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Original Research Article

GROSS STUDIES OF THE PONS AND MEDULLA OBLONGATA OF THE AFRICAN STRIPED GROUND SQUIRREL (XERUS ERYTHROPUS)

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ABSTRACT

African striped ground squirrels (*Xerus erythropus*) are commonly consumed small mammals (bush meat) by rural dwellers as protein supplement. This study was aimed at providing information on the gross morphology of the brain of twenty (20) African striped ground squirrel-*Xerus erythropus* (10 males and 10 females), with an average bodyweight and body length of 481.60 ±21.55g and 43.84±0.53cm respectively. Each squirrel was euthanized using ketamine hydrochloride at 80mg/kg body weight, thereafter perfused with neutral buffered formal saline and then the brains were extracted by craniotomy. The dorsal view of the whole brain revealed that the two cerebral hemispheres were distinctly divided by longitudinal fissure and separated from the cerebellum by a transverse fissure. The pons was small and curved to form a triangular shape dorsally and widened out to form a convex shape ventrally. The medulla oblongata was conical (funnel shape) in shape. Dorsally, the medulla oblongata is divided into open and closed medulla. Other structures typical of the mammalian medulla oblongata's dorsal surface such as, cuneate fasciculus, dorsal intermediate sulcus, lateral furniculus and dorsal lateral sulcus were not visible. The trapezoid body (covered by olivary bodies), which was medially divided into equal halves by the ventral median fissure, was the most prominent feature ventrally. The present study shows that the cerebellum of the African Striped ground squirrel covered only the rostral part of the myelencephalon represented by the 4th ventricle. The results of this study can be used for comparative neuroanatomical studies and for the clinical diagnosis of brainstem disorders.

Keywords: African striped ground squirrel, Medulla Oblongata, Pons, Zaria

INTRODUCTION

Squirrels are mammals which belong to order *Rodentia*, species *Xerus erythropus* consisting of small or medium size rodents (Thorington & Hoffmann, 2005). They are indigenous to America, Africa and Eurasia (Whatton, 2012). Ground squirrel has an overall uniform appearance and their fur colour varies with ages and season. Striped ground squirrels are diurnal herbivores, active during the day and spend almost their entire lives on the ground, although they are capable of climbing into bushes to reach their food. In Nigeria (especially south Nigeria), squirrel is one of the most commonly consumed small mammal species (bush meat) by rural dwellers as supplementary protein diet (Ajayi, 1979, Adeola & Decker, 1987). Also, apart from consumption as food, they are also used by Nigerian farmers in cultural ceremonies, for medicinal purposes i.e. components of anti-poison drug and as ingredients in prevention of convulsion in children and also used to enhanced fertility in men as an aphrodisiac (Ajayi, 1979; Adeola, 1992).

Several studies have been done on the brain of other rodents which include morphologic studies of the forebrain and cerebellum of grasscutter (Byanet & Dzenda, 2014), gross anatomical organization of cerebellum of grasscutter (Byanet & Dzenda, 2012), anatomical study of the brain of the African Giant rat (Ibe *et al.,* 2014) and gross observation of medulla oblongata of African grasscutter (Ibe, *et al.,* 2017). However, there is paucity of information on the gross study of the pons and medulla oblongata of the squirrel in Nigeria which can assist in the breeding and domestication of this animal. This study aimed to evaluate and establish the gross features of the pons and medulla oblongata of the African striped ground squirrel. This will supplement the excessive use of other laboratory animals such as the rabbits, guinea pigs and Wister rats. Therefore, it is important to have a concise neuro-anatomical knowledge of this animal. Also, literatures revealed paucity of information on the gross features of the pons and medulla oblongata of this animal but other rodents such as the grasscutter (*Thryonomys swinderianus*) and African giant pouched rat (*Cricetomys gambianus*) have been extensively studied. Therefore, the information which will be obtained from this study will be the first to the best of my knowledge to be documented on the gross estimates of the pons and medulla oblongata of striped ground squirrels (*Xerus erythropus*). Apart from research purposes, these animals, if successfully bred and domesticated can serve as good supplements for meat and poultry.

