# FRONTOSAGITTAL AND VERTEBRAL INDICES OF WEST AFRICAN DWARF GOAT

**NNAJI, Theophilus, UBADIAGHA, Uzoamaka and UDEGBULAM, Sunday**
Department of Veterinary Surgery, Faculty of Veterinary Medicine, University of Nigeria, Nsukka

**Corresponding Author:** Nnaji, T. O. Department of Veterinary Surgery, Faculty of Veterinary Medicine, University of Nigeria, Nsukka. **Email:** theonnaji@gmail.com **Phone:** +234 8064813448

**ABSTRACT**

***Thoracic malformations in animals induce exercise intolerance and reduce the reproductive performance due to respiratory distress. Some of these deformities can be corrected by surgical intervention. Frontosagittal and vertebral indices are crucial for diagnosis and surgical corrections of these anomalies. This information is not available in West African dwarf goat (WADG). The normal radiographic anatomy of the thoracic cage and the thoracic indices were evaluated in 10 West African dwarf goats of both sexes (5 male and 5 female), age one and half to three years using dorsoventral and lateral projections. The mean frontosagittal index (FSI) was 1.11 ± 0.004 and 1.13 ± 0.03 for the male and female WADG respectively while the mean vertebral index was 13.11 ± 0.34 and 13.00 ± 0.79, respectively. There was no significant difference in these indices between the sexes. This study shows that sex is not a key factor in determination of FSI and VI of WADS either for diagnostic purposes or for quantitative assessment of the degree of surgical correction of thoracic cage anomalies.***

**Keywords:** Frontosagittal index, Vertebral index, Thoracic malformation, West African dwarf goat (WADG)

## INTRODUCTION

The West African dwarf goats are present in all humid Africa from the Southern Sudan to the West Coast (Epstein, 1971). Probably the most important characteristic of these dwarf goats is their tolerance to trypanosomiasis (Gall, 1996). The dwarf goats are stocky with short legs and a short and wide head. The face is straight or slightly concave. In the humid zone of southern Nigeria, 91% of the subsistent farmers see goat keeping as a vital source of income to their families (Mathewman, 1977). Anatomically the, skeletal system consists of a framework of hard structures which support and protect the soft tissues of animals (Sissions and Grossman, 1975).

The skeletal framework of the thorax of West African dwarf goat (WAD) is formed by the thoracic vertebrae (dorsally), the thirteen pairs of ribs or sometimes fourteen pairs of ribs (laterally), and the sternum (ventrally) (Farrow *et al.,* 1994).

Congenital malformations of the chest wall are occasionally encountered in domestic animals most especially in dogs, cat and sometimes in the caprine species. The majority of these anomalies involve the bony parts of the thorax; the sternum, spine and ribs. Some of these anomalies include pectus excavatum, pectus carinatum, lordosis, kyphosis and scoliosis which may affect the normal physiologic and functional performance of such animals. Radiographic indicators of pectus excavatum for instance are a marked dorsal deviation of the caudal aspect of the sternum, acute angulations of the associated costal cartilages, and dorsal displacement of the heart in lateral view.

Preoperative and postoperative measurements of the frontosagittal and vertebral indices have been employed to

quantitatively assess the degree of deformity as well as surgical correction of some of the chest wall anomalies in dogs (Nnaji *et al*., 2010).

The frontosagittal index (FSI) is the ratio between the width of the thorax at the tenth thoracic vertebrae as measured on a dorsoventral (DV) or ventrodorsal radiograph and the distance between the center of the ventral surface of $T_{10}$ and the nearest point on the sternum (Farrow *et al.,* 1994). The vertebral index (VI) is the ratio between the distance from the center of the dorsal surface of $T_{10}$ to the nearest point on the sternum and the central dorsoventral diameter of $T_{10}$ (Farrow *et al.,* 1994).

Frontosagittal and vertebral indices have been successfully determined in dogs and cats but little or no work has been done on our West African dwarf goats. In view of the socio-economic importance of West African dwarf goat in the humid tropics and particularly in the Southern part of Nigeria, it becomes very much imperative to have an in-depth knowledge of the frontosagittal and vertebral indices of the West African dwarf goat. This will be of paramount importance in disease diagnosis, prognostic evaluation as well as in determination of the degree of surgical corrections of such cases that affect their chest walls.

