Morphological characterization of the testis and epididymis in crossbred sheep and indigenous goats in Jammu

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Abstract

The present study was conducted on 20 samples of (10 from each species) testis and epididymis from freshly slaughtered apparently healthy adult crossbred sheep & non-descript goats. Testes of both crossbred sheep and non-descript goats were large, irregularly elliptical and rounded to oval in shape. Lateral surface was more convex than the medial one. Convexity of the cranial border was more than the caudal border irrespective of the species. The epididymis was attached to the caudomedial border of the testis. The upper end was occupied by the head of epididymis whereas the lower end was connected to the tail of epididymis. The testes of crossbred sheep was brownish red whereas it was white in colour in non-descript goats. Testes of crossbred sheep showed conspicuous surface vascularity as compared to non-descript goats. Mediastinum testis was central in position. Epididymis was an elongated structure which was closely attached to the caudo-medial aspect of testis in both the species. The epididymis consisted of caput, corpus and cauda. Corpus was the narrowest of the three parts of the epididymis in both the species. Biometrical parameters were significantly higher in sheep than in goats. Within each species, the biometrical parameters did not show significant difference between right and left sides. Corpus was the longest part of epididymis in both the species under study followed by caput and cauda was the shortest part. However, caput of epididymis was the widest and heaviest part in both the species and cauda epididymis was the thickest part.

Keywords: Biometry, Crossbred sheep, Epididymis, Goat, Testis

Introduction

Sheep and goats are of the oldest domesticated species useful to humans. They contribute substantially to income and food security of most of the households in rural areas. Sheep and goat being well conformed and stress resilient animals thrives better in the hilly and other inaccessible areas where it is difficult for other livestock to cope the adversities of terrain and harsh environment, warrants food and economic security of the poor communities (Khan et al. 2013). The Union Territory of Jammu and Kashmir being a hilly and temperate state is ideally suited for rearing of sheep and goat owing to its favourable agro-climatic and topographical conditions and richness in natural fodder resources in the form of pastures, orchards, aquatic vegetation etc. (Suri et al. 2022). Sheep and goat rearing as secondary occupation has played an important role in boosting the economy of these rural people. Goat is a seasonal breeder and most sheep have a breeding season (tupping) in the autumn, through some are able to breed year-round.

The testis and epididymis are very important organs of male reproductive system. Functionally the testis is both exocrine and endocrine, producing the spermatozoa and synchronized with the male sex hormone-testosterone. The size of the testis and functional testicular characteristics are indicators of sexual activity and semen production from the daily sperm production potential of the animals and also, the testes shape, size and location vary species to species but the vital structure of organs is the same (Khan et al. 2014). The epididymis is formed by long, highly convoluted duct, which is the site for maturation and storage of spermatozoa. The head or caput rests on the dorso-caudal border of the testis; the body is represented by a thin strip-like structure located on the caudomedial border of the testis. The tail is an enlarged promontory-like structure located on the ventromedial border of the testis and is easily palpable through the scrotum (Goyal and Williams 1991).

Testicular parameters would indicate the level of sexual activity and semen production from the daily sperm production potential in buck. The study was conducted with an objective to comparatively characterize the gross morphology and biometric features of the testis and epididymis in crossbred sheep and indigenous goats of Jammu, with the aim of identifying species-related probable anatomical variations relevant to reproductive biology. Moreover, the available literature on comparative anatomical details of testis and epididymis of adult crossbred sheep and non-descript goats is scant which prompted to undertake this present work on the comparative anatomical studies on the testis and epididymis of non-descript sheep and goat of Jammu region of U.T. of Jammu and Kashmir.

Materials and methods

A total of 20 samples of (10 from each species of animal) testis and epididymis from freshly slaughtered apparently healthy adult crossbred sheep & non-descript goats varying in age from 1.5 to 3 years were collected from the slaughter houses located in and around Jammu city and immediately brought to the laboratory of the Division of Veterinary Anatomy, F.V.Sc. & A.H., SKUAST-J, R.S. Pura. The age was estimated by examining the dentition. Immediately after reaching the laboratory, the gross anatomical features of the testis and epididymis were studied. Following biometrical parameters were recorded:

Testis

a) Length (cm) : Distance between the dorsal and ventral poles of the testis.

b) Width (cm) : Antero- posterior diameter of the testis at its middle part.

c) Thickness (cm) : Medio-lateral distance at the middle of the testis.