MATERIALS AND METHODS

EXPERIMENTAL ANIMALS AND MANAGEMENT

Ten (10) African striped ground squirrels (five male and five female) were used for this study. The animals were captured live from the wild in Zaria, Kaduna State, Nigeria. They were acclimatized for one month in standard laboratory cages in the animal pen of the Department of Veterinary Anatomy, Ahmadu Bello University Zaria, Nigeria. The animals were given access to food and water *ad libitum* throughout the experimental period. They were physically examined during the pre-experimental period and only apparently healthy ones were utilized.

MORPHOMETRIC PARAMETERS

The body weight of each squirrel was obtained using a weighing balance model JJ1000, USA with a capacity of 1000g and sensitivity of 0.01g.The mean length, width and depth of the pons and medulla oblongata were obtained with a venire calliper (MG6001DC, General Tools and Instruments Company, New York; sensitivity: 0.01mm). Gross pictures were taken using canon digital camera power shot (SX170 IS) with 64-megapixel sensor (focal length: 28-448mm, 7.5cm (3.0") TFT. Histological pictures were taken using light microscope (Amscope, T120B) and a digital microscope camera (DCM 510 megapixel, ScopePhoto® China) at ×40, ×100, ×250, ×400.

BRAIN EXTRACTION

Each squirrel was euthanized using ketamine anaesthetic at 80mg/kg. Each brain was perfused (intra-cardiac route) with 10% phosphate buffered formalin. Each skull was exposed after skinning and stripping off all the facial muscles within 30 minutes of euthanasia. Craniotomy was carried out through the calvaria to expose the dura matter, which was later cut with curved pointed scissors. The falxcerebri and tectorium cerebelli were pulled from the longitudinal and transverse fissures by gentle traction. The cerebral vein was transected and at this stage, the brain was still in the cranium fixed in 10% phosphate buffered formalin for two days to enhance easy extraction as described by Ramaswamy (1978).

HARVEST OF PONS AND MEDULLA OBLONGATA

The pons and medulla oblongata were isolated from the rest of the brain by gently pulling apart the two cerebral hemispheres at the occipital lobe to expose the corpus callosum. The entire corpus callosum together with septum pellucidum and the body and rostral commisure of the fornix were severed in the midline and this separated the cerebrum from the brainstem and cerebellum. Then the floculli of the cerebellum were raised manually to expose the cerebellar peduncle which was severed starting with the laterally located brachium restiformis, followed by the middle brachium pontis and then the brachium conjuctivum. The brainstem was freed from the cranial nerves by simple trimming using scalpel blade, an incision was made at the transverse fissure between the pons and caudal colliculi to isolate the pons and medulla oblongata from the midbrain while incision made at the ponto-medullary junction separates the medulla oblongata from the pons.

RESULTS

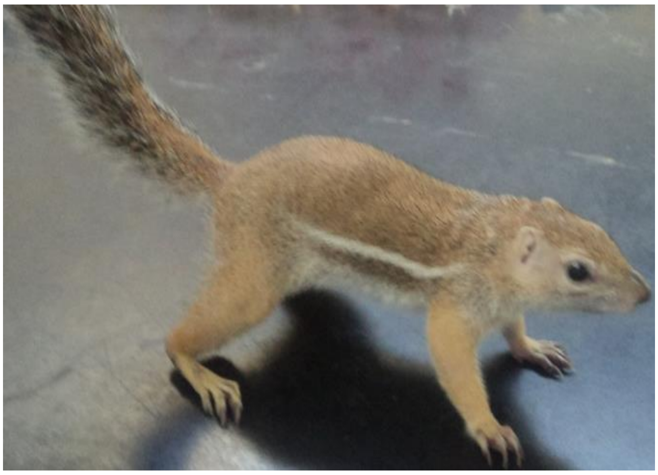

Figure 1: Image of a matured African striped ground squirrel studied

Figure II: Head of African striped ground squirrel showing the small ears and large eyes.