## MATERIALS AND METHODS

**Experimental Animals:** Ten (10) West African dwarf goats were randomly selected and bought from our local markets. Five of them were male while remaining 5 were female. The age ranged from one and a half to three years. These animals were examined, dewormed and kept in University of Nigeria Veterinary Teaching Hospital Animal House for two weeks for acclimatization. Physical and clinical examinations carried out at the end of acclimatization were normal in all the goats and so, the animals were adjudged healthy for the study (Straub *et al.,* 2002).

**Radiography:** For proper positioning and quality radiographs, the goats were restrained chemically using xylazine HCL (VMD Arendonk, Belgium) at a dose of 0.05mg\kg intramuscularly (Kumar, 2002). Each of the animals was then positioned for radiographic investigation with the help of some assistants who were protected with lead–impregnated aprons and hand gloves (WHO, 2004; Lattimer, 2005).

Dorsoventral and right lateral thoracic projections of each of the goats were obtained using a grid and exposure factors commensurate with the animals thoracic thickness (Green, 1998). The x-ray beam was collimated in each case to include the entire thorax. Each of the radiographs was identified permanently with lead marker.

For the dorsoventral view, the animals were placed in ventral recumbency with the thoracic vertebrae superimposed on the sternum. The forelegs were pulled slightly forward and the elbows were abducted (rotated outward) so that the shoulders were displace cranio-medially and the scapulae were shifted laterally away from the cranial lung field. The rear limbs were allowed to flex in a crouching position and the heads lowered between the forelimbs to decrease the thickness of the caudal cervical musculature over the cranial lung field. The x-ray beams were centered over the $5^{th}$ intercostal space and the radiographs then taken at maximum inspiration (Ticer, 1975).

For the right lateral view, the goats were positioned in right lateral recumbency and the forelimbs were pulled cranially so that most of the triceps musculatures were displaced from the cranial aspect of the thorax. The sternum of each animal was elevated to a level above the x-ray table equal to that of the thoracic vertebrae to prevent rotation. Their necks were extended and the occipito–atlantal joints were allowed to flex approximately 45 degrees to avoid displacement of the trachea. The x–ray beams were centered at the $5^{th}$ thoracic intercostals space and radiographs taken at maximum inspiration (Ticer, 1975).

Each exposed film was processed manually dried in the air and properly kept in an appropriately pre-labelled envelope before the next radiographic projection to avoid a mix-up of radiographs. Measurements were taken of

each processed film after which all the radiographs were returned into their respective envelopes.

**Measured Indices:** From the dorsoventral radiographs, the following measurement was made for each goat:

i) The width of the thorax at the tenth thoracic vertebra ($T_{10}$) = A (Figure 1).

From the right lateral radiographs, the following measurements were made for each goat using transparent ruler:

ii) The distance between the centre of the ventral surface of $T_{10}$ and the nearest point on the sternum = B (Figure 2).
iii) The distance from the centre of the dorsal surface of $T_{10}$ to the nearest point on the sternum = C (Figure 3).

The central dorsoventral diameter of $T_{10}$ (i.e. the height of the body of $T_{10}$) = D (Figure 2). The frontosagittal index and the vertebral index of each of the goat studied were determined according to Farrow *et al.* (1994) as follows: Frontosagittal index (FSI) = Width of thorax at $T_{10}$ (on DV view) ÷ Distance between the center of the ventral surface of $T_{10}$ and the nearest position on the sternum, i.e. FSI = A/B. Vertebral index (VI) = Distance from the center of the dorsal surface of $T_{10}$ to the nearest point on the sternum ÷ Central dorsoventral diameter of $T_{10,}$ i.e. VI = C/D

**Statistical Analysis:** The results of this study were subjected to statistical analysis of means using student's t–test.

## RESULTS

The thoracic cavity consists of 13 thoracic vertebrae dorsally, 13 pairs of ribs of which 7 were sternal while the rest were asternal and ventrally the sternum which was seen running caudally with slight convexity to accommodate the content of the thoracic cavity. The radiographs showed the shape of the thorax was similar in all the WADGs even though there were variations in the measurements. There was no significant dorsal or ventral deviation of the sternebrae.

