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Morphological study of the uterus in adult female Mandya sheep (*Ovis aries*)

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Abstract
This study was conducted on the Uterus of six healthy, nonpregnant adult Mandya ewes collected from a slaughterhouse in Malavali Taluka, Karnataka. Samples were used for gross anatomical and morphometric study, using Vernier calipers, measuring scales, and nonelastic thread. Gross anatomical observations revealed that the Uterus is bicornuate and bipartite, a tubular organ positioned within the pelvic cavity. Comprising two uterine horns (cornua uteri), a single uterine body (corpus uteri), and caudal constriction (cervix uteri). The genital system was anchored by the broad ligament, which extends from the ventral surface of the Uterus to the lateral walls of pelvic cavity. At the divergence point, the two uterine horns were connected by an Intercornual ligament. Internally, the Uterus exhibited 83-90 brown caruncles. Morphometric measurements showed that the mean lengths of the right and left uterine horns were 9.73±0.17 cm and 13.02±0.57 cm, respectively, indicating a statistically significant difference (p<0.05). The widths of the right horn at the uterotubal junction and middle of horn were 0.567±0.04 cm and 1.90±0.063 cm, respectively; for the left horn, these measurements were 0.533±0.04 cm and 1.80±0.068 cm, respectively with no significant difference noted (p>0.05). The corpus uteri measured 2.27±0.13 cm in length and 1.87±0.10 cm in width. The cervix measured 3.35±0.11 cm long and 1.03±0.05 cm wide, with the number of cervical folds ranging from four to six. These morphometric insights have practical application in breeding management, infertility diagnosis, and treatment. This study enhances the understanding of the reproductive anatomy of the Mandya ewe.

Keywords: Ewe, Mandya sheep, morphometric, uterus

Introduction
The Mandya sheep is a small-sized, compact breed native to the Mandya district of Karnataka, and neighbouring regions of Bengaluru Rural and Mysuru (Bhat and Arora., 2009) [4]. The coat colour of these sheep are predominantly whitish, with some individuals exhibiting a light brown face that may extend to the neck. They possess a distinctive, reversed U-shaped body conformation when viewed from the rear, long drooping leaf-like ears, and a slightly Roman nose (Figure 1). Both sexes are typically polled. (Jain *et al.*, 2005) [11] Mandya sheep are generally raised in small flocks of two to four animals, often in backyard systems. They are well-adapted to the semi-arid climate of the southern dry zone (Jain *et al.*, 2014) [12]. According to the 2013 breed-wise livestock survey by the Department of Animal Husbandry, Dairying, and Fisheries, Government of India, the Mandya sheep population was 2,44,468. This breed is considered a prominent indigenous meat breed in Karnataka, recognized for its superior meat quality (Dinakar *et al.*, 2019) [7]. In terms of reproductive characteristics, Mandya ewes reach sexual maturity at approximately 650 days of age, and the litter size is typically one. The first birth usually occurs at around 645.4±26.1 days of age (Ravi *et al.*, 1998) [7]. Regarding reproductive anatomy, the Uterus plays a crucial role in fertilization, embryo nourishment, and fetal development (Bergstein-Galan *et al.*, 2018) [2]. While detailed morphological studies of the Uterus in cattle, buffalo, mare, and goats are available, specific studies on the uterine morphology of Mandya ewes are minimal.

Materials and Methods
Six non-pregnant Uterus of adult Mandya sheep were collected from the local slaughter house in Malavali taluka of Karnataka state. Identifying the Mandya sheep by its phenotypic

Characteristics (Jain *et al.*, 2005) [11] and age was determined by the dentition (Pitassi *et al.*, 2022) [16]. After immediate slaughtering, the female reproductive tract was separated from the pelvic viscera by fine dissection and thoroughly checked for gross pathological lesion. Pelvic symphysiotomy is performed to visualize the anatomical structure and its placement, which was recorded. The broad ligament, the loose connective tissue, and the fat surrounding the Uterus, Vulva, and the retroperitoneal part of the vagina were removed for better examination, and the complete genital tract was preserved in a container with ice gel pack at a temperature of around 4 °Celsius. The collected samples were brought to the Department of Veterinary Anatomy, Veterinary College, Hebbal, for gross morphological and morphometric study. The morphometric study was done using a vernier caliper, a measuring scale, and a non-elastic thread. The length of the cornua uteri was taken from the point of divergence to the utero-tubal junction, and the width of the cornua uteri was taken at the utero-tubal junction and the middle. The length of the corpus uteri will be measured from the point of opening of the cornua uteri to the internal os of the cervix. The width of the corpus uteri will be taken at the middle of the body. The length of the cervix uteri will be measured from the external os to the internal os. The width of the cervix uteri will be taken at the middle of the cervix uteri. The compiled data is subjected to statistical analysis using GraphPad Prism software version 10. The methodology followed was adapted from Botlagunta *et al.*, (2022) [5], ensuring consistency and accuracy in the measurements.

