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Morphological Changes in Sperm Cells during Epididymal Transit in West African Dwarf Buck

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Abstract

The spermatozoa characteristics during epididymal transit were studied in healthy West African dwarf (WAD) goat bucks. The caput epididymis had a value of 27.0% of abnormal sperm cell, which is significantly different ($P<0.05$) from the 21.0% of corpus and 23.0% of the cauda epididymis. There was no significant difference ($P>0.05$) between the values of corpus and caudal epididymis. The caput epididymis also had 6.0% spermatozoa with proximal cytoplasmic droplets which differed significantly ($P<0.05$) from that of the corpus (1.20%) and the cauda (0.9%). The values for coiled tails and the total abnormal sperm cells showed that caput epididymis had higher abnormal spermatozoa, which was closely followed by cauda while the corpus epididymis had the least. There were more spermatozoa with looped tails in the cauda epididymis (1.68%) than in other segment (corpus: 0.95% and caput: 0.80%). The testicular and epididymal parameters were positively correlated (weight of testis and epididymis; weight of testis, scrotal circumference, testicular circumference, weight of epididymis and weight of testis ($r = >0.05$) except the correlation values between length of epididymis and length of tests ($r = 0.30$).

Introduction

The morphological changes of spermatozoa due to frequency of ejaculation and season have been studied by Igboeli (1974), Okere *et al.*, (1986) and Oyeyemi *et al.*, (1996). The epididymis is an extremely large convoluted structure which is closely attached to the dorsal part of the lateral surface of the testicle (Setchell, 1977). Its functions include storage, maturation and absorption of sperm cell. Changes occurring in sperm morphology during epididymal migration have been correlated with the functional integrity of the testis and the epididymis (Rao, 1971). This has led to the classification of sperm defects into primary and secondary or major and minor defects (Bloom, 1973) although Moss *et al.* (1988) classified these defects into primary, secondary and tertiary or miscellaneous.

Morris *et al.* (1979) and Coulter (1982) discovered that within a species of animal there is a good correlation between spermatozoa production, testicular sizes and the age of the animal. Skinner (1975) reported increase testicular weight as the age of Boer buck increases and this determined the amount of spermatozoa present in the epididymis. It has been reported that some sperm cells' defects such as the "knobbed acrosome" and the "dag defects" are breed specific (in bull)

and heritable (Bloom, 1977 and Akusu *et al.*, 1985).

Comprehensive studies on the morphological changes of spermatozoa during epididymis transit in WAD goat bucks have not been reported. Therefore the study was carried out to investigate the differences in morphological characteristics of sperm cells in each segment of the epididymis of the buck in order to accurately interpret morphological abnormalities of the sperm cells in relation to their epididymal location.

Materials and Methods

Animal Examination

Ante-mortem examination was carried out on the bucks for obvious physical abnormalities and infections such as mange and ectoparasites. The animals were then weighed. The intrascrotal testes were palpated for proportional sizes, pendulum-like nature, cryptorchidism, flabbiness, and orchitis and testicular consistency.

Sample Collection

Forty testes (20 pairs) from sexually matured clinically healthy West African Dwarf (WAD) goat bucks, aged between 2 and 4 years and weighing between 19-22kg from known farms were collected before slaughter. The intrascrotal testes were weighted immediately and placed in a well-insulated box maintained at 37°C.

Semen Collection

The weights of testes and epididymis, testes alone, epididymis alone and their lengths were determined using either a weighing machine or flexible tape, as appropriate. Each epididymis (right, left) was neatly and carefully trimmed off the body of the testis and semen samples were sucked into a Pasteur pipette from the three parts of the epididymis (caput, corpus and cauda) through an incision into the lumen and using 2-4 drop of 2.9% sodium citrate as the flushing fluid.

Semen Preparation

The collected sperm sample from each part was separated in sample tubes containing 0.5ml of 10% normal saline. The sodium citrate diluted samples were used for the estimation of spermatozoa motility and the preparation of smears stained with Well and Awa stain for acrosomal integrity (Wells and Awa, 1970). Formal saline was used to fix the sperm cells during counting in the haemocytometer. The semen sample was analyzed for other characteristics by conventional methods (Moss *et al.*, 1988).

Data Analysis

Mean percentage values were tested by statistical methods as outlined in the General Linear Models Procedure (Dunn and Clark, 1972), while "*t*" test and correlation coefficients were calculated using procedure of Steel and Torrie (1986).

Results

The summary of the percentage mean values of spermatozoa characteristics at different parts of the epididymis, regardless of age of the animal, is presented in Table 1. The caput epididymis has a significantly higher mean value of 2.18% ($P<0.05$) of abnormal sperm head compared to the corpus 1.4% and cauda 1.4%. There were more acrosomal damage in the cauda epididymis (0.63%) which differed significantly from the value in the corpus

and caput epididymis (0.40% and 0.38%, respectively) ($P<0.05$).

The incidence of proximal cytoplasmic droplets is higher in the caput epididymis as shown in Table 1. Furthermore, the incidence of distal cytoplasmic droplets in the caput, corpus and cauda epididymis were 0.78, 3.08 and 6.18, respectively. This shows that there is a significant difference ($P<0.05$) in the incidence of distal cytoplasmic droplets in the cauda compared to the corpus and the caput epididymis. There was no significant difference in the values of abnormal midpiece in the caput, corpus and cauda epididymis. The values in these three parts differed significantly ($P<0.05$) in detached sperm heads and tail abnormalities. Detached sperm abnormalities in caput was 3.40% corpus 4.3% and cauda 2.70% while simple bent tail abnormalities for caput, corpus and cauda epididymis were 2.10%, 3.40% and 4.4%, respectively.

Total abnormal sperm cells in caput epididymis differed significantly ($P<0.05$) to that of corpus and cauda epididymis. There was no significant difference between corpus and cauda epididymis, though the latter is relatively higher than the former.

The correlation coefficient for the testicular and epididymal parameters (weight of testes (WT), length of testes (LT), testicular circumference (CT), weight of testis an epididymis (WTE), weight of epididymis (WE) and length of epididymis (LE) are presented in Table 2. Except for the length of testes and length of epididymis that were not positively correlated ($P>0.05$) other testicular parameters showed positive correlation with each other.

Discussion

The observed morphological changes which spermatozoa undergo in the caput epididymis are at variance with the reports of some other workers. For example, Almquist and Amann (1962) observed a decreased incidence of head abnormalities from the caput epididymis to the cauda epididymis, while in this study, frequency of abnormal sperm heads in caput (2.20%) differed significantly ($P<0.05$) from that of corpus (1.40%) and cauda epididymis (1.40%).

The value of abnormal acrosome in the cauda epididymis (0.063%) is significant higher ($P<0.05$) than values of corpus (0.40%) and caput epididymis (0.38%). This may be due to cauda epididymis being more affected by constituent and defective development. These findings agreed with the report of Setchell (1977).

The level of immaturity of the sperm cells were indicated by cytoplasmic droplets which showed a significant difference ($P<0.05$) between the values of proximal cytoplasmic droplets in caput epididymis compared with corpus and cauda epididymis which did not differ significantly ($P>0.05$). While the value of distal cytoplasmic droplets in the cauda differed significantly ($P<0.05$) compared with the values of distal cytoplasmic droplets in the corpus and caput epididymis. The ability of the sperm to fertilize