Macroscopically on the dorsal view of the whole brain, the two cerebral hemispheres were distinctly divided by longitudinal fissure and separated from cerebellum by a transverse fissure. The cerebral cortex was devoid of prominent gyri and sulci and appears as smooth surface which classified the squirrel brain in the lissencephalic group. The cerebellar hemisphere was coiled and covered the rostral medulla including the fourth ventricle (Figure III) while on the ventral surface of the whole brain; the olfactory bulb and tract were prominent and continued into the ipsilateral pyriform lobes. The optic nerves were also conspicuous and unite at the optic chiasma which was rostral to the obvious mamillary body. Caudal to the mamillary body was the prominent pons which was bounded laterally by trigeminal nerve and separated from the rostral medulla (trapezoid body) by a transverse fissure. Also, visible on this view were; the olivary bodies, pyramids, ventral median sulcus, ventrolateral sulcus, pyramidal decussation and the spinal medulla (Figure IV).

GROSS DESCRIPTION OF THE PONS

This structure was small and curved to form triangular shape dorsally and widen out forming a convex shape ventrally (Figure IV). The caudal colliculi lied on the triangular shaped pons and medulla dorsocranially and dorsocaudally, it's slightly pointed out and limited by the open medulla at the rostral aspect of the fourth ventricle (Figure V).

The ventral view is smooth and has prominent longitudinal fissure (basilar sulcus) which divide it into two halves. It was separated from rostral medulla oblongata (trapezoid body) by a transverse fissure (pontomedullary junction) which is the landmark for isolating the pons from the medulla oblongata (Figure IV).

The abducens nerve (cranial nerve VI) was located slightly caudal to the pontomedullary junction in this species and laterally, the pons is bounded by the trigeminal nerve which is a large cranial nerve (Figure IV).

GROSS DESCRIPTION OF MYELENCEPHALON

The myelencephalon was conical (funnel shape) in shape that is, broad or widen cranially and narrow caudally as it joins the spinal cord (Figure VI). The ventral surface lies on basilar portion of the occipital bone while the craniodorsal surface was covered by the cerebellum and the caudodorsal surface was embedded in the first cervical vertebrae (Figure III).

DORSAL VIEW OF MEDULLA OBLONGATA

On this view, the medulla oblongata is divided into open and closed medulla. Rostrally, the open medulla is separated from the colliculi and pons by a transverse fissure (colliculo-pontomedullary junction). Immediately caudal to this fissure was the sulcus limitans on each half (Figure V). Lateral to the sulcus limitans was the peduncle which attaches the medulla oblongata to the cerebellum and medial to the sulcus was the median sulcus which was a continuation of dorsal median sulcus of the closed medulla (Figure V). This dorsal median sulcus divides the medulla oblongata into equal symmetrical halves. The large cavity or depression of the open medulla is the rhomboid fossa (the floor of this fossa is the 4th ventricle) which gradually narrows down rostrocaudally and was limited by the obex which was a slight protuberance on this view (Figure V). Immediately lateral to the obex was tubercle gracilis which prominence was oval and caudal to the cerebellar peduncle. It also contributes to the caudal border of floor of the 4th ventricle (Figure V). Caudomedial to the obex was the dorsal median sulcus which is distinct and visible. However, mediolateral to this sulcus was the fasciculus gracilis which is slightly faint (Figure V). Other structure typical of the dorsal surface of mammalian medulla oblongata such as cuneate fasciculus, dorsal intermediate sulcus, lateral furniculus and dorsal lateral sulcus were not conspicuous or readily seen (Figure V).

