buffalo by El-Nahla (1982). McLeod (1958) in bovine recorded that the medulla oblongata was conical in outline while Raghavan and Kachroo (1964) asserted that in ox it was pyramidal. In dog the rostral wide part was three times the caudal narrow one; in sheep two and half times, in donkey two time, more than one and half in pig and cat. Dellmann and McClure(1975)mentioned that the medulla oblongata of pig was relatively wider than that of other domestic animals. The present investigation revealed the same description but in dog.

The ventral median fissure was deep and well developed in dog, pig, sheep and cat along its whole length, similar to that observed by Amin (1984) in goat, El-Nahla (1982) in water buffalo. In donkey, similar to that mentioned in horse by Dellmann and McClure (1975), El-khaligi (1977) in camel that the rostral part of the ventral median fissure was faint and occupied by the corpus trapezoideum.

The medullary pyramids was broad faint and not prominent in sheep and pig. Similar to that was recorded by Dellmann and McClure (1975) in the same animal as well as Amin (1984) in goat. Ganguli and Singh (1977) in Indian sheep recorded that the medullary pyramids were well marked. In donkey the medullary pyramids were narrow and well distinct on the rostral two thirds, then became less prominent and disappear with the substance of the medulla oblongata. Similar to that described in water buffalo by El-Nahla (1982), in camel by El-khaligi (1977) and Mansour (1983). On contrary to that by Dellmann and McClure (1975) who mentioned that the pyramids were well distinct in horse. In dog and cat the medullary pyramids appeared thick and well prominent; similar to that mentioned by Dellmann and McClure (1975) in dog.

The pyramidal decussation in dog and cat were not distinct, a similar result was recorded by Evan's and Delahunta (1996) who mentioned that the decussation itself was difficult to be seen for it occurs as the pyramidal fibers were passing dorsally into the parenchyma of the medulla. In sheep and pig the decussated fibers appear at the caudal end of the medulla oblongata. Although, Ganguli and Singh (1977) in Indian sheep mentioned that the pyramidal decussation were well distinct. Amin (1984) in goat; Dellmann and McClure (1975) in small ruminant mentioned that the decussation was not distinct. In donkey the decussation appeared at the distal third of the pyramids where the pyramids decreased in size and continued to disappear in the substance of the medulla. Similar to that was mentioned by El-Nahla (1982) in water buffalo. However El-Khaligi (1977) and Mansour (1983) in camel reported that the decussation was distinct. Verhaart (1967) in his report concluded that the pyramidal decussation has to be accepted as a structural feature, variable but specific for each species. Staal (1961) and Staal and Verhaart (1963) concluded that the pyramidal decussation has to be considered as a major structural feature of the mammalian brainstem. Luhan (1959) reported after death of his patient that; if the pyramidal decussation happens through out the length of the cord and not at the special level as usual or the absence of the usual crossing, therefore should be regarded as a very remarkable structural abnormality.

Concerning to the trapezoid body; the result of the present study in dog was in agreement with that mentioned by Dellmann and McClure (1975), Evan's and Delahunta (1996) that the trapezoid body was more prominent and of large size than any other domestic animals. They added that, this indicated a more developed auditory system with which it is associated. Marsden and Rowland (1965) mentioned that in cat which possessed a well developed cochlear nucleus, the trapezoid body represented the most advanced stage in its phylogeny at the subprimate level. In donkey the trapezoid body continued at the midline rostral to the pyramids, this was in accordance with that recorded by Dellmann and McClure (1975) in horse, Sisson and Grossman (1969) in ox and El-Nahla (1982) in water buffalo. In pig the result of the present study was in agreement with that mentioned by Dellmann and McClure (1975)that the trapezoid body was broader and faint . Our result in sheep was in the same line with that of Ganguli and Singh (1977) and Dellmann and McClure (1975) in small ruminant that the trapezoid body was clearly demarcated.

