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Topographic and Morphometric Anatomy of the Caudo-Frontal Depression of Black Bengal Goat (*Capra hircus*) with Its Implication of Cornual Nerve Block

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ABSTRACT

The study was planned to investigate the topographic and morphometric anatomy of the caudo-frontal depression of the Black Bengal Goat, as well as to determine the site for the cornual nerve block. A total of 33 Head samples from both sexes of adult Black Bengal goat were studied. Dissection was performed to explore the course of the cornual nerve, emphasizing where it passed over the caudo-frontal depression. The mean distance between the lateral margin of orbit to the caudo-frontal depression and the caudolateral base of the horn to the caudo-frontal depression were 1.01±0.03 and 0.50±0.04 cm, respectively. Again, the mean length and breadth of the caudo-frontal depression were 0.99±0.07 and 0.36±0.05 cm, respectively. This topographic and morphometric anatomy of the caudal-frontal depression of the Black Bengal goats will be helpful for veterinary practitioners in determining the most convenient site for the cornual nerve block of the Black Bengal goats.

Keywords: Black bengal goat, caudo-frontal depression, cornual nerve block, morphometry, topography.

INTRODUCTION

Caudo-frontal depression is a unique bilateral osteological feature found in goat breeds between the lateral boundary of orbit and the caudolateral base of the horn. The actual location of these depressions is on the cornual process of the frontal bone of both sides of the skull (Olopade et al., 2006).

The functional indication of this unique depression was first described by Shawulu (Shawulu et al., 2013) for local anesthesia in the dehorning of Sahel Goat. Surgical dehorning in adult Black Bengal goat found in Bangladesh is more invasive and painful. Thus, field veterinary practitioners need special knowledge and techniques for desensitization to dehorn the Black Bengal goat successfully.

Several findings (Getty, 1975; Butler, 1967) revealed that the cornual branch of zygomaticotemporal and infratrochlear nerves innervates the horn of goats. So, blocking these two nerves is required prior to the dehorning of the Black Bengal goat. Compared to the large ruminant-like ox, which has only one (cornual branch of zygomaticotemporal) nerve that innervates the horn (Hoffsis, 1995; La Fontaine, 2006). Here, the cornual branch of the zygomaticotemporal nerve block is archived at the midpoint between the dorsolateral

margin of the orbit and the dorsolateral base of the horn (Bourne, 2011; Vitums, 1954). Again, the infratrochlear nerve block is archived at the dorsomedial margin of the eye (Jenkins, 1986).

But, the involvement of the caudo-frontal depression may make the cornual nerve block easier as it passes over this depression. For that, we need precise knowledge of the location, shape, and size (topographic and morphometric anatomy) of the caudo-frontal depression from the Black Bengal goat's skull.

Only one study was carried out on morphometry of the caudo-frontal depression in Sahel goats (Shawulu et al., 2013). However, we need more knowledge of the location of reference points in this area to understand the relationship between depression and the cornual and infratrochlear nerve.

Thus, the study was planned to investigate the topographic and morphometric anatomy of the caudo-frontal depression of the Black Bengal goat in Bangladesh, with its implications as a landmark for cornual nerve block.

MATERIALS & METHODS

Sample collection and study area

The study was conducted on 33 head samples of adult Black Bengal goats of both sexes. These head samples of goats were collected from the local Slaughter house, Khulshi, Chattogram.

We tried to collect the similar shaped head samples of the adult Black Bengal goat in relation to their age. For that, we have applied the dentition method described by different authors (Getty, 1975; Assan, 2012). The deformities of the collected head samples of goats were eliminated.

Ethical Consideration

The head samples of goats were collected from the local Slaughter house, Khulshi, Chattogram, Bangladesh. Again, we have followed the guideline of Animal Experimentation Ethics Committee (AEEC) of Chattogram Veterinary and Animal Sciences University (CVASU) and standard procedure of desensitization for infratrochlear and cornual nerves block in live goat (Laura, 2012).

Dissection and Explore of Caudo-frontal Depression and Cornual Nerve

After obtaining permission (from Department of Anatomy and Histology, Chattogram Veterinary and Animal Sciences University), dissection was performed to expose the caudo-frontal depression and the cornual nerve on both sides. We have followed the standard procedure of dissection to expose the caudo-frontal depression and cornual nerves from both sexes of adult Black Bengal goats (Clark et al., 2016; Constantinescu, 2001).

Skull processing from the collected head sample

The skin and muscles from the goat's head were gently removed. Then, they were processed to form the dried bone using standard techniques described by different authors (Hildebrand, 1968; Merai, 2012; Gofur & Khan, 2010).