**Figure 1: Dorsoventral radiograph of one of the WADGs showing how the width of the thorax at the tenth thoracic vertebra was measured**

**Figure 2: A lateral thoracic radiograph showing how distance between the centre of the ventral surface of the tenth thoracic vertebra and the nearest point on the sternum and the height of the body of the tenth thoracic vertebra were measured**

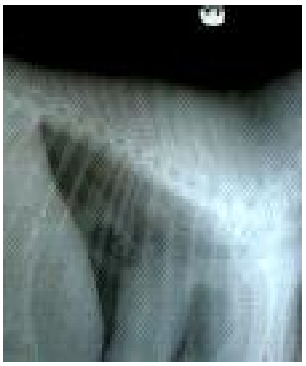

**Figure 3: A lateral thoracic radiograph showing how the distance from the centre of the dorsal surface of the tenth thoracic vertebra to the nearest point on the sternum was measured**

The frontosagittal indices ranged from 1.02 – 1.27 while that of the vertebral indices was 10.50 – 15.30. It was noted that the frontosagittal index was highest (1.27) and least (1.02) among the male WADGs.

The mean frontosagittal index for both sexes (Table 1) was 1.11 ± 0.004 and 1.13 ± 0.03 for the male and the female respectively. The vertical diameter of the thorax of the female WADG measured 9.5 to 19.8 cm while that of the male was 13.4 – 18.0 cm.

The mean vertebral index (VI) for the male and female (Table 2) was 13.11 ± 0.03 and 13.00 ± 0.79, respectively. There was however no significant difference ($p \geq 0.05$) in the FSI and VI of both sexes.

**Table 1: Frontosaggital indices for the male and female West African dwarf goat**

| FSI (Male) | FSI (Female) |
|---|---|
| 1.02 | 1.06 |
| 1.06 | 1.09 |
| 1.06 | 1.24 |
| 1.14 | 1.19 |
| 1.27 | 1.09 |
| 1.11 ± 0.004[a] | 1.13 ± 0.03[a] |

a = Means on the same row with different superscript varied significantly ($p<0.05$)

**Table 2: Vertebral indices for male and female West African dwarf goat**

| VI (Male) | VI (Female) |
|---|---|
| 12.92 | 10.50 |
| 14.36 | 12.40 |
| 12.33 | 13.69 |
| 13.13 | 15.30 |
| 12.79 | 13.12 |
| 13.11 ± 0.34[a] | 13.00 ± 0.79[a] |

a = Means on the same row with different superscript varied significantly ($p<0.05$)

## DISCUSSION

The absence of significant dorsal or ventral deviation of the sternebrae from the radiographs agrees with the normal thoracic radiograph of other breeds of goats (Sissons and Grossman, 1975).The FSI and VI of WADG were not gender dependent and this explains why there was no significant variations ($p>0.05$) of these indices between the sexes. Although the vertical diameter of the thorax of the female WADG measured 9.5 to 19.8 cm while those of the male was 13.4 – 18.0 cm, there was no significant variation ($p>0.05$) in the vertical diameters of both sexes. This could be due to the fact that they were of the same age range and were reared at the same plain of nutrition. The vertical diameter is important in detection of pectus carinatum. In Pectus carinatum, the thorax is compressed laterally and the caudal aspect of the sternum is displaced ventrally (outwards) causing increase in vertical diameter of the thorax in the affected area (Suter, 1984; Farrow *et al.,* 1996).

Attempts to get published work on the various indices in other breeds of goat have not been successful. Goat breeds vary much in size and body conformation and this would have discouraged or slowed down work on these indices. Secondly as food animals, a greater number of farmers my prefer to sacrifice the animals rather than spending money on goat with thoracic anomalies. This might have contributed in fewer numbers of such cases being presented for treatment in our clinics and hence down playing on the need to determine those indices. Nevertheless determination of these indices is quite important for any patient that is to undergo correction of pectus anomalies. For successful correction to be achieved, it is important to know the normal FSI and VI as these would aid in determining the degree of surgical correction. This work has established the normal FSI and VI of WADG however further works need to be done to elucidate the effects of age on these indices since age has been found to affect these indices in dogs (Nnaji *et al.,* 2010)

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