In the present study the facial tubercle of pig was well distinct rounded area located partially on the medial part of the corpus trapezoideum and partially on the medulla oblongata lateral to the pyramids. On the other hand, Dellmann and McClure (1975) in the same animal mentioned that, the facial tubercle form a very slight elevation caudal to the corpus trapezoideum. In donkey and sheep the facial tubercle was faint circular area, however Dellmann and McClure (1975) in horse and small ruminant mentioned that it was slightly prominent, they added that in some specimens of horse it was clear caudal to the trapezoid body and lateral to the pyramids. The present study was in accordance with that described by Marsden and Rowland (1965) that the facial tubercle could not be demarcated in cat.

The ventrolateral sulcus in dog and cat was in agreement with that mentioned by Dellmann and McClure (1975) in the same animals, where the sulcus was very deep. Dellmann and McClure (1975) mentioned that the ventrolateral sulcus was indistinct in horse, while in donkey it was observed at the rostral fourth.

The 4^{th} ventricle in pig resemble in outline that of ox and bovine. It is diamond in contour (McLeod, 1958 as well as Raghavan and Kachroo, 1964). However Fitzgerald (1961) in domestic animals described it circular. The rhomboid fossa in sheep and donkey was quadrilateral in outline. Amin (1984) in goat described it triangular. Fitzgerald (1961) described the 4^{th} ventricle of horse and sheep as having an elongated teaspoon. El-khaligi (1977) in camel mentioned that the outline of the rhomboid fossa was pear shaped, Mansour (1983) in the same animal observed it rhomboid in shape similar to that of water buffalo as described by El-Nahla(1982). Dellmann and McClure (1975) mentioned that the rhomboid fossa of ruminant was quadrilateral in shape similar to that of sheep, horse and dog Fitzgerald (1961) in his cast observed it very long with a width half its length. Dellmann and McClure (1975) observed it as a quadrangular structure terminate rostrally and caudally in a point.

The sulcus limitanse in dog was invisible. However, Dellmann and McClure (1975) in the same animal mentioned that it was visible. Amin (1984)in goat, El-Nahla (1982) in water buffalo mentioned that the sulcus limitanse represented by two faint grooves. In donkey the sulcus limitanse was well visible, however El-Khaligi (1977) concluded that it was well marked in camel than in horse.

Concerning the vestibular eminence, it was well developed in dog which was similar to that mentioned by Dellmann and McClure (1975) in the same animal. The present study recorded that the vestibular eminence was well developed in cat, dog, donkey followed by sheep and pig. The same was given by Dellmann and McClure (1975) who added that it was developed much better in ox than in horse.

The dorsolateral sulcus was indistinct in pig, donkey and sheep; similar to that mentioned by Dellmann and McClure (1975) in horse as well as El-Nahla (1982) in water buffalo. Mansour (1983) in camel recorded that, it was well distinct. In pig it was faint however Dellmann and McClure (1975)described it a prominent groove.

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LEGENDS

Fig. 1: Diagram showing the methods of measurements of the:Brain, A -Brainstem, B -Pons and Medulla oblongata,C -Pons, D- Medulla oblongata, E.

Fig. 1`:A photograph showing the orientation of the brainstem of pig. (scale 1cm).

Fig. 2: Photographs of the ventral aspect of the brain showing:- the shape of the brain, the ventral surface of the pons and medulla in: donkey, A; sheep, B; pig, C; dog, D and cat, E (Scale 1cm).

Fig. 3: The same photographs of Fig(2) with high magnification (scale 1cm)showing:⁂Basilar projection ●-Corpus trapezoideum Δ-Dentation of the pons borders ■-Pyramidal decussation ➤-Basilar sulcus 1-Rostral border 2-Caudal border 3-Ventral median fissure 4-Medullary pyramids 5-Facial tubercle 6-Olivary eminence 7-Ventrolateral sulcus 8-Rootlets of the V nerve.

Fig. 3′: Diagram showing the shape of the pons in donkey, A; sheep, B; pig, C; dog, D and cat, E showing: ➤Rostral border ● Caudal border ⁂Trigeminal nerve.