The length, width and thickness of each testis was recorded using a Vernier Callipers.

d) Weight (g) : It was recorded using Monopan Electronic Balance (Systronics) with sensitivity from 0.02 mg to 310 g.

e) Shape Index (%) : Shape index was calculated as per Barnal and Sinha (1981)

$$\frac{\text{Testis width}}{\text{Testis length}} \times 100$$

f) Testicular volume (TV) ($cm^{3)}$: It was calculated as per Wrobel et al. (1988).

$TV = 1/6 \times \Pi \times \text{Length (cm)} \times \text{width}^2\ (cm^{2)}$

True testicular volume was obtained using testicular volume multiplied by a correction factor (0.945) for ruminant testis (Wrobel, 1990).

h) Testicular parenchymal volume (TPV) ($cm^{3)}$: Testicular parenchymal volume was considered as 89% of true testicular volume since 11% of the true testicular volume was due to volume contributed by tunica albugenia and mediastinum testis (Wrobel et al. 1988).

Epididymis

Each epididymis was separated from the testis and divided into caput, corpus and cauda based on the external morphology. Length (cm), width (cm) and thickness (cm) of each segment of the epididymis was measured using Vernier Callipers. The weight (gm) of each segment of epididymis was recorded using a Monopan Electronic Balance (Systronics) with sensitivity from 0.02 mg to 310 g.

Data generated was analyzed using standard statistical procedure (Snedecor and Cochran 1994).

Results and discussion

Gross morphology

The testes and epididymides were paired organs located in the scrotum. The testicles of crossbred sheep and non-descript goats were positioned vertically between the thighs. In the current investigation, the testes of both crossbred sheep and non-descript goats were found to be big, irregularly elliptical, and rounded to oval in shape. These results were consistent with the findings of Karimi et al. (2019) in Ghezel ram and Nimase et al. (2023) in Deccani ram. In both the species studied, each testicle had two surfaces, two borders, and two extremities. The lateral surface was more convex than the medial one, which was flattened. The convexity of the cranial border was greater than the caudal border, regardless of the species. The epididymis was connected to the caudomedial border of the testis (Fig. 1). The head of epididymis occupied the upper end (extremitas capitata), while the lower end (extremitas caudata) was attached to the tail of epididymis. The tunica albuginea, or connective tissue capsule, enveloped both testicles. The parenchyma was brownish red in crossbred sheep and creamish yellow in non-descript goats. The outer surface of testes of crossbred sheep was brownish red in colour whereas in non-descript goats, it was white in colour. Testis of crossbred sheep showed conspicuous surface vascularity as compared to non-descript goats (Fig.2, 3).

The mediastinum testis in both the species was central in position (Fig. 4). This fibrous tissue contains numerous fine tubules (rete testis) in the central part. It was found in both species' core parenchyma of the testis and extended dorso-ventrally, as described by Pathak et al. (2016) in goats. Connective tissue strands penetrated the parenchyma from all the sides.

The epididymis was an extended structure that was closely connected to the caudo-medial portion of the testis in both the species (Fig. 1). The epididymis comprised of three parts: caput, corpus, and cauda (Fig. 2, 3). Caput was firmly connected to the capsule of the testis. The corpus was the narrowest of the three parts of the epididymis in both species.

Biometry

The biometrical parameters of testis and epididymis of crossbred sheep and non-descript goats are depicted in Table 1 and 2. Within each species under study, all biometrical measures showed no significant difference between the right and left sides. Similar findings were reported by Oyeyemi et al. (2012) in Sahel bucks, AL-Mahmodi et al. (2017) in rams and bucks, and Baldaniya et al. (2020) in bucks. Karimi et al. (2019) in Ghezel ram and Singh et al. (2022) in buck found that biometrical characteristics of the testis and epididymis differed significantly between the left and right sides. The left side displayed higher values than the right one.

Sheep had significantly higher testicular and epididymal volumes and weights ($P<0.05$) than goats. However, within each species, there was no significant difference between the left and right testis and epididymis. The right testis had higher values in sheep, but the left testis had higher values in goats. The average weight of the right and the left testis were 105.80±0.92 gm and 107.79±1.18 gm in the sexually mature ram, respectively (Nimase et al. 2023). Such differences in testicular weight documented by various experts could be attributed to age and species variation.

