

Research Article: Basic and Applied Anatomy

Gross morphometric study of the eyeball and tongue of the Nigerian local dog

Olumayowa Olawumi Igado

Department of Veterinary Anatomy, Faculty of Veterinary Medicine, University of Ibadan, Nigeria.

Received May 27, 2011; accepted July 23, 2011

Summary

This study investigates the morphometry of two sense organs, the eyeball and tongue, of the Nigerian local dog (11 males, 14 females), all aged 2 years and above. The samples were grouped according to gender and weight (up to 12 kg or above that weight). The average values obtained for the weights of the left and right eyeballs and the tongue were 3.77 ± 0.51 g, 3.68 ± 0.74 g and 2.96 ± 0.38 g respectively, while the length of the tongue, its thickness and width at the root and apex were 14.20 ± 2.29 cm, 0.87 ± 0.30 cm, and 0.21 ± 0.05 cm respectively. The circumferences of the eyeballs (antero-posterior, mediolateral and peri-orbital) were all found to be higher in females, except the antero-posterior circumference of left eye, in spite of heavier eyeballs in males. Also, the females showed a wider rima oris and higher values for most of the tongue measurements. A positive correlation existed between the weight of the animal and that of the head and tongue, while a negative correlation was observed between the body weight and the weight of the eyeballs. This report highlights the presence of sexual dimorphism and mild lateral asymmetry in this rarely reported breed of dog. The data obtained from this study may find application in feeding physiology, ophthalmic clinical manipulations and comparative anatomy.

Key words

Canine; glossal morphometry; ocular morphometry; sexual dimorphism.

Introduction

The Nigerian local dogs are indigenous to Nigeria; they are mainly used for hunting in the wild by the local people and are also used as guard dogs and pets in the urban areas. They are about 4.5 million and are reputed to be more resistant to diseases caused by blood parasites (e.g. babesiosis, trypanosomosis) relative to 'exotic' or imported breeds (Olayemi *et al.*, 2009).

The eye and tongue are essential sense organs, pertaining to sight and taste respectively. The vertebrate organ of vision comprises a number of structures: the globe of the eye (bulbus oculi), the optic nerve, the eyelids (palpebrae), lacrimal gland and nictitating gland, ocular and extra-ocular muscles and the bones that form the orbit (Diesem, 1975). Important ocular morphometric indices include: eyeball weight, eyeball circumference (antero-posterior, medio-lateral and peri-orbital) and eyelid measurements. Some of these indices had been reported in the different breeds

Corresponding author. E-mail: mayowaigado@yahoo.com; Phone: +23408035790102.

of goat in Nigeria (Olopade *et al.*, 2005), horse, mule, cow, calf, sheep, dog and cat (Gelatt, 1981). The tongue is not only important as the organ of taste (due to the presence of the taste buds), but also because it aids in prehension, lapping, grooming and manipulating food in the mouth. It occupies the greater part of the oral cavity and also extends to the oropharynx. It is attached by the root, possesses a body and a free apex, and is a muscular organ capable of vigorous and precise movements. In the canine, the tongue is used to procure heat loss by panting (Dyce *et al.*, 2002).

There have been various reports on the Nigerian local dog (Awah and Nottidge, 1998; Olayemi *et al.*, 2009), but there is still a dearth of information on the gross morphology of this breed of dog. This study aims to determine the measurements of the eye and tongue of this breed of dogs in an effort to provide basic research data and also differentiate it from other breeds of dogs.

Materials and Methods

Ethical approval for this study was obtained from the Ethical Committee of the Faculty of Veterinary Medicine, University of Ibadan, Nigeria, Ethical code number 'ethic/05/11/01'. All procedures followed the Guide for the care and use of experimental animals (Faculty of Veterinary Medicine, University of Ibadan, Nigeria).

A total of twenty-five clinically healthy adult Nigerian local dogs (11 males, 14 females) were used for this study. All animals were aged 2 years or more. Age was obtained from vendors and confirmed using the dental formula according to Dyce *et al.*, (2002). The animals were weighed with a standard bathroom scale and euthanized by intravenous injection of pentobarbitone.