Fig. 4: Photographs of the dorsal aspect of the medulla oblongata in: donkey, A; sheep, B; pig, C, dog, D; cat, E and caudo-dorsal in pig, C̀; (scale 1cm) showing:-
⁂-Rhomboid fossa ➤-Ventral median fissure Δ -Sulcus limitanse ●-Obex ⤚-Vestibular tubercle ■-Ventral part of 4th ventricle □-Dorsal part of 4th ventricle *- Nuclei of facial eminence °- Rostral velum 1-Dorsal median septum 2-Nucleus Gracilis 3-Nucleus Cuneatus 4-Nuclei of trigeminal nerve 5-Intermediate nucleus 6-Dorsolateral sulcus 7-Rostral cerebellar peduncle 8- Middle cerebellar peduncle 9-Caudal cerebellar peduncle.

Fig. 4′: A photograph of the dorsal aspect of the medulla oblongata in recorded two cases of dogs showing: the shape of the rhomboid fossa (scale 1cm).

Table 1: Showing the relative and absolute length (L) and weight (W) of the brainstem to that of the brain in examined animals.

Animal	Brain				Brainstem				Brainstem/Brain			
	(L)		(W)		(L)		(W)		(L)		(W)	
	Cm	SD	Gr	SD	Cm	SD	Gr	SD	%	SD	%	SD
Donkey	12.5	±1.7	350.2	±13.7	7.8	±0.70	37.3	±3.60	62.4	±5.3	10.7	±1.2
Sheep	10.5	±1.1	110.1	±09.5	6.0	±0.30	15.6	±1.20	60.0	±5.1	14.2	±0.9
Pig	08.0	±0.2	079.1	±08.2	3.7	±0.10	16.8	±1.80	46.3	±3.1	21.2	±1.7
Dog	09.7	±0.9	070.2	±06.2	6.3	±0.50	09.0	±0.10	65.0	±6.2	12.8	±1.4
Cat	05.3	±0.7	018.7	±05.0	3.2	±0.09	02.3	±0.23	60.4	±3.7	12.3	±1.5

Table 2: Showing the relative and absolute values of the length and weight (cm) of the Medulla and pons/total length and weight of the brain, brainstem in examined animals.

Animal	Medulla +Pons				Medulla + Pons/Brain				Medulla Pons/Brainstem			
	(L)		(W)		(L)		(W)		(L)		(W)	
	Cm	SD	Gr	SD	%	SD	%	SD	%	SD	%	SD
Donkey	4.2	±0.45	19.7	±1.40	33.6	±2.9	5.6	±0.5	53.9	±5.15	52.8	±3.70
Sheep	3.2	±0.15	06.8	±0.70	30.5	±1.8	6.2	±0.3	53.3	±4.70	43.6	±3.60
Pig	2.9	±0.23	03.0	±0.40	36.3	±2.6	3.8	±0.6	78.4	±6.22	17.9	±1.28
Dog	3.4	±0.18	02.8	±0.10	35.1	±2.7	4.0	±0.1	54.0	±5.15	31.1	±2.50
Cat	2.4	±0.15	0.60	±0.04	45.3	±2.6	3.2	±0.1	75.0	±6.08	26.1	±2.12

Table3: Showing the relative and absolute length, width of the pons, pons/brain and pons/brainstem in examined animals.

Animal	Length		Pons/Brain		Pons/Brainstem		Wiidth	
	Cm	SD	%	SD	%	SD	Cm	SD
Donkey	1.50	±0.15	12.0	±1.0	19.2	± 1.6	2.8	±0.23
Sheep	1.00	±0.09	09.5	±0.7	16.7	±1.29	2.2	±0.12
Pig	0.95	±0.18	11.9	±1.0	25.7	±1.80	2.8	±0.23
Dog	1.20	±0.08	12.4	±0.9	19.1	±1.60	2.0	±0.19
Cat	0.90	±0.13	17.0	±1.3	28.1	±1.95	1.2	±0.90

Table 4: Showing the relative and absolute length of the medulla; medulla/brain, brainstem in examined animals.