VENTRAL VIEW OF THE MEDULLA OBLOBGATA

The prominent features rostrocaudally are; trapezoid body (covered by olivary bodies) which was medially divided into equal halves by the ventral median fissure (Figure IV). Mediolateral to the ventral median sulcus was the prominent pyramids which are separated from the olivary prominence by the ventral lateral sulcus on the trapezoid body (Figure IV). The pyramids extend from the pyramidal decussation to the pontomedullary junction (Figure IV). Lateral to the olivary prominence was the vestibulocochlear nerve which lies medial to the paraflocculus of the cerebellum and caudal to the trigeminal nerves (Figure IV). Caudally, the medulla oblongata could be differentiated from the spinal cord by the prominent transverse depression called pyramidal decussation at the level of the foramen magnum, then slightly extend caudally to this depression at the level of nuchal flexure (spinomedullary junction) (Figure VI). Also, of importance are some of the cranial nerves that were grossly seen in this study; the glossopharyngeal nerve (CN IX), was seen on the caudal medulla just about 1/3 of the caudal limit of the pyramid and lateral to the ventral lateral sulcus. Caudolateral to CN IX, laterally on pyramidal decussation was the accessory nerve (CN XI) while the hypoglossal nerve (CN XII) was seen extending from the pyramidal decussation to the ventrodorsal surface of trapezoid body (Figure IV).

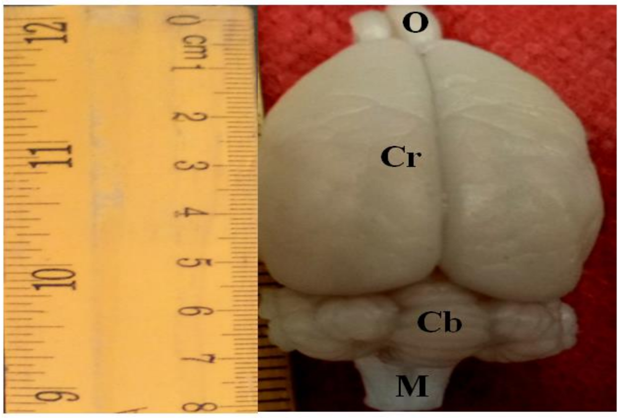

Figure III: Dorsal view of the whole brain. O: Olfactory bulb, Cr: Cerebrum, Cb: Cerebellum, M: Medulla oblongata.

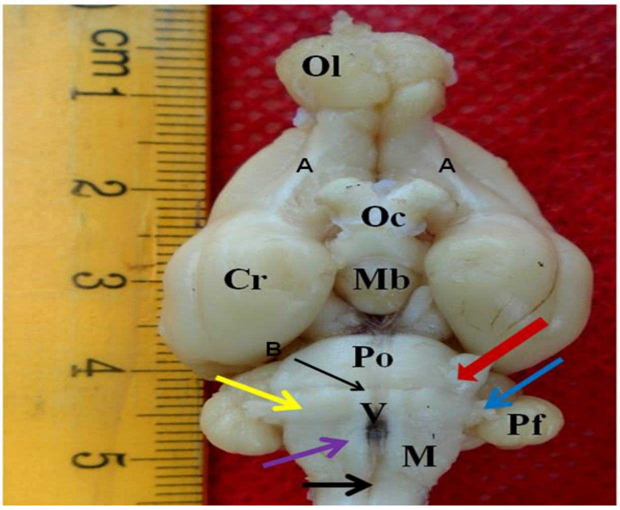

Figure IV: Ventral view of the whole brain. OI: Olfactory bulb, A: Olfactory tract, Optic chiasma (Oc), Pyriform lobe of cerebrum (Cr), mammillary body (Mb), Pons (Po), B: Pontomedullary junction, Paraflocculus of cerebellum (Pf), ventral median fissure (V), medulla oblongata (M), Olivary body (yellow arrow), trigeminal nerve (red arrow), vestibulocochlear nerve (blue arrow), ventrolateral sulcus (purple arrow), pyramidal decussation (black arrow).