The eyeballs were removed according to the method described by Keller (1975). Briefly, the eyelids were sutured together with continuous suture pattern from the medial to the lateral canthus, the lids were pulled with artery forceps and a scalpel blade was used to dissect around the periorbital fat and muscles as traction was applied to the lids. This exposed the orbit till the optic nerve was reached and severed. The eyeball was placed on a dissecting board, and the eyelids, periorbital fat, muscles and connective tissue were removed. Measurements were taken immediately after removal of the eyeballs. Linear measurements of the eyeball (antero-posterior, mediolateral and periorbital circumferences) were measured with the aid of a thread, the length of which was subsequently determined with the aid of a vernier calliper. All ocular measurements were determined for both eyeballs.

The tongues were removed by dissecting the skin and the glossal muscles from the ventral aspect of the lower jaw. All adhering structures were dissected away, and the tongue was dissected out from the space between the two halves of the mandible. Measurements were determined with the aid of a vernier calliper.

1. **Weight of animal (WOA):** This was determined with the aid of a standard bathroom scale.
2. **Weight of head (WOH):** Measured with the aid of a weighing scale.
3. **Weight of eyeball:** Determined with a digital weighing scale (Microwa® Swiss balance, Mettler-Toledo, Switzerland) and recorded in grams.
4. **Antero-posterior circumference of the eyeball:** The circumference of the eyeball, around the median plane from the anterior to the posterior pole.

5. **Medio-lateral circumference of the eyeball:** The circumference of the eyeball along the mediolateral plane (equator).
6. **Peri-orbital circumference of the eyeball:** The circumference of the eyeball, measured immediately caudal to the cornea, along the mediolateral and antero-posterior planes.
7. **Rima oris length:** Determined using a twine, as the distance between the two lateral commissures of the closed lips. The length of twine was then determined with the aid of a vernier calliper.
8. **Weight of tongue:** Determined with the aid of a digital weighing balance (Micro-wa®) and recorded in grams.
9. **Length of tongue:** The distance between the root and the apex, determined with the aid of a vernier calliper and recorded in centimetres.
10. **Thickness of the tongue at the root:** Thickness of the tongue, along the dorso-ventral surface, measured at the root with a vernier calliper.
11. **Thickness of the tongue, mid-length (body):** Thickness of the tongue, along the dorso-ventral surface, measured at the body with a vernier calliper.
12. **Thickness of the tongue at the apex:** Thickness of the tongue, along the dorso-ventral surface, measured at the apex or the tip of the tongue with a vernier calliper.
13. **Width of tongue at the root:** The distance between the two lateral aspects of the tongue, measured at the root with a vernier calliper.
14. **Width of tongue, mid-length (body):** The distance between the two lateral aspects of the tongue, measured at the body with the aid of a vernier calliper.
15. **Width of tongue at the apex:** The distance between the two lateral aspects of the tongue, measured at the apex or the tip with a vernier calliper.
16. **Number of palatine ridges:** Number of ridges on the hard palate.

Statistical analysis: All data obtained were analysed with Student's 't' test (GraphPad Prism 4.0, GraphPad Software, La Jolla, CA), and $P < 0.05$ was accepted as significant.

Results

The results are presented in Tab. 1, separately according to gender and weight (up to 12 kg or above that weight).

The eyeballs had an almost spherical appearance while the tongue had the characteristic dorso-ventrally flattened appearance, with a median groove on the dorsum, as earlier described by Getty (1975) and Dyce *et al.*, (2002). The ridges on the hard palate were consistently eight in number, with a median raphe separating them into the left and right sides.