Animal	Length		Medulla /Brain		Medulla /Brainstem	
	Cm	SD	%	SD	%	SD
Donkey	2.7	±0.21	21.6	±1.60	34.6	±2.01
Sheep	2.2	±0.17	21.0	±1.53	36.7	±1.09
Pig	1.9	±0.13	23.8	±2.01	51.4	±3.70
Dog	2.2	±0.19	22.7	±1.59	34.9	±2.60
Cat	1.5	±0.13	28.3	±2.30	46.9	±3.20

Table 5: Showing the mean relative width of the medulla oblongata at different levels along its length in examined animals.

Animal	Width of the medulla oblongata at the					
	Rostral end		Caudal end		Rostral/Caudal ratio	
	Cm	SD	%	SD	%	SD
Donkey	3.7	± 0.31	1.8	± 0.12	2.1	±0.19
Sheep	3.2	± 0.28	1.4	±0.08	2.3	±0.12
Pig	2.4	± 0.13	1.4	±0.06	1.7	±0.15
Dog	2.9	± 0.10	1.0	±0.01	2.9	±0.23
Cat	1.4	± 0.07	0.9	±0.07	1.6	±0.09

Table 6: Showing the mean thickness of the medulla oblongata at different levels along its length in examined animals.

Animal	Thickness of the medulla oblongata in(Cm) at the					
	C.trapezoideum		Obex		Decussation	
Donkey	1.7	± 0.10	1.3	±0.03	0.8	±0.03
Sheep	1.1	± 0.09	1.0	±0.09	0.8	±0.09
Pig	0.9	± 0.03	1.2	±0.04	0.4	±0.06
Dog	1.1	± 1.00	0.5	±0.01	0.7	±0.09
Cat	0.8	± 0.07	0.5	±0.03	0.4	±0.02

Table 7: Showing the relative values of the different structures on the ventral aspect of the medulla oblongata in examined animals in (Cm).

Animal	Width of Pyramids		Corpus trapezoid.		Facial tubercle		Olivary eminnence	
	Rostral	Caudal	Length	Width	Width	Length	Length	Width
Donkey	0.3±0.09	0.2±0.02	0.5±0.09	2.4±0.18	0.40±0.07	0.40±0.31	0.6±0.02	0.8±0.02
Sheep	0.3±0.15	0.4±0.01	0.5±0.31	3.0±0.13	0.20±0.06	0.20±0.01	0.7±0.02	0.7±0.01
Pig	0.5±0.17	0.3±0.02	0.8±1.00	2.0±0.14	0.70±0.34	0.70±0.13	0.8±0.01	0.8±0.15
Dog	0.5±0.08	0.3±0.05	0.4±0.08	2.4±0.16	0.20±0.41	0.20±0.01	0.5±0.03	0.7±0.20
Cat	0.5±0.09	0.3±0.06	0.5±0.04	1.8±0.19	0.15±0.01	0.15±0.07	0.4±0.04	0.3±0.01

Table 8: Showing the relative values of the different structures on the dorsal aspect of the medulla oblongata in examined animals in (Cm)

Animals	Length.of Rh. fossa	Width at cerebral crura	Length of sulcus limitanse	Distance between Sulcus / ventral median fissure
Donkey	3.3 ±0.15	1.5 ±0.15	1.6 ±0.16	0.4 ±0.12
Sheep	2.5 ±0.12	1.1 ±0.09	2.5 ±0.23	0.3 ±0.09
Pig	1.5 ±0.15 (0.9)±0.13 + (0.6)±0.11	1.1 ±0.12	1.3 ±0.12	0.2 ±0.11
Dog	1.5 ±0.09	0.7 ±0.11	-------------	----------------
Cat	1.5 ±0.07	0.9 ±0.09	-------------	----------------