Results and Discussion

The Uterus of the Mandya ewe was an elongated, musculo-membranous tubular organ, comprising two uterine horns (cornua uteri) and one uterine body(corpus uteri) respectively. The caudal end of the corpus uteri was cervix. The uterus of Mandya ewe was bipartite in nature (Figure 2) with small intercournual ligament between the two cornua uteri (Figure 3), Similar observations were reported in small ruminant (Nickel *et al.*, 1979) [14]. Anatomically, the non-pregnant Uterus was located ventral to the rectum within the pelvic cavity, and its ventral surface adjacent to the dorsal surface of the urinary bladder, similar to the findings in ruminant (Ellenport., 1975) [8]. The pelvic peritoneum covered the Uterus, and it was secured to the pelvic wall by the broad ligament, which attached dorso-laterally to the walls of pelvic cavity (Figure 4). These anatomical relationships are consistent with findings in other ruminants, such as goats (Al-darajee and Al-Mayahi., 2024) [1] and Nellore sheep (Botlagunta *et al.*, 2022) [5]. The corpus uteri continued caudally as a constricted structure with four to six annular folds, with narrow passage (Figure 5). A similar study of the cervix uteri was reported in ewes (Kershaw *et al.*, 2005) [13], which ended with a pointed slit into the vagina (Figure 6), similar to the findings in sheep (Nischitha *et al.*, 2021) [15]. The morphometric analysis revealed that the left cornua uteri measured 13.02±0.57 cm in length, while the right cornua uteri measured 9.73±0.17 cm (Table 1). Statistical data revealed a significant difference ($p<0.05$) in the length of the left and right uterine cornua (Graph 1), These measurements are close to those reported in goats (Bergstein-Galan *et al.*, 2018) [2] and sheep (Botlagunta *et al.*, 2022; Sahu *et al.*, 2017) [5, 18]. The mean width of the right cornua uteri at the utero-tubal junction and at middle was 0.533±0.04cm and 1.9±0.063cm respectively. The width of left cornua uteri at the utero-tubal junction and at middle was 0.533±0.04cm and 1.80±0.068cm respectively. (Table 1). which may be correlated with finding of Giraldo *et al.*, 2009 [9] which suggest that 45.3% pregnancies occurred in the left uterine horn, whereas 54.7% occurred in the right. However, there was no significant difference in the width of the left uterine cornua at the utero-tubal junction (Graph 2) and the middle (Graph 3). Morphometrics of corpus uteri measured 2.27±0.13cm in length and 1.87±0.10cm in width at the middle (Table 2). The cervix uteri, which was the narrow, caudal portion of the Uterus, measured 3.35±0.11cm in length and 1.03±0.05 cm in width (Table 2). The number of cervical folds observed was four to six (Table 3), which was consistent with the range typically found in ewes by (Chinchakar *et al.*, 1990) and in goats by (Bhat *et al.*, 2011) [3]. The internal surface of the corpus uteri featured small, button-shaped, brown-colored, concave structures known as caruncles (Figure 7) similar to those reported in ewes (Hadek, R., 1955). The number of caruncles observed was 83-90 (Table 4), which is similar to the findings reported by (Chinchkar *et al.*, 1990) [6] in Bannur ewes and by (Bhat *et al.*, 2011) [3] in Kashmiri sheep. The presence of number of caruncle for forming the placentome during pregnancy were critical for the development and nourishment of the fetus during gestation, as observed in neonates by (Sudhakara Rao *et al.*, 2021) [19].