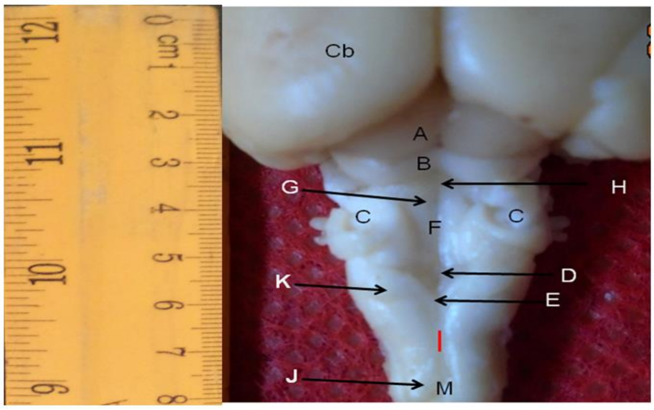

Figure V: Dorsal view of medulla oblongata. A: rostral colliculi, B: caudal colliculi, C: cerebellar peduncle, D: median sulcus, E: obex, F: rhomboid fossa, G: sulcuslimitans, H: colliculo-pontomedullary junction, I: dorsal median sulcus, J: fasciculusgracilis, K. tubercle gracilis

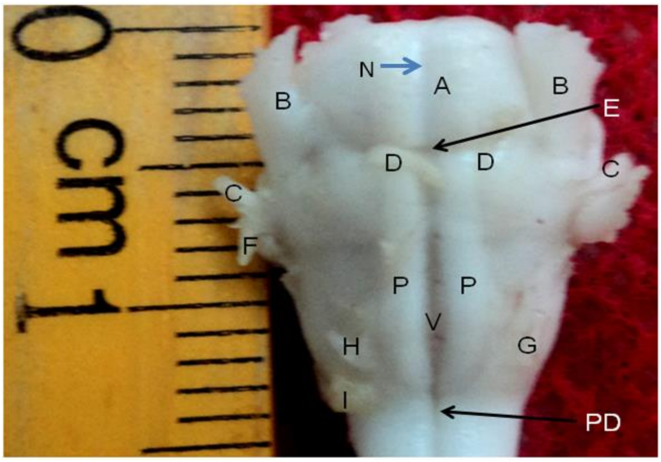

Figure VI: Ventral view of pons and medulla oblongata. A. pons, B. trigeminal nerve, C. facial nerve, D. abducens nerve, E. pontomedullary junction, F. vestibulocochlear nerve, G. hypoglossal nerve, H. glossopharyngeal nerve, I. accessory nerve, N. ventral longitudinal fissure (basilar sulcus), P. pyramids, V. ventral median fissure

DISCUSSION

Macroscopically, the pons and medulla oblongata of the squirrel are similar to that of other rodents with slight variation. Potter & Bruek, (1958) reported that the medulla oblongata in guinea pig is almost completely covered by the cerebellum. This differs from that of squirrel and the present study shows that the cerebellum covered only the rostral part of the medulla dorsally and represented by the 4th ventricle. The pons and the pontomedullary junction is conspicuous in squirrels, this is in agreement with the findings of Roberts & Noel (2019) who reported a conspicuous pons in rats but with less distinct pontomedullary junction. The distinct pontomedullary junction in squirrels is in agreement with the findings of Shashi *et al.*, (2020) who reported clear demarcation between the pons and medulla oblongata in guinea fowl but in contrary with the findings of Sunil *et al*. (2019) who reported that there is no clear demarcation between the pons and medulla oblongata of domestic fowl. A convex shaped pons was seen in squirrels which are in contrary to the report of Jacqueline (2023) in cat and Joy & Angerine (2002) in human who both reported that on ventral view the pons appears as bridge transmitting various nerve fibers. Our findings also vary. The funnel (both) to triangular shaped medulla oblongata in squirrels is in contrary to the findings of Ajayi *et al*. (2011) who reported conical shaped medulla oblongata in grasscutter. The similarities may be due to common feeding pattern and order strata classification but the differences observed may be due to diurnality, adaptability and species variations.

