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Gross Observations and Morphometry of the Medulla Oblongata of the African Grasscutter (*Thryonomys swinderianus*)

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Abstract: The study was carried out to elucidate on the macroscopic structure of the medulla oblongata of the grasscutter. A total of ten matured, apparently, healthy African grasscutters were used to investigate the morphologic and morphometric features of the medulla oblongata. The mean body weight and brain weight were 2600±194.95 g and 12.15±0.48 g, respectively. The ratio of the brain to body weight was approximately 1:214. The mean weight of the medulla oblongata was found to be 1.104±0.10 g and this accounted for about 9% of the total brain weight. The mean lengths of the whole brain and medulla oblongata were 4.945±0.091 and 1.376±0.082 cm, respectively. The gross anatomical features of the medulla oblongata were typical of that observed in terrestrial mammals however slight structural differences were observed.

Key words: Grasscutter, medulla oblongata, morphology, morphometry, terrestrial mammals, Nigeria

INTRODUCTION

Studies of the morphology of the various parts of the mammalian brain of captive animals have been carried out including the morphometric studies of the cerebellum and forebrain of the African giant rat (Nzalak *et al*., 2005); morphometric observations of the brain of the African grasscutter (Umosen *et al*., 2008); morphometric assessment of the brain stem and cerebellar vermis with midsaggital magnetic resonance imaging; the effects of age and sex (Mursheed *et al*., 2003). Some investigations have also been carried out on the domestic ruminants, including the morphometric investigation of the brain of West African dwarf sheep in Nigeria (Olopade *et al*., 2005); preliminary morphometric investigation of the brain of red Sokoto (Maradi) goat (Olopade and Onwuka, 2002); shapes and sizes of different mammalian cerebellum (Sultan and Braitenberg, 1993). These studies emphasized the morphology of the whole brain and were focused on the weights and lengths of the cerebral cortex, olfactory bulbs and cerebellum. There is still paucity of information on the neuroanatomy of the grasscutter, especially in the area of the medulla oblongata.

The African grasscutter is a highly rated delicacy in Central and West Africa (Baptist and Mensah, 1986) and the animals have been hunted for several decades (Happold, 1987) to the extent that they may become endangered in the near future. For this reason, attempts are being made at domesticating the grasscutter (NRC, 1991; Anonymous, 1993). A good knowledge of the biology of the grasscutter is necessary for the successful domestication of the animals. This is necessary in order to understand the physiology of the various body systems.

The medulla oblongata is an important part of the brain which contains the nuclei of the glossopharyngeal, vagus, hypoglossal and accessory cranial nerves (Dyce *et al*., 2002; Inderbir, 2003) involved in the control of vital body functions (Fig. 1).

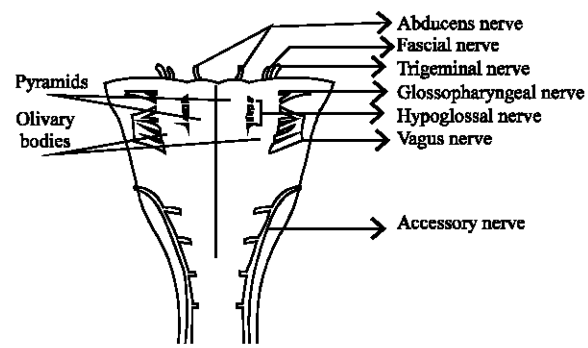

Fig. 1: A schematic diagram of the medulla oblongata of the grasscutter (*Thryonomys swinderianus*) showing the cranial nerve rootlets

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The present study was carried out in order to determine the macroscopic anatomy of the medulla oblongata, an integral part of the brainstem and to generate base-line data on the medulla oblongata in the grasscutter.

MATERIALS AND METHODS

Ten adult grasscutters were used for the study. The animals were captured directly from the wild in Otukpo (6°49 North, 8°40 East) Benue state, Nigeria. They were transported by road in a motor car to the animal house in the Department of Veterinary Anatomy, Ahmadu Bello University, Zaria using standard laboratory grasscutter cages. The animals were acclimatized for 3 weeks before commencement of the experiment during which they were given access to fresh elephant grass (*Pennisetum purpureum*) and water *ad libitum*. In this period they were also physically examined and observed to certify a healthy status before the commencement of the study.

The grasscutters were sedated with gaseous chloroform in a confined container and weighed using a weighing balance (P1210 Mettler Instruments AG, Switzerland) with a sensitivity of 0.1 g. The body weight of each rat was recorded in grams. Thereafter, the animal was sacrificed. The brain of each rat was removed according to the method of Harper and Maser (1975). Morphologic and morphometric studies were conducted after the brains were fixed in Bouin's solution. The weights (g) of the whole brain were taken using a mettle balance (P1210, Mettler Instruments AG, Switzerland) with a sensitivity of 0.01 g.