Measurements and Data Collection

All the caudo-frontal depression from the goat head were studied to record their topographic and morphometric anatomy at the laboratory of the Department of Anatomy and Histology, Chattogram Veterinary and Animal Sciences University (CVASU), Khulshi, Chattogram, Bangladesh. The following studies were conducted on the collected head samples and dried skulls of both sexes of the adult Black Bengal goat -

1. The caudo-frontal depression and cornual nerve were identified from the dissected goat's head samples (both male and female) on the lateral sides of both cornual processes of the frontal bones.
2. The shape and topographic anatomy of the caudo-frontal depression from the dried skull of both sexes of adult Black Bengal goats were measured and recorded.

3. The length and breadth of the caudo-frontal depression from the dried skull of both sexes of adult Black Bengal goats were measured and recorded.
4. The distance between the lateral margin of the orbital cavity to the caudo-frontal depression from the dried skull of both sexes of adult Black Bengal goats was measured and recorded.
5. The distance between the caudolateral base of the horn and the caudo-frontal depression from the dried skull of both sexes of adult Black Bengal goats was measured and recorded.

Finally, the knowledge of topography and mean distance among lateral margin of the orbit, caudo-frontal depression, and caudolateral base of the horn were applied to desensitization of the cornual nerve of a live Black Bengal goat.

STATISTICAL ANALYSIS

All these measurements were tabulated in Microsoft Excel 10. The analysis of the shape of the caudo-frontal depression in both sexes of adult Black Bengal goats was carried out using percentage (%). The measurement of distance between the lateral margin of orbit to the caudo-frontal depression and the caudo-lateral base of horn to caudo-frontal depression were analyzed with Graph Pad Prism Software (Version 8.0, San Diego, California, USA), and results were presented as mean measurement with standard deviation (Mean±SD). A significance level of 5% was considered in all the statistical analyses for this study.

RESULT

Topography of Caudo-frontal Depression and Cornual Nerve

In the dissected head samples of both sexes of adult Black Bengal goat, the cornual nerve was always present between the lateral canthus of the eye (lateral margin of the orbit) and caudolateral base of horn on both sides (Figure 1). There were no topographic differences between right and left cornual nerves of both sex of adult Black Bengal goat.

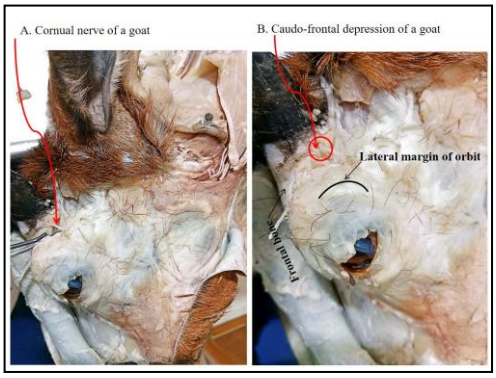

Figure 1 A) Cornual nerve and B) caudofrontal depression of a Black Bengal goat

After removing muscles and other tissue, an oval depression is exposed just under the cornual nerve on both sides. These were the caudo-frontal depressions that lie on the lateral side of the continual process of the frontal bone (Figure 1). Again, they were located just above the temporal fossa on both sides of the goat's skull.

Shape, Length, and Breadth of Caudo-frontal Depression

The processed and dried samples of the goat's skull revealed the actual shape, length, and breadth of the Caudo-frontal depressions, which were presented in (Table 1) and (Table 2).

Table 1 Variation of the Shape of Caudo-frontal Depression in Black Bengal Goat

Parameters		Sample Number (n)	Percentages (%)
Shape of Caudo-frontal Depression	Oval-shaped	38	57.58%
	Blade-shaped	28	42.42%

Here, the oval-shaped caudo-frontal depressions (Figure 2) were predominant (57.58%) compared to the blade-shaped caudal-frontal depression (42.42%).

The mean length of the caudo-frontal depression on both sexes of adult goats was 0.99±0.07 cm (Table 2). Again, the mean breadth of the caudo-frontal depression on both sexes of adult goats was 0.36±0.05 cm.

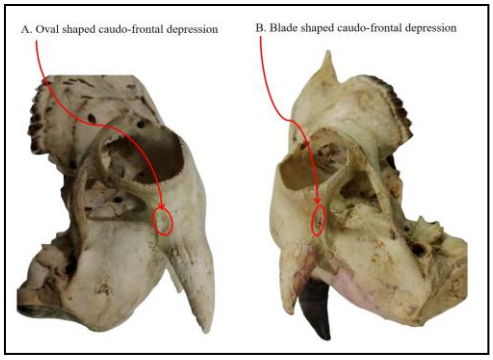

Figure 2 Shape of the caudofrontal depression in Black Bengal goat; A0 Oval shaped caudo-frontal depression, and B) Blade shaped caudo-frontal depression.