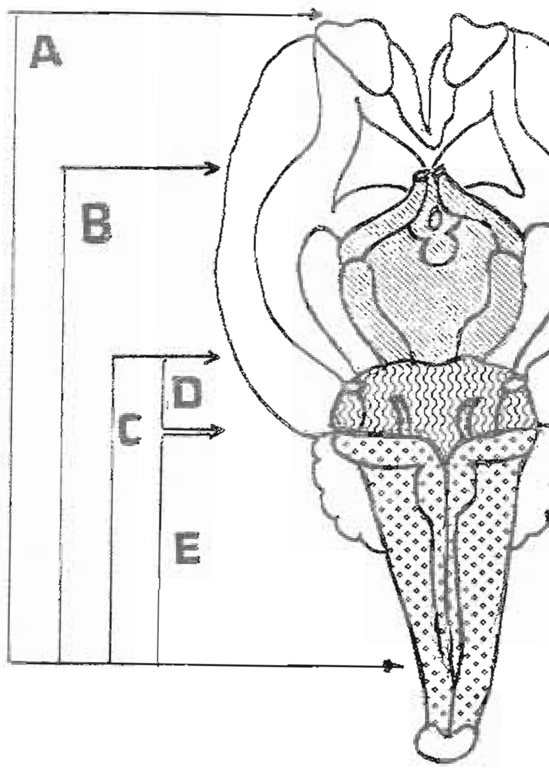
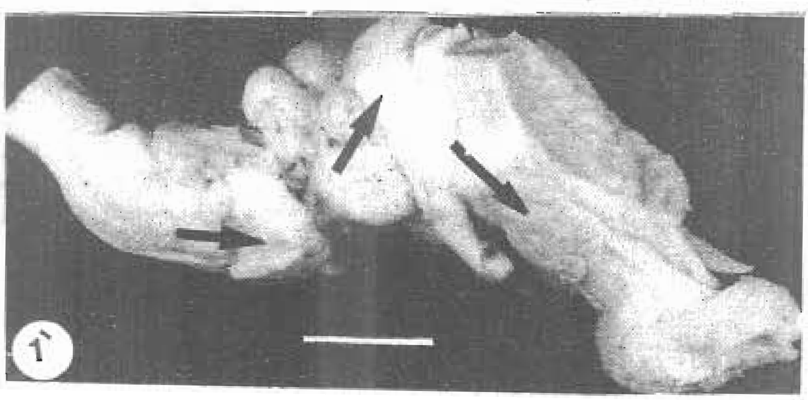