The average body weight and head weight measured for the dogs used in this study were 14 ± 4.44 kg and 0.94 ± 0.25 kg respectively; with the males weighing 15.75 ± 6.19 kg and 1.05 ± 0.24 kg respectively while the females weighed 14.5 ± 4.38 kg and 0.98 ± 0.28 kg respectively. Although the females recorded higher values for most of the parameters measured, no statistically significant differences were observed ($P > 0.05$) between genders. Based on weight, interestingly, animals weigh-

Table 1 – Morphometrics of the eyeball and tongue of the Nigerian local dog

	Total n=25	Male n= 11	Female n= 14	Dogs ≤12kg n=12	Dogs >12kg n=13
Weight of animal (kg)	14.00 ± 4.44	15.75 ± 6.19	14.50 ± 4.38	11.33 ± 1.12*	17.43 ± 4.83*
Weight of head (kg)	0.94 ± 0.25	1.05 ± 0.24	0.98 ± 0.28	0.84 ± 0.15	1.08 ± 0.30
Weight of left eyeball (g)	3.77 ± 0.51	3.87 ± 0.40	3.68 ± 0.61	3.96 ± 0.42**	3.34 ± 0.48*
Weight of right eyeball (g)	3.68 ± 0.74	3.77 ± 0.37	3.61 ± 0.98	3.88 ± 0.34#	3.37 ± 1.11
Antero-posterior circumference, left eye (cm)	6.46 ± 0.37	6.52 ± 0.30	6.42 ± 0.45	6.56 ± 0.28#	6.20 ± 0.52
Antero-posterior circumference, right eye (cm)	6.67 ± 0.36	6.58 ± 0.37	6.76 ± 0.37	6.64 ± 0.37	6.65 ± 0.52
Mediolateral circumference, left eye (cm)	6.41 ± 0.35	6.40 ± 0.34	6.41 ± 0.39	6.43 ± 0.34#	6.38 ± 0.34
Mediolateral circumference, right eye (cm)	6.52 ± 0.37	6.42 ± 0.28	6.60 ± 0.43	6.44 ± 0.26	6.65 ± 0.52
Peri-orbital circumference, left eye (cm)	6.67 ± 0.23	6.64 ± 0.23	6.70 ± 0.25	6.68 ± 0.26	6.65 ± 0.07
Peri-orbital circumference, right eye (cm)	6.79 ± 0.25	6.64 ± 0.22	6.94 ± 0.20	6.81 ± 0.27#	6.73 ± 0.25
Rima oris length (cm)	14.54 ± 1.48	14.50 ± 0.50	15.00 ± 1.84	14.00 ± 1.23	15.40 ± 1.55
Weight of tongue (g)	46.15 ± 14.55	42.22 ± 7.05	48.95 ± 18.25	42.99 ± 9.93	50.57 ± 19.81
Length of tongue (cm)	14.20 ± 2.29	13.44 ± 1.19	14.83 ± 2.88	13.84 ± 2.13	15.17 ± 2.90
Thickness of tongue, root (cm)	0.87 ± 0.30	0.72 ± 0.23	1.00 ± 0.32	0.89 ± 0.34#	0.83 ± 0.25
Thickness of tongue, mid-length (cm)	1.28 ± 0.34	1.12 ± 0.11	1.42 ± 0.42	1.28 ± 0.36	1.30 ± 0.36
Thickness of tongue, apex (cm)	0.21 ± 0.05	0.18 ± 0.05	0.23 ± 0.05	0.20 ± 0.05	0.23 ± 0.06
Width of tongue, root (cm)	2.96 ± 0.38	3.14 ± 0.39	2.80 ± 0.32	3.01 ± 0.36#	2.80 ± 0.44
Width of tongue, mid-length (cm)	3.60 ± 0.35	3.52 ± 0.26	3.67 ± 0.42	3.56 ± 0.39#	3.70 ± 0.26
Width of tongue, apex (cm)	1.74 ± 0.45	1.86 ± 0.20	1.63 ± 0.62	1.80 ± 0.46#	1.57 ± 0.55
Number of ridges on hard palate	8.00 ± 0.00	8.00 ± 0.00	8.00 ± 0.00	8.00 ± 0.00	8.00 ± 0.00