However, the data presented in Table 2 shows significant differences (both in length and breadth) between the right and left caudal-frontal depression in both sexes of goats. Here, the length of both the right and left caudo-frontal depressions of female Black Bengal goats (1.02±0.05, 1.06±0.03) are more than the male (0.92±0.02, 0.93±0.02), respectively. Again, the female goat has the higher breadth in caudo-frontal depression both on the right and left sides (0.40±0.02, 0.39±0.01) compared to the male (0.35±0.03, 0.28±0.02), respectively.

Table 2 Length and Breadth of Caudo-frontal Depression of Both Sex of Adult Black Bengal Goat on Right and Left Sides (Here, CFD = Caudo-Frontal Depression, and cm = Centimeters)

Parameters	Length of CFD (cm)		Mean Length (cm)	Breadth of CFD (cm)		Mean Breadth (cm)
	Right	Left		Right	Left	
Male Goat (n= 15)	0.92±0.02	0.93±0.02	0.99±0.07	0.35±0.03	0.28±0.02	0.36±0.05
Female Goat(n=18)	1.02±0.05	1.06±0.03		0.40±0.02	0.39±0.01	

Distance between the Lateral Margin of Orbit to Caudo-frontal Depression

The distance between the lateral margin of the orbit to the caudo-frontal depression is presented in (Table 3).

Table 3: Distance Between Lateral Margin of Orbit to Caudo-frontal Depression of Both Sex of Adult Black Bengal Goat on Right and Left Sides (Here, LMO = Lateral Margin of Orbit, and cm = centimeters).

Parameters	Length of CFD (cm)		Mean Length (cm)	Breadth of CFD (cm)		Mean Breadth (cm)
	Right	Left		Right	Left	
Male Goat (n= 15)	0.92±0.02	0.93±0.02	0.99±0.07	0.35±0.03	0.28±0.02	0.36±0.05
Female Goat(n=18)	1.02±0.05	1.06±0.03		0.40±0.02	0.39±0.01	

Here, the mean distance between the lateral margin of orbit to the caudo-frontal depression (Figure 3) in both sexes of the adult goats was 1.01±0.03 cm on both sides.

But these distances are always higher in female goats on the right and left sides (1.00±0.03, 1.02±0.02) than these the males (0.95±0.02, 0.98±0.01), respectively.

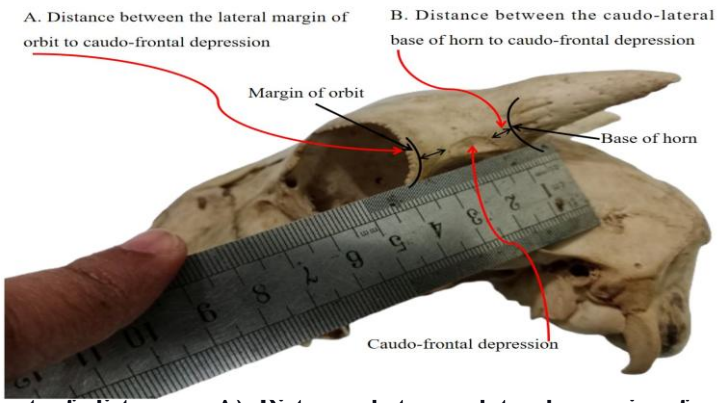

Figure 3 Measurement of distances; A) Distance between lateral margin of orbit to caudo-frontal depression; and B) Distance between the caudo-lateral base of horn to caudo-frontal depression

Distance between the Caudolateral Base of the Horn to Caudo-frontal Depression

Table 4 shows the distance between the caudolateral base of the horn and the caudo-frontal depression. Here, the mean distance between the caudolateral base of the horn to caudo-frontal depression (Figure 3) in both sexes of adult Black Bengal was 0.60±0.15 cm.

Table 4: Distance Between Caudo-Lateral Base of Horn to Caudo-Frontal Depression of Both Sex of Adult Black Bengal Goat on Right and Left Sides (Here, CLBH = Caudo-Lateral Base of the Horn, and cm = Centimeters).

Parameters	Distance Between CLBH to CFD (cm)		Mean Distance (cm)	Mean Distance (cm)
	Right	Left		
Male Goat (n= 15)	0.47±0.02	0.46±0.03	0.47±0.02	0.50±0.04
Female Goat(n=18)	0.53±0.01	0.54±0.03	0.53±0.02	

The mean distance on the right and left sides of female goat are 0.53±0.01 and 0.54±0.03 cm, respectively. Whereas the male has lower values on both the right and left sides (0.47±0.02, 0.46±0.03, respectively) compared to the female goat.