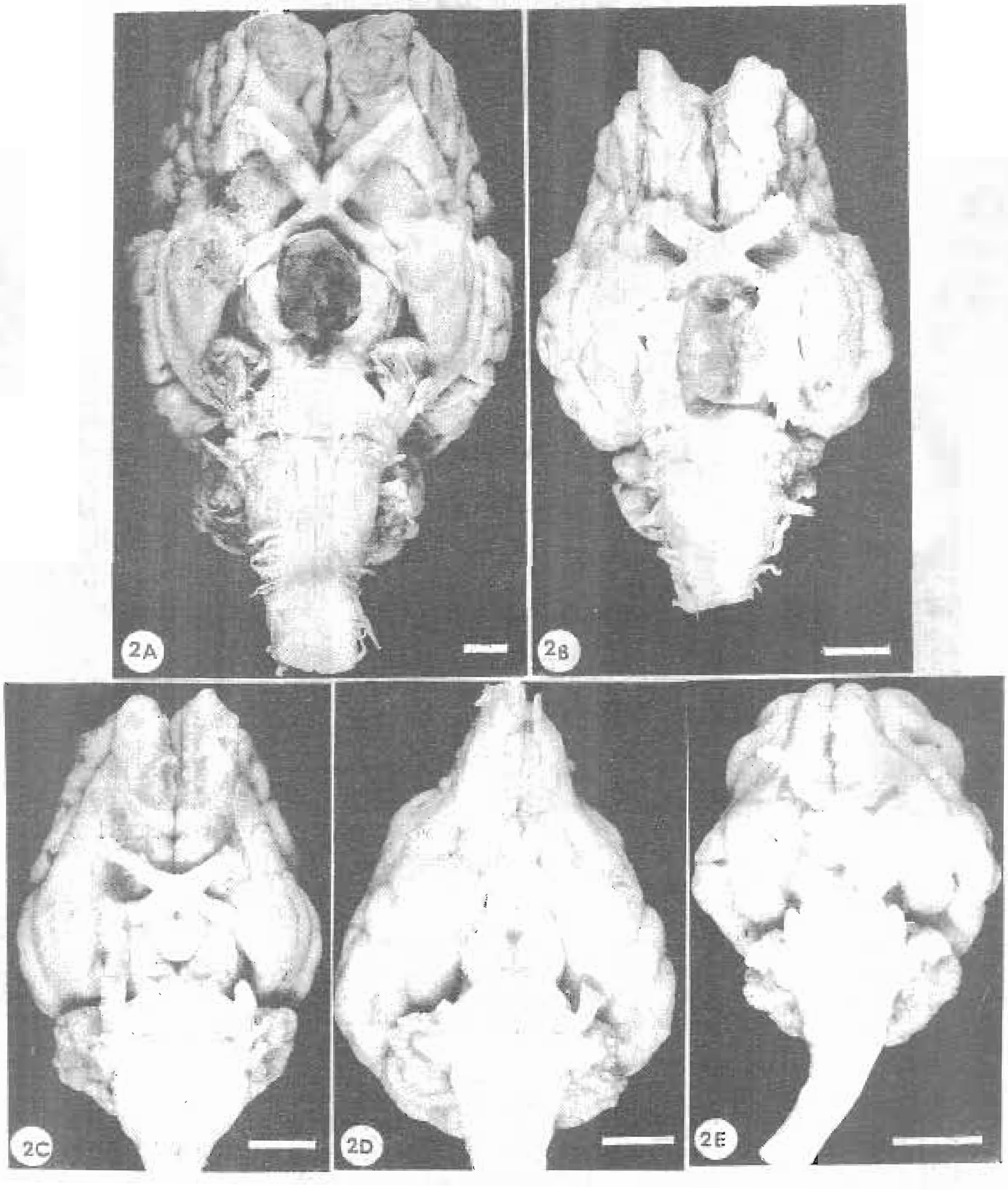