Table 1: Gross morphometric measurement of the uterine cornua (cm)

Animal	Body Weight (Kgs)	Right cornua of Uterus			Left cornua of Uterus		
		Length(cm)	Width (cm)		Length(cm)	Width (cm)	
			Junction	Middle		Junction	Middle
1	18.40	10.1	0.5	1.8	11.2	0.7	1.6
2	16.35	9.2	0.7	2.1	12.3	0.4	1.9
3	19	9.7	0.5	2.0	12.1	0.6	1.6
4	20	10.2	0.7	2.0	14.2	0.4	1.9
5	25	9.3	0.6	1.7	15.1	0.5	2.0
6	16.25	9.9	0.4	1.8	13.2	0.6	1.8
Mean±SE	19.50 ± 1.29	9.73± 0.17	0.567±0.04	1.9±0.063	13.02±0.57	0.533±0.04	1.80±0.068

Table 2: Gross morphometric measurement of the corpus uteri (cm)

Animal	Length (cm)	Width (cm)
1	2.1	2.0
2	1.9	1.5
3	2.0	1.7
4	2.6	2.1
5	2.3	2.1
6	2.7	1.8
Mean±SE	2.27 ± 0.13	1.87± 0.10

Table 3: Gross morphometric measurement of the Cervix uteri (cm)

Animal	Number fold	Length(cm)	Width(cm)
1	4	3.3	0.9
2	5	3.1	0.9
3	6	3.0	1.0
4	4	3.6	1.1
5	5	3.4	1.2
6	4	3.7	1.1
Mean±SE	4.67± 0.27	3.35±0.11	1.03± 0.05

Table 4: Number of caruncles observed on the internal surface of cornua and corpus of the Uterus

Animal	No. of caruncles
1	83
2	82
3	85
4	90
5	89
6	88
Mean±SE	86.17 ± 1.35

Fig 1: Showing typical Mandya ewe

Fig 2: Photograph of corpus uteri of Mandya ewe showing bipartite (arrow) corpus uteri

Fig 3: Photograph of uterus of Mandya ewe showing intercornual-ligament (arrow)

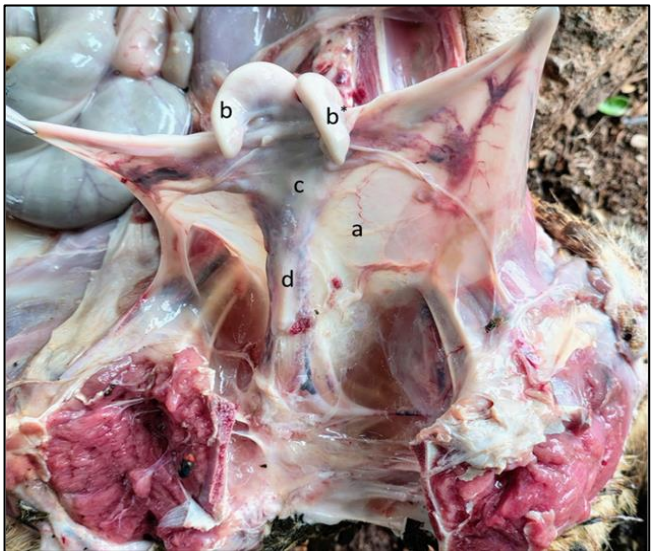


Fig 4: Photograph of genital system of Mandya ewe showing broad ligament(a), right cornua uteri(b), left cornua uteri(b*), ventral surface of corpus uteri(c) and ventral surface of cervix uteri(d)

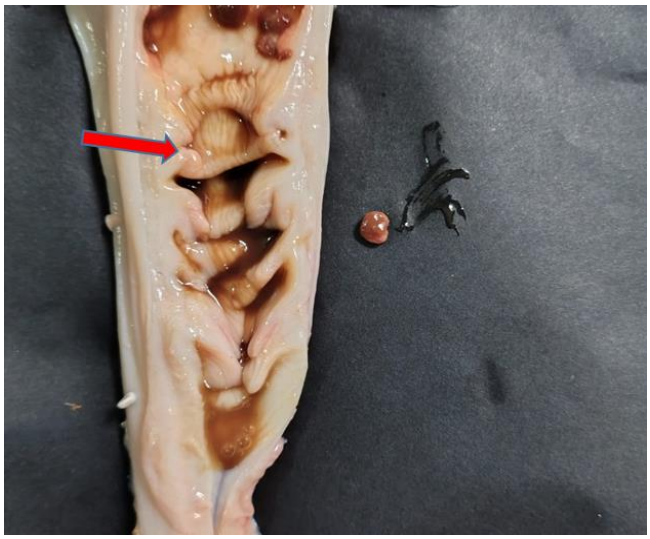


Fig 5: Photograph of cervix uteri of Mandya ewe showing cervical folds (arrow)