Linear measurements of the whole brain were taken with the aid of Vernier Caliper (MG6001DC, General Tools and Instrument Company, New York; Sensitivity 0.01 mm) and a metric rule. Values obtained were recorded in centimetres. Photographs were taken with a digital camera (SONY® Cybershot, DSC-W110, 7.2 MP, x4 optical zoom, Japan). All recorded weights and lengths of the brains were expressed as mean±standard error of the mean (±SEM). Values were subjected to Student's t-test and Pearson's correlation analysis. Values of $p<0.05$ were considered significant.

RESULTS AND DISCUSSION

The weights and dimensions of the fixed brains as well as lengths of the medulla oblongata of the African grasscutter are shown in Table 1 and 2.

Table 1: Weights of the body, fixed brain and medulla oblongata of the African grasscutter (Mean±SEM, n = 10)

Animal number	Body weight (g)	Brain weight (g)	Weight of medulla oblongata (g)
1	1750	10.24	0.51
2	2250	13.75	1.25
3	2600	9.39	0.76
4	1500	11.18	0.90
5	2900	13.12	1.18
6	2800	11.66	1.02
7	2950	13.61	1.37
8	2600	12.18	1.15
9	3150	12.84	1.55
10	3500	13.50	1.35
Mean±SEM	2600±194.95	12.15±0.48	1.104±0.10
Brain weight (%)	-	100	9.09

Brain weight to body weight ratio = 1: 214; Mean brain weight = 0.47% of mean body weight

Table 2: Length of the whole brain and medulla oblongata of the African grasscutter (Mean±SEM)

Animal number	Brain length (cm)	Lenght of medulla oblongata (cm)
1	4.35	1.07
2	5.28	1.97
3	4.80	1.37
4	4.90	1.13
5	5.12	1.26
6	4.76	1.33
7	5.29	1.31
8	5.00	1.35
9	4.70	1.33
10	5.26	1.64
Mean±SEM	4.946±0.096	1.376±0.082
Brain length (%)	100	27.82

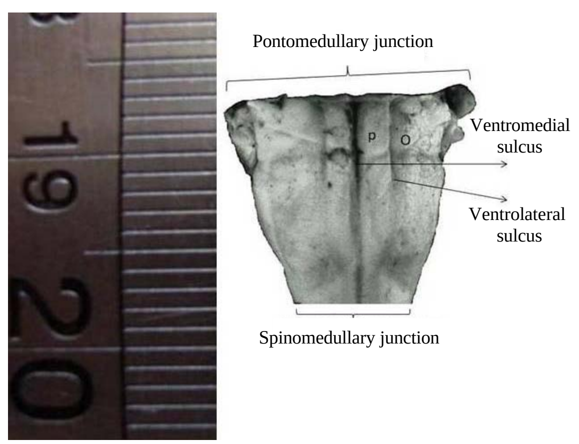

Fig. 2: Ventral view of the medulla oblongata of the grasscutter (*Thryonomys swinderianus*). Note the Pyramid (P) and the Olivary body (O)

Macroscopic features: The medulla oblongata of the African grasscutter was conical in shape (Fig. 2). It was located caudal to the pons. Its dorsal surface formed the lower boundary of the fourth ventricle lodged in a groove on the ventral surface of the cerebellum. Caudally, the medulla oblongata continued as the spinal cord with the

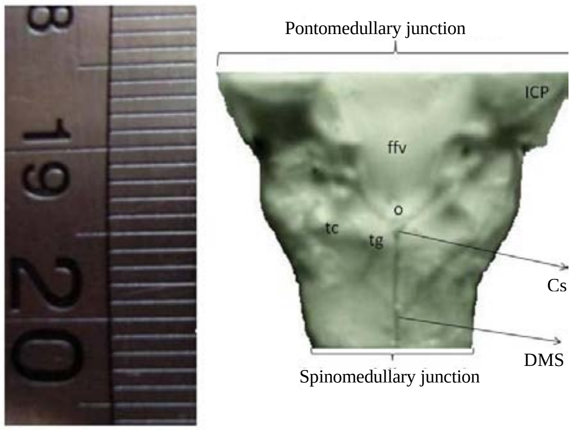

Fig. 3: Dorsal view of the medulla oblongata showing the floor of the fourth ventricle (ffv), gracile tubercle (tg), cuneate tubercle (tc), Dorsal Median Sulcus (DMS), Obex (O), Camalus scriptorius (Cs) and the Inferior Cerebellar Peduncle (ICP)

foramen magnum as the boundary. The ventral surface of the medulla oblongata had a ventral median fissure (Fig. 2) which was a continuation of the ventral median fissure of the spinal cord. It terminated just before the pons. On either side of the ventral median fissure were two elongated prominences, the pyramids (Fig. 2) which were broader rostrally and narrowed out caudally. On the lateral side of the medulla between the pyramids and the inferior cerebellar peduncles were two elongated prominences, olivary bodies. The olivary bodies were not very prominent however their outlines could be traced (Fig. 2). Between the pyramid and the olivary body was a ventrolateral sulcus. On the medial side of the olivary body laid the root of the hypoglossal nerve and on the lateral side but separated from it by a groove, laid the roots of the accessory, vagus and glossopharyngeal nerves. The part of the medulla oblongata between this groove and the ventral median fissure corresponded with the lateral column of the spinal cord.