The left testis of sheep was 9.32 ± 0.34 cm long, whereas the length of right testis was 9.29 ± 0.31 cm. Sheep had significantly longer ($P<0.05$) left and right testes compared to goats (7.24 ± 0.19 cm and 7.17 ± 0.1 cm, respectively). However, within each species, there was no significant variation between the right and left testis, as also observed by Patni et al. (2016) in local Pantja goats. Many researchers reported significantly longer left testicles in goats (Kabiraj et al. 2011; Al-Mahmodi et al. 2017; Chaudhary et al. 2018; Baldanya et al. 2020). Kabiraj et al. (2011) recorded the length of the left testicle in the black Bengal bucks at age of 0.5 to 1.0, 1.5 to 2.0 and 2.5 to 3.0 years which was 6.10 ± 0.13 cm, 7.20 ± 0.31 cm and 7.85 ± 0.22 cm and for right testicle was 5.85 ± 0.13 cm, 6.90 ± 0.33 cm and 7.35 ± 0.18 cm, respectively. Baldaniya et al. (2020) reported longer left testis (7.04 ± 1.03 cm) than right testis (6.83 ± 0.90 cm) in mature buck. In morbid buck, left testis (7.94 ± 0.16 cm) was significantly longer than right testis (7.55 ± 0.16 cm) (Singh et al. 2022). The differences in values seen among various researchers could be attributed to age and species variation. Similarly, testes in sheep were significantly wider ($P<0.05$) than in goats. The width of sheep's left and right testis was 6.39 ± 0.19 cm and 6.44 ± 0.18 cm, respectively. In present study, the measurements for goats were 5.14 ± 0.11 cm and 5.16 ± 0.12 cm, respectively. True testicular volume was recorded as 155.7 ± 13.84

Table 1: Biometrical parameters of testis of crossbred sheep and non-descript goats

Parameter	Crossbred sheep		Non-descript goats	
	Left	Right	Left	Right
Weight of testis (gm)	164.11±14.20^{b}	170.51±15.53^{b}	86.03±5.16^{a}	85.12±5.42^{a}
Weight of epididymis (gm)	25.66±2.68^{b}	26.67±2.84^{b}	12.29±1.08^{a}	12.21±1.02^{a}
Weight (testis+ epididymis) (gm)	191.20±16.35^{b}	198.68±17.61^{b}	102.29±6.99^{a}	101.55±7.31^{a}
Length (cm)	9.32±0.34^{b}	9.29±0.31^{b}	7.24±0.19^{a}	7.17±0.17^{a}
Width (cm)	6.39±0.19^{b}	6.44±0.18^{b}	5.14±0.11^{a}	5.16±0.12^{a}
Thickness (cm)	3.71±0.18	3.91±0.21	3.46±0.09	3.46±0.11
Shape index	68.75±1.36	69.53±1.09	71.11±1.15	72.02±1.05
Testicular volume (ml)	155.7±13.84^{b}	161.7±15.16^{b}	85.8±4.42^{a}	84.8±4.59^{a}
True testicular volume (cm$^{3)}$	190.53±16.37^{b}	194.33±15.13^{b}	95.93±6.21^{a}	96.3±6.23^{a}
Testicular parenchyma (cm^{3})	169.57±14.57^{b}	172.96±14.18^{b}	85.57±5.54^{a}	85.33±5.52^{a}

Mean value with same superscript (a, b) within row do not differ significantly (p>0.05)

Table 2: Comparative biometrical parameters of epididymis

Parameter	Crossbred sheep		Non-descript goat	
	Left	Right	Left	Right
Caput				
Length (cm)	4.99±0.27^{b}	5.13±0.26^{b}	4.06±0.16^{a}	4.02±0.13^{a}
Width (cm)	2.78±0.12	2.88±0.12	2.59±0.091	2.68±0.06
Thickness (cm)	0.94±0.12	0.90±0.12	0.89±0.11	0.80±0.04
Weight(gm)	11.13±1.44^{b}	11.14±1.36^{b}	6.12±0.56^{a}	6.00±0.47^{a}
Volume(ml)	10.63±1.55^{b}	10.81±1.59^{b}	5.77±0.46^{a}	5.56±0.35^{a}
S-index	56.25±2.07^{b}	56.60±2.35^{b}	64.58±3.31^{a}	67.14±2.81^{a}
Corpus				
Length (cm)	8.98±0.36^{b}	8.98±0.39^{b}	6.87±0.33^{a}	6.82±0.28^{a}
Width (cm)	0.81±0.05^{b}	0.85±0.06^{b}	0.63±0.03^{a}	0.67±0.04^{a}
Thickness (cm)	0.37±0.03	0.35±0.01	0.32±0.01	0.33±0.02
Weight(gm)	4.13±0.45^{b}	4.10±0.46^{b}	1.66±0.19^{a}	1.82±0.23^{a}
Volume(ml)	4.17±0.44^{b}	4.14±0.58^{b}	1.67±0.22^{a}	1.69±0.20^{a}
S-index	9.11±0.66	9.53±0.72	9.87±0.64	9.85±0.47
Cauda				
Length (cm)	3.39±0.21^{b}	3.61±0.21^{b}	2.73±0.26^{a}	2.53±0.18^{a}
Width (cm)	2.58±0.09^{b}	2.55±0.09^{b}	1.99±0.10^{a}	1.93±0.10^{a}
Thickness (cm)	1.35±0.07^{ab}	1.48±0.06^{b}	1.19±0.04^{a}	1.30±0.07^{ab}
Weight(gm)	9.96±1.01^{b}	10.60±1.06^{b}	4.44±0.49^{a}	4.27±0.49^{a}
Volume(ml)	9.52±1.04^{b}	10.32±1.21^{b}	4.29±0.52^{a}	4.06±0.49^{a}
S-index	77.56±3.84	71.45±2.41	77.78±7.60	78.18±5.10