*Indicates statistically significant differences (P<0.05) between dogs weighing ≤12 kg and those weighing >12 kg. # Indicates values which are higher in dogs weighing ≤12 kg relative to dogs weighing >12 kg; No statistically significant difference was observed between males and females.

ing up to 12 kg recorded higher values for the ocular parameters except for the antero-posterior and mediolateral circumferences of the right eye (6.64 ± 0.37 cm and 6.44 ± 0.26 cm respectively, against 6.65 ± 0.52 and 6.65 ± 0.52 cm respectively for dogs weighing >12 kg); while for the tongue parameters the values obtained for the thickness at the root and for the width at root and apex were found to be higher in animals weighing up to 12 kg (0.89 ± 0.34 cm, 3.01 ± 0.36 cm and 1.8 ± 0.46 cm respectively, against 0.83 ± 0.25 cm, 2.8 ± 0.44 cm and 1.57 ± 0.55 cm respectively in dogs weighing >12 kg). Interestingly, the right eye maintained slightly higher values for the antero-posterior and mediolateral circumferences relative to the left eye (for both male and female), while the peri-orbital circumference remained the same. In spite of these differences the weight of the left eyeball was observed to be slightly heavier. No statistically significant differences were however observed ($P > 0.05$). Considering weight, statistically significant differences ($P < 0.05$) were only observed in the weight of the animal and the weight of the left eyeball. The relative weights (organ weight to body weight) of the head, both eyeballs (summation of weight of the two eyeballs) and tongue were calculated as 6.71%, 0.053% and 0.329% respectively (males: 6.67%, 0.049% and 0.268% respectively; females: 6.76%, 0.05% and 0.338% respectively). Pearson's correlation coefficient revealed a positive correlation of the weight of the animal with that of the head ($r = 0.553$), a slightly positive correlation with the weight of tongue ($r = 0.193$) and negative correlations with the weight of the eyeballs ($r = -0.575$ and -0.662 for left and right eyeballs respectively).

Discussion

In this study, the males had heavier body weights relative to the females. This result is in consonance with the report of Campbell (1990), who reported that males of most animal species are usually heavier than the females of the same age. Although the weights of the head and the two eyeballs were heavier in the males, the linear measurements were higher in the females. This shows that a seemingly bigger eyeball might not necessarily be heavier. It is speculated that this disparity might be due to differences in the individual weight and viscosity or density of the structures of the eyeball. The disparity observed in the values obtained for weight, antero-posterior and mediolateral circumferences of the left and right eyes may be irrelevant and inconsequential, as no statistically significant differences were observed. Further research is however required to determine the reason for this disparity. The mean weight of the eyeball obtained in this study is less than that obtained in man (7.5 g, Riordan-Eva and Whitcher, 2008), Nigerian goat breeds (7.2-8.7 g, Olopade *et al.*, 2005) and small dogs (10.9 g; Bayer, 1914). Also, data obtained from this study suggest a similarity with the relative eyeball weight obtained in the Nigerian local pigs (0.054%), but gave lower values when compared to the relative head and tongue weights in the same animal (10.53% and 0.48% respectively; Olopade *et al.*, 2011). A slight asymmetry was observed between the right and left ocular values. This is similar to earlier reports in other domestic animals (Getty, 1975; Olopade *et al.*, 2005). Although no statistically significant differences were observed ($P > 0.05$), the values for the tongue parameters were higher in the females except for the width of the tongue at the root and the apex, this coupled with the fact that the relative tongue weight of

the females were higher shows that the females have bigger tongues; this observation also corresponds to the wider rima oris length observed in the females. The reason for the bigger tongues in the females is not clear as currently, there are no data suggesting that either sex is better at prehension, lapping, grooming or heat dissipation by panting, but undocumented observation reveal that the females groom the puppies more, especially after birth. The bigger tongues in the females could probably be an adaptive feature to aid in grooming the young.