CONCLUSION

The results obtained from this study indicates that African ground squirrels have excellent motor functions and balance with excellent sense of sight and hearing which are required for adaptation in their habitats. Hence, the findings of present study would constitute baseline data of strong relevance in wildlife comparative neuroanatomical studies and diagnosis of brainstem pathologies.

Conflict of interest: No conflict of interest.

REFERENCES

Adeola, M.O. (1992). Importance of wild animals and their parts in the culture, religious festivals, and traditional medicine of Nigeria. *Environmental Conservation*, 19,125-134.

Adeola, M.O. & Decker, E. (1987). Wildlife utilization in rural Nigeria. In Clers, B. D. (edition) *Proceedings of the International symposium and conference on wildlife management in Sub-Saharan Africa, Harare, Zimbabwe,* 512-521

Ajayi, S.S. (1979). Utilization of forest wildlife in West Africa. Misc/79/26, *Food and Agriculture Organisation, Rome,* 79.

Ajayi, S.S., Ojo, S.A., Onyeanusi, B.I., George, B.M., Ayo, J., Salami, S.O. & Ibe, C.S. (2011). Morphometry of medulla oblongata of African grasscutter. *Veterinary Research,* 4(1), 5-8.

Byanet, O. & Dzenda, T. (2014). Quantitative Biometry of Body and Brain in the Grasscutter (*Thryonomys swinderianus*) and African Giant Rat (*Cricetomys gambianus*): Encephalization Quotient Implication. *Research in Neuroscience*; 3(1), 1-6.

Byanet, O. & Dzenda, T. (2012). Quantitative Biometry of Body& Brain in the Grasscutter (Thryonomys *swinderianus*) and African Giant Rat (*Cricetomy gambianus). Research in Neuroscience*, 2326-1226.

Ibe, C.S., Onyeanusi, B.I. & Hambolu, J.O. (2014). Functional morphology of the brain of the African giant pouched rat (*Cricetomys gambianus* Waterhouse, 1840). *Onderstepoort Journal of Veterinary Research*, 81(1), 01-07.

Ibe, C.S., Ikpegbu, E. & Nzalak, O. (2017). Relationship between age and brainstem allometry in the African grasscutter (*Thryonomys swinderianus* - Temminck, 1827). *Journal of the South African Veterinary Association*, 88(0), a1481.

Jacqueline, L. (2023). Gross and functional anatomy of the feline brain. *Veterinary Psychiatry of Cats,* 10(4), 13-21.

Joy, B. & Angerine, J.R. (2002). Enzyclopedia of human brain, Neuronal organization. *Neurological science*, 23-25.

Potter, G.E. & Brueck, W.L. (1958). Nervous System of guinea pig (*Cavia porcellus*). Beta Biological Society, 29(4), 185-196.

Robert, L.M. & Noel, D. (2019). The brain and spinal cord. *Anatomy and histology of the laboratory rat in toxicology and biomedical research,* 13, 43-45.

Shashi, K., Balwant, M., Hemant, J., Devendra, S., Nishant, P. & Gajendra, S. (2020). Gross anatomy and morphometry of the brain in guinea fowl. *International journal of livestock research,* 10(11), 79-84

Sunil, K.G., Haswitha, S. & Amandeep, K. (2019). Gross morphological study in the brain of fowl (*Gallus domesticus*). *Indian journal of veterinary science and biotechnology,* 14(4), 31-37.

Thorington, R. & Hoffmann, R. (2005). Family Sciuridae. Mammal species of the World. A taxonomic and geographic reference. *John Hopkins University press, Baltimore, UK*. 754-818

Whatton, F. (2012). Squirrel of the world. John Hopkins University press Baltimore, UK, 81-90.