Mean value with same superscript (a, b) within row do not differ significantly (p>0.05)

cm^3 and 161.7 ± 15.16 cm^3 for left and right testis of sheep, respectively which were significantly (P<0.05) greater than in goats in which it was recorded as 85.8 ± 4.42 cm^3 for left testis and 84.8 ± 4.59 cm^3 for right testis. Similar pattern was also observed for testicular parenchyma which was significantly (P<0.05) greater in sheep as compared to goats.

In present study, the length, weight, volume and shape index of caput of epididymis were found to be significantly (P<0.05) greater in sheep as compared to goat. In sheep, length of caput was 4.99 ± 0.27 cm for left and 5.13 ± 0.26 cm for right side. The same for goat was 4.06 ± 0.16 cm and 4.02 ± 0.13 cm, respectively. Weight and volume of left caput of sheep was 11.13 ± 1.44 gm and 10.63 ± 1.55 ml and for right caput the values were 11.14 ± 1.36 gm and 10.81 ± 1.59 ml. Weight and volume of left caput of goat was 6.12 ± 0.56 gm and 5.77 ± 0.46 ml and for right caput the values were 6.00 ± 0.47 gm and 5.56 ± 0.35 ml. Shape index was inversely proportion to the length, as a result of which the values were significantly (P<0.05) higher in sheep as compared to goat. In morbid buck, length, width and weight of left caput was 4.02 ± 0.09 cm, 3.33 ± 0.10 cm and 3.48 ± 0.09 gm, respectively which was significantly higher than right caput in which the same was 3.79 ± 0.08 cm, 3.00 ± 0.08 cm and 3.17 ± 0.09 gm, respectively (Singh et al. 2022).

Fig. 1 Left and right testicle and epididymis of non-descript goats. Epididymis showing corpus (C) and cauda (Cd). Epididymis is attached along the caudo-medial aspect of testis. Vas deferens (v) is lateral to the epididymis

Left testis and epididymis Right testis and epididymis

Fig. 2 Left and right testicle and epididymis of crossbred sheep. Epididymis showing caput (Cp), corpus (C) and cauda (Cd). Testis showing prominent surface vascularization.

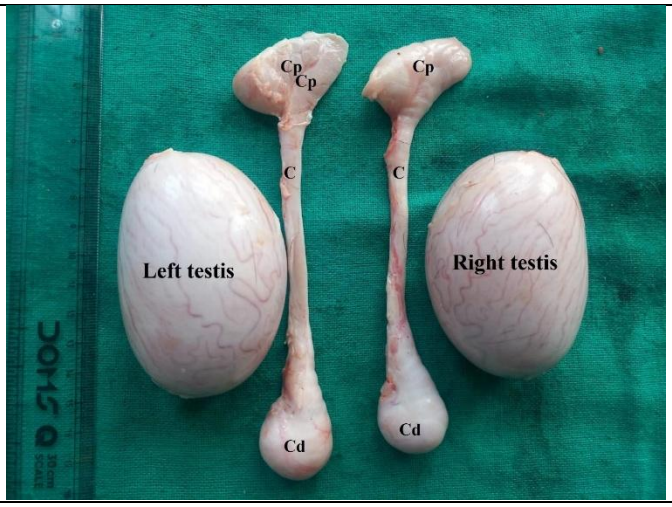

Fig. 3 Left and right testicle and epididymis of non-descript goats. Epididymis showing caput (Cp), corpus (C) and cauda (Cd). Testis showing surface vascularization which is less conspicuous than in crossbred sheep.