Some values were observed to be higher in animals weighing ≤ 12 kg, but no statistically significant differences were observed ($P > 0.05$; Tab. 1). This lack of significant difference in spite of the higher body and head weight in dogs weighing more than 12 kg shows that the values of these parameters may not necessarily be size dependent in adult animals. Also, coupled with the fact that a negative correlation was observed between the weight of the animal and the weight of the eyeballs, it can also imply that smaller dogs (and by extension, younger dogs) of this breed have relatively bigger eyes. The head weight had the highest positive correlation with the body weight; this was followed by the tongue. This is supported by the absolute values obtained, since these two parameters were observed to be quite higher in animals weighing more than 12 kg. Also, the sexual disparity observed in the tongue parameters is inconsistent with the earlier reports in pigs (Olopade *et al.*, 2011) and in human foetuses and children (Stiebert, 1985). All the animals examined had eight palatine ridges each, showing that this value is constant in the adult of this species, irrespective of the gender or size. This is similar to the 8 to 10 ridges previously reported in dogs, and 7 to 9 in the cat, but considerably lower than the 20 in pig and 15 in ruminants (Getty, 1975).

This study presents the eye and tongue morphometrics of the Nigerian local dog, showing the presence of sexual dimorphism and symmetrical variations. As many as two thousand distinct breeds of dogs have been developed in the world, with the American Kennel Club of the United States of America recognising about 125 breeds (Getty, 1975). The findings of this study may find application in the study of the visual structure of this breed of dog, in the fields of comparative, regional and clinical anatomical studies, in ophthalmic manipulations, and may also help to better understand this unique breed of domestic dog.

Acknowledgements

The author gratefully acknowledges the technical assistance of Dr. O.K. Ekeolu

References

- Awah J.N., Nottidge H.O. (1998) Serum biochemical parameters in clinically healthy dogs in Ibadan. *Trop. Vet.*, 16: 123-129.
- Bayer J. (1914) *Augenheilkunde*. 3rd edn. Braumueller, Wien.
- Campbell N.A. (1990) *Biology*. 2nd edn. The Benjamin/Cummings Publishing Company, New York. Pp. 229-343.
- Diesem C.D. (1975) Gross anatomic structure of equine and bovine orbit and its content. *Am. J. Vet. Res.* 29: 1769-1781.

- Dyce K.M., Sack W.O., Wensing C.J.G. (2002) Textbook of Veterinary Anatomy. 3rd edn. W.B. Saunders Company, Philadelphia.
- Getty R. (1975) Sisson and Grossman's The Anatomy of the Domestic Animals. 5th edn. W.B. Saunders Company, Philadelphia
- Gelatt K.W. (1981). Veterinary Ophthalmology 1st edn. Lea and Febieger, London.
- Keller W.F. (1975) Eucleation of the eyeball. In: Bojrab M.J.: Current Techniques in Small Animal Surgery. Lea & Febiger, Philadelphia. In: Olopade J.O., Kwari H.D., Agbase I.O., Onwuka S.K. (2005). Morphometric studies of the eyeballs of three breeds of goats in Nigeria. *Int. J. Morphol.* 23: 377-380.
- Olayemi F.O., Azeez I.O., Ogunyemi A., Ighagbon F.O. (2009) Study on erythrocyte values on the Nigerian indigenous dog. *Folia Vet.* 53: 65-67.
- Olopade J.O., Kwari H.D., Agbase I.O., Onwuka S.K. (2005) Morphometric studies of the eyeballs of three breeds of goats in Nigeria. *Int. J. Morphol.* 23: 377-380.
- Olopade J.O., Igado O.O., Nwafor C.I., Alamu A.O., Onwuka S.K. (2011) Some aspects of the craniofacial indices and macro neurometrics of the Nigerian local pig (*Sus scrofa*). *Ital. J. Anat. Embryol.* 116: 38-44.
- Riordan-Eva P., Whitcher J.P. (2008) Vaughan & Asbury's General Ophthalmology. 17th edn. Lange Medical Books, New York.
- Siebert J.R. (1985) A morphometric study of normal and abnormal fetal to childhood tongue size. *Arch. Oral Biol.* 30: 433-440.