Fig (1)

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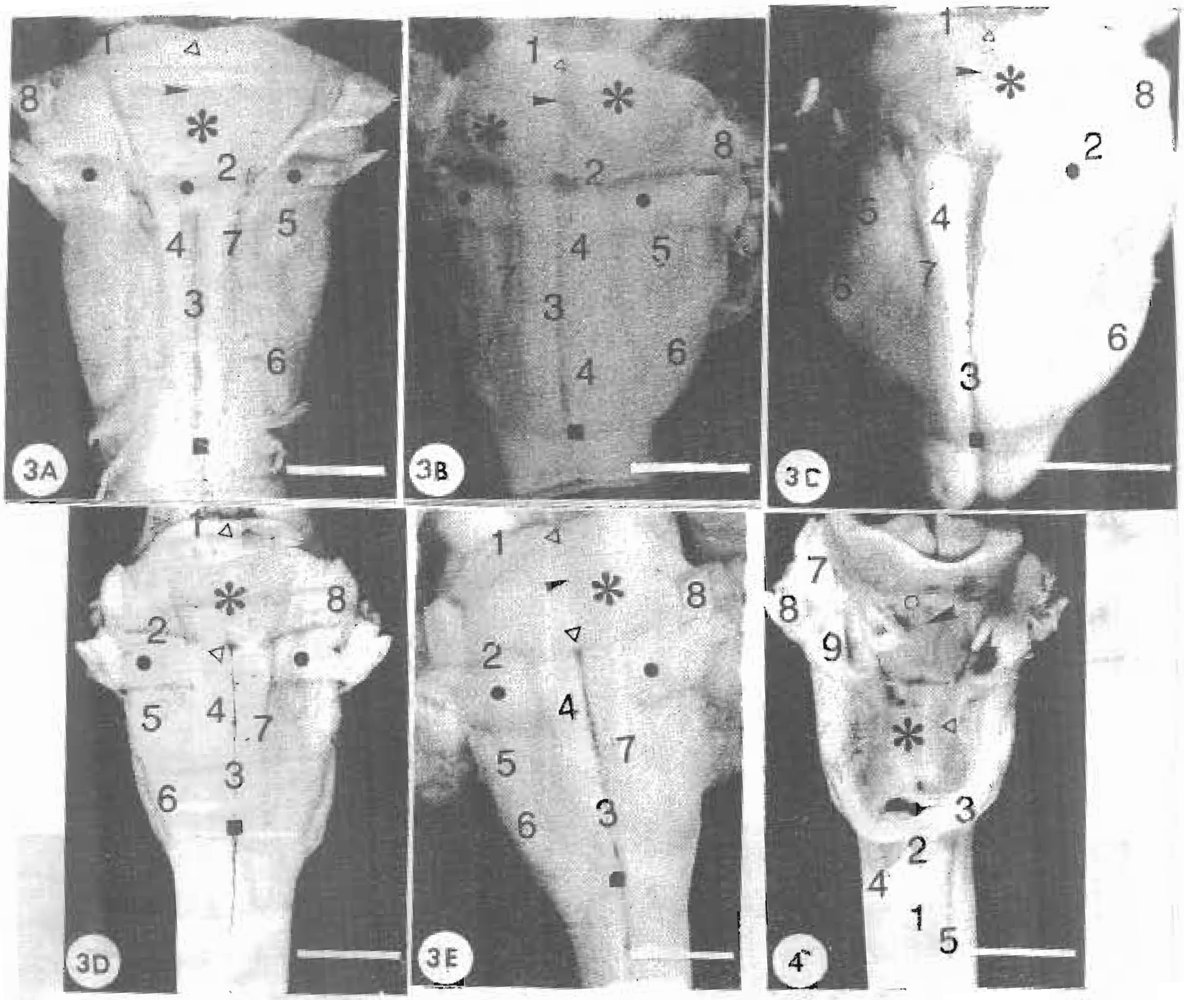