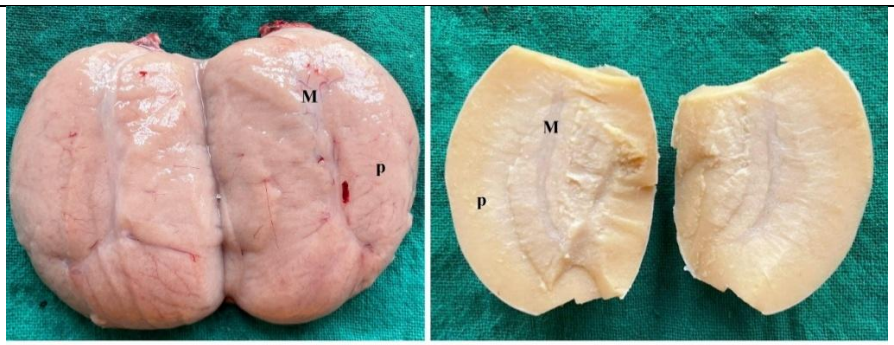

Fig. 4 Longitudinal section of testis showing mediastinum testis (M) and parenchyma (p).

In regard to corpus of epididymis, the length, width, weight and volume showed significant (P<0.05) difference between sheep and goats under study. In sheep, length and width of caput were 8.98 ± 0.36 cm and 0.81 ± 0.05 cm for left and 8.98 ± 0.39 cm and 0.85 ± 0.06 cm for right side. The same for goat were 6.87 ± 0.33 cm and 0.63 ± 0.03 cm for left and 6.82 ± 0.28 cm and 0.67 ± 0.04 cm for right, respectively. Weight and volume of left caput of sheep were 4.13 ± 0.45 gm and 4.17 ± 0.44 ml and for right caput the values were 4.10 ± 0.46 gm and 4.14 ± 0.58 ml. Weight and volume of left caput of goat were 1.66 ± 0.19 gm and 1.67 ± 0.22 ml and for right caput the values were 1.82 ± 0.23 gm and 1.69 ± 0.20 ml. Singh et al. (2022) reported that the length, width and weight of left corpus was 6.30 ± 0.14 cm, 0.50 ± 0.01 cm and 2.56 ± 0.06 gm, respectively which was significantly higher than right caput in which the same was 6.00 ± 0.15 cm, 0.44 ± 0.01 cm and 2.30 ± 0.07 gm, respectively in morbid buck.

Similarly, for cauda of epididymis, length, width, weight and volume showed significant (P<0.05) difference between sheep and goats. In sheep, length and width of caput were 3.39 ± 0.21 cm and 2.58 ± 0.09 cm for left and 3.61 ± 0.21 cm and 2.55 ± 0.09 cm for right side. The same for goat were 2.73 ± 0.26 cm and 1.99 ± 0.10 cm for left and 2.53 ± 0.18 cm and 1.93 ± 0.10 cm for right, respectively. Weight and volume of left caput of sheep were 9.96 ± 1.01 gm and 9.52 ± 1.04 ml and for right caput the values were 10.60 ± 1.06 gm and 10.32 ± 1.21 ml. Weight and volume of left caput of goat were 4.44 ± 0.49 gm and 4.29 ± 0.52 ml and for right caput the values were 4.27 ± 0.49 gm and 4.06 ± 0.49 ml. In mature buck, average length and weight of left epididymis was12.83 ± 1.56 cm and 11.35 ± 2.17 gm, respectively whereas the same for right epididymis was 12.29 ± 1.56 cm and 11.41 ± 2.07 gm, respectively (Baldaniya et al. 2020). In morbid buck, weight of left cauda (3.70 ± 0.09 gm) was significantly higher than right cauda (3.40 ± 0.09 gm) (Singh et al. 2022).

The corpus was the longest part of epididymis in both the species under study followed by caput and the cauda was the shortest part. However, caput of epididymis was the widest and heaviest part in both the species. Cauda of epididymis was the thickest part.

Conclusion

The present study extended the in-depth knowledge regarding the morphology of testis and epididymis of crossbred sheep and non-descript goats of Jammu region which further adds to the literature. Testes in both the species were elliptical and rounded to oval in shape. Testes of crossbred sheep showed conspicuous surface vascularity as compared to non-descript goats. Mediastinum testis was central in position. Epididymis was an elongated structure which was closely attached to the caudo-medial aspect of testis in both the species. Biometrical parameters were significantly higher in sheep than in goats. Within each species, the biometrical parameters did not show significant difference between right and left sides.

Conflict of interest: The authors declare that there are no conflicts of interest.

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