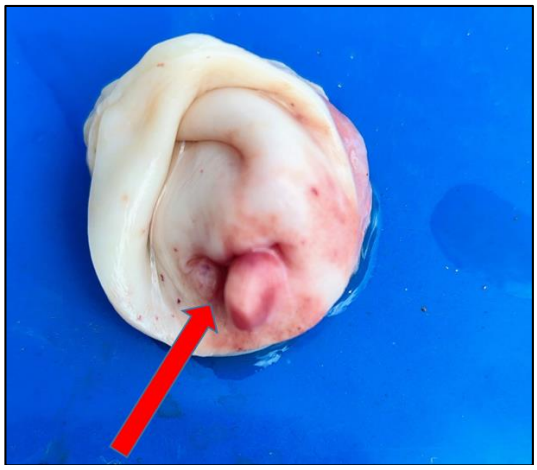
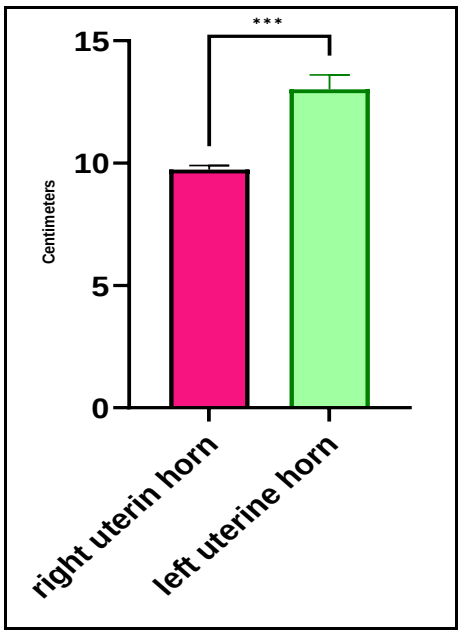
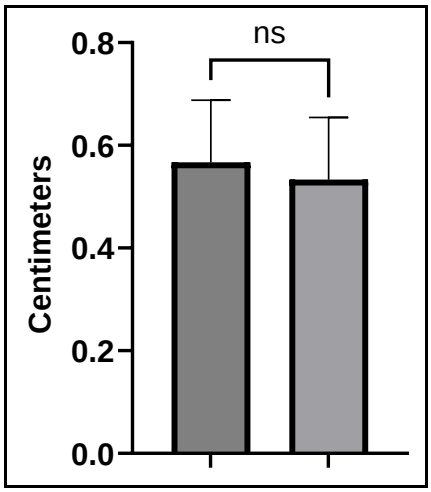


Fig 6: Photograph of external os Mandya ewe showing slit like opening of cervix uteri (arrow)

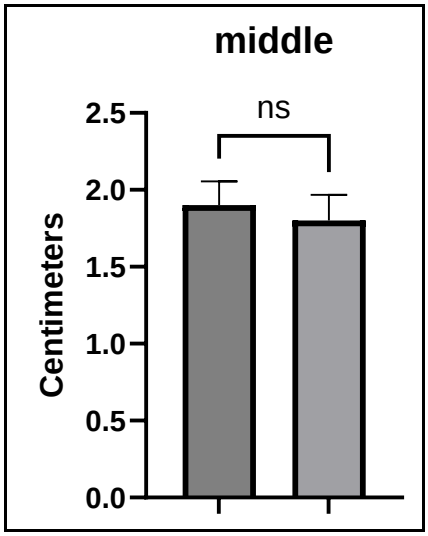
Fig 7: Photograph of internal surface of corpus uteri showing brown colored concave shaped caruncles (arrow)



Graph 1: Comparision of length of right and left cornu uteri of Madgyal sheep



Graph 2: Comparision of width of right and left cornua uteri at uterotubal junction



Graph 3: Comparision of width of right and left cornua uteri at middle

Conclusion

The findings of this study offer valuable insights into the anatomy and morphology of the Uterus in Mandya ewes, thereby contributing to a deeper understanding of their reproductive biology. These data can be useful for improving breeding and reproductive management practices of this breed. This study takes us to a point where there is calibre to establish the relationship between the caruncle number and fetus body weight and litter size.

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