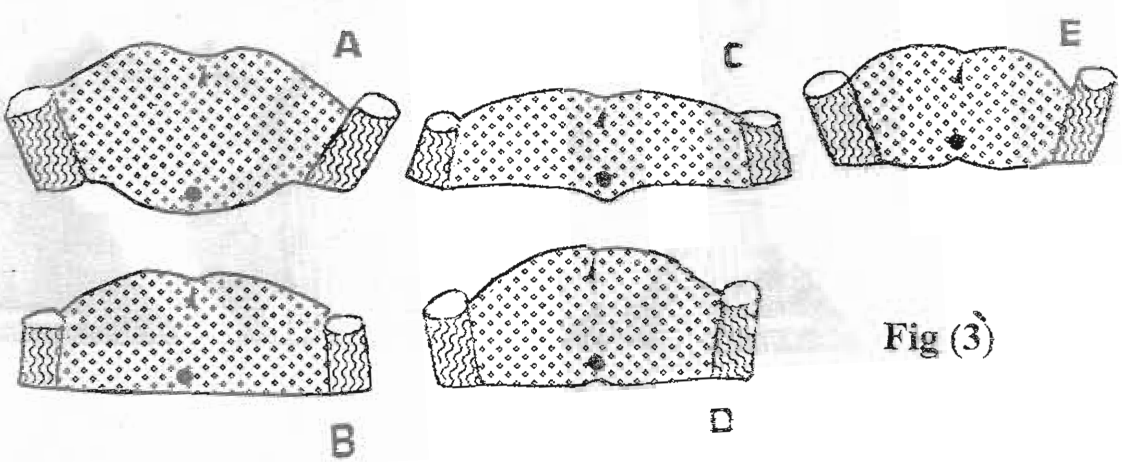
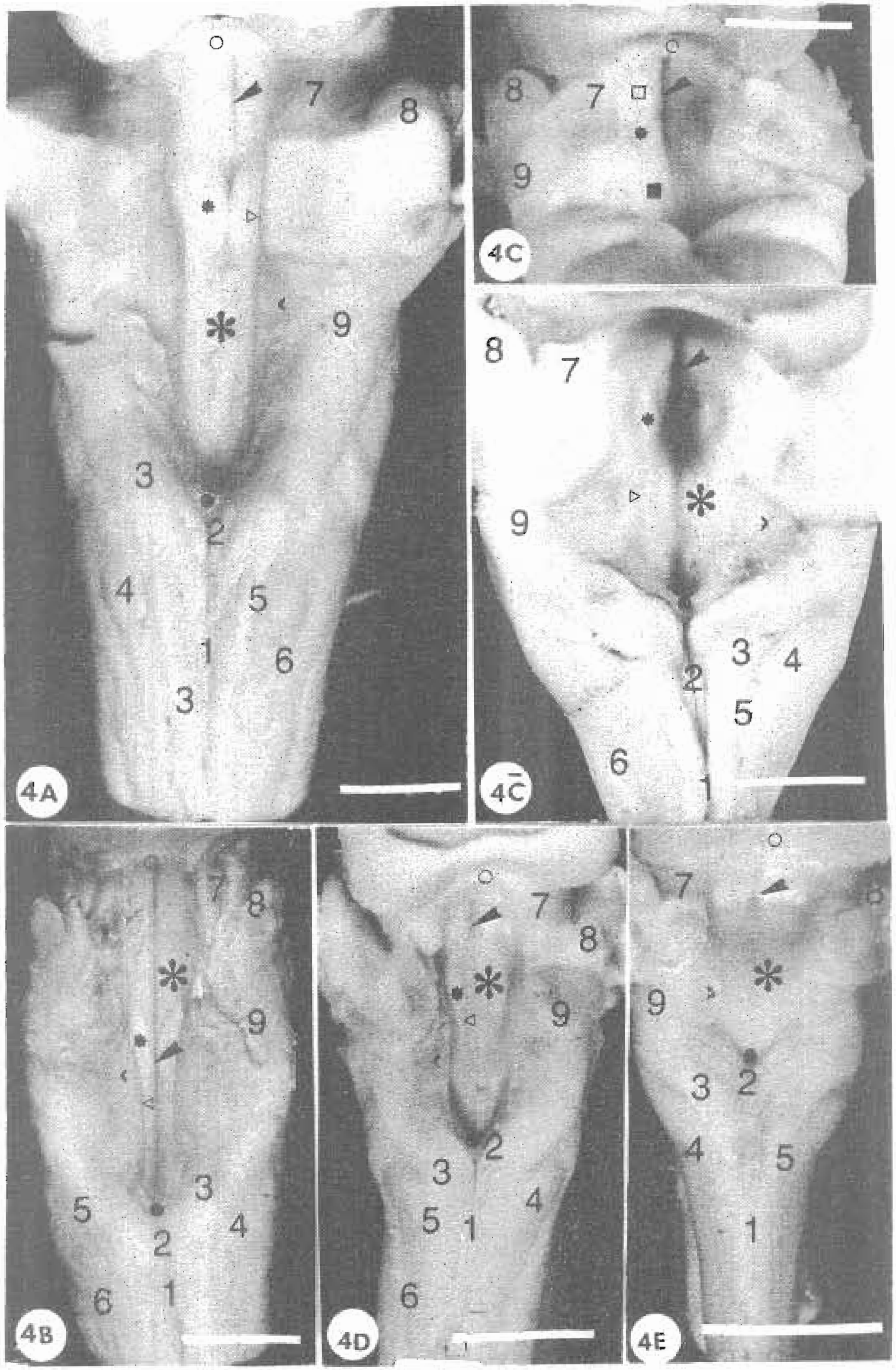


Fig (3̀)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