Application of the Research Knowledge to Desensitization of Cornual Nerve

We applied the mean value distance (between the lateral margin of orbit to caudo-frontal depression and caudolateral base of the horn to caudo-frontal depression;1.01±0.03, and 0.50±0.04 cm, respectively) and topographic anatomy of caudal-frontal depression to desensitization the cornual nerve from a live Black Bengal goat. First, we identified the suggested landmark and performed desensitization of the nerve. We have also performed desensitization of infratrochlear nerve along with cornual nerve. All hygienic measurements and precautions are considered during the desensitization of the cornual and infratrochlear nerves block.

DISCUSSION

Topographic Anatomy of Caudo-frontal Depression and Cornual Nerve

The dissected sample of adult Black Bengal goats of both sexes showed the cornual nerve on both sides. This information was supported by the findings of Getty, Ghosh, and Clark (Getty, 1975, Ghosh, 2012, and Clark et al., 2016). The gross view of length, thickness, and other appearances of cornual nerves on both sides in both sexes of adult Black Bengal goat are similar. This cornual nerve extends from the caudal end of the orbital margin to the caudo-lateral base of the respective horn.

The dissected Black Bengal goat's head sample also showed that the caudo-frontal depression lies on the lateral side of the continual process of the frontal bone. A similar observation was reported in the Sahel, Red Sokoto, and West African Dwarf Goat Breeds (Olopade et al., 2006; Shawulu et al., 2013).

Morphometric Anatomy of Caudo-frontal Depression (Shape, Length, and Breadth)

The present study showed two types of caudo-frontal depression in both sexes of adult Black Bengal goats. Here, oval-shaped caudo-frontal depressions (76%) are predominant over the blade-shaped depression (24%). Still, now, there is no such documentation on the variation in the shape of the caudal-frontal depression in the goat breed.

The mean length of the caudo-frontal depression on both sexes of adult goats was 0.99±0.07 cm. Here, the female Black Bengal goat showed higher length on both the right and left sides (1.02±0.05 and 1.06±0.03, respectively) than the male. No previous study has been conducted on the length of caudo-frontal depression in the goat breed. But, this variation in length between female and male goats may be due to larger cranial and facial morphometric

parameters (Wang et al., 2021; García et al., 2002; Samuel et al., 2013).

Again, the female Black Bengal goat showed higher breadth in caudo-frontal depression both on the right and left sides (0.40±0.02, 0.39±0.01) compared to the male (0.35±0.03, 0.28±0.02); respectively. This finding was supported by the study of Shawulu et al., 2013.

But, if we compare the breadth of caudo-frontal depression among the goat breed like Black Bengal, Sahel, and Red Sokoto, then it showed a significant difference.

The value of breadth in Black Bengal males (0.35±0.03; 0.28±0.02) and female (0.40±0.02, 0.39±0.01) is lower than the Sahel male (0.84±0.04,0.85±0.13), and female (1.01±0.09, 0.97±0.14) on right and left sides; respectively. This may be due to the environmental factors of various geographical locations (Albarella et al., 2009; Goodarzi et al., 2014).

Distance between the Lateral Margin of Orbit to Caudo-frontal Depression

The distance between the lateral margin of the orbit to the caudo-frontal depression on the right and left side of a female Black Bengal goat's skull (1.0±0.03, 1.02±0.02) is higher than that of the male (0.95±0.02, 0.98±0.01); respectively. A similar finding was also found in the study of Shawulu et al., 2013. However, a slight variation in this distance is found between Black Bengal and Sahel goats (Kwari et al., 2004). Again, this variation may be due to the environmental factors of various geographical locations (Albarella et al., 2009).

Distance between the Caudolateral Base of the Horn to Caudo-frontal Depression

The mean distance between the caudolateral base of the horn to the caudo-frontal depression on the right and left sides of male goats are 0.47±0.02 and 0.46±0.03 cm, respectively. These values are lower than those of the female goat (00.53±0.01 and 0.54±0.03). This finding was supported by the previous study of Shawulu et al., 2013. However, slight breed variation is found between the Black Bengal and Sahel goats.

Desensitization of Cornual Nerve in Live Goat

After morphometric and topographic evaluation, the landmark (caudo-frontal depression) is determined for local anesthesia (Taylor, 1991). Both the nerves infratrochlear and cornual branches of zygomaticotemporal (Buttle et al., 1986) were desensitized. We tested the sensation of the horn and found it inactive; thus, a successful desensitization of the infratrochlear nerve was performed.

CONCLUSION

The topographic and morphometric anatomy of the caudo-frontal depression will help veterinarians to localize this depression more precisely (1.01±0.03 cm away from the lateral margin of the orbit and 0.50±0.04 cm away from the caudolateral base of horn) for cornual nerve block. As a landmark, this caudo-frontal depression will also be helpful for veterinarians to quickly locate the cornual nerve block site and avoid the toxicity of local anesthesia. However, further research on the variation of caudo-frontal depression in both sexes of different goat breeds should be performed.

Declaration by Authors

Ethical Approval: Approved

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