The dorsal surface of the medulla oblongata formed the floor of the fourth ventricle (Fig. 3), lodged in a groove on the ventral surface of the cerebellum, the vellecular cerebella. The dorsal median sulcus of the spinal cord continued into the medulla oblongata. Also, the dorsomedial column of the cord (fasciculus gracilis) continued into the medulla oblongata. It expanded as it approached the fourth ventricle forming the gracile tubercle (Fig. 3). On reaching the fourth ventricle, the tubercles of opposite sides separate to some extent. The dorsolateral column of the cord (fasciculus cuneatus) also expanded as it extended upwards forming an eminence, the cuneate tubercle (Fig. 2). On the lateral side of the medulla oblongata were the inferior cerebellar peduncles.

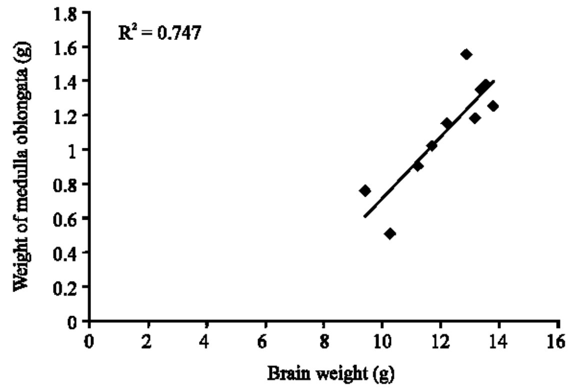

Fig. 4: Graph showing the positive linear relationship between the weight of the medulla oblongata and the whole brain weight

Morphometric observations: The mean body weight of the rats was 2600±194.95 g while the mean weights of the brain and medulla oblongata were 12.15±0.48 g and 1.104±0.10 g, respectively as shown in Table 1. The mean lengths of the brain and medulla oblongata were 4.946±0.096 and 1.376±0.082 cm, respectively (Table 2). The length of the medulla oblongata accounted for about 28% of the total brain length. The various parameters measured in the study (Table 1 and 2) were correlated with the body weight of the grasscutter. There were significant correlation between the body weight and weight of the medulla oblongata ($r = 0.717$, $p<0.05$), brain weight and brain length ($r = 0.761$, $p< 0.05$) and the brain length and brain width ($r = 0.744$, $p<0.05$). There were highly significant relationships between the brain weight and weight of the medulla oblongata ($r = 0.865$, $p<0.01$). This relationship was further expressed in a graph (Fig. 4) and a regression formula deduced. Based on the data obtained, a regression formula was deduced as follows:

$$y = 0.1796x-1.0776$$

Where:

y = Weight of medulla oblongata

x = Weight of the whole brain

This means that with a given weight of the whole brain (x), the approximate weight of the medulla oblongata (y) can be calculated using the formula. The medulla oblongata of the grasscutter (*Thryonomys swinderianus*) can be roughly divided into rostral and caudal parts (open and closed parts) similar to what is obtainable in other mammals. In the caudal part, the fourth ventricle closes to become a narrow central canal which continues down into the spinal cord. The mean body weight (2600±194.95 g) observed in this study was similar to the value of 2,602.7 g, obtained in the study of Okorie and Ekechukwu (2004). The relative mean brain to body weight of the

African grasscutter (0.47%) was less than that of the African giant rat (0.52%) as reported by Nzalak *et al.* (2005). The brain weight to body weight ratio of the grasscutter (1: 214) was higher than that of the rabbits (1: 300) (Russel, 1979). However, it was less than that of the African giant rat (1: 193) (Nzalak *et al.*, 2005). Brain size may be a rudimentary indicator of the intelligence of a brain. However, according to Dunbar and Shultz higher ratios of brain to body mass may increase the amount of brain mass available for more complex cognitive tasks. Dunbar and Shultz also stated that brain size in vertebrates may relate to social rather than mechanical skill. The ratio of brain to body weight was higher than the ratios obtained in the squirrel monkey, marmoset, mouse, squirrel, fox, dog, cat and the African Giant rat (Russel, 1979; Nzalak *et al.*, 2005).

There was a highly significant relationship between the brain weight and the weight of the medulla oblongata ($r = 0.865$, $p<0.001$). This signifies that there is a positive linear relationship between the brain weight and the weight of the medulla oblongata. The finding of the present study has shown that the medulla oblongata was directly and strongly related to the weight of the entire brain. There was also a significant relationship between the length of the brain and the length of the medulla oblongata ($r = 0.638$, $p<0.05$). Sexual dimorphism was not observed in the study. This may have been due to the small sample size.

CONCLUSION

The information obtained from this study may serve as base-line data for the investigation of comparative neuroanatomy among the wild rodents. It may be of value in the neurophysiologic, toxicologic and pathologic studies of the grasscutter. Whole brain weight may also be approximated using the formula in pathological conditions where parts of the medulla oblongata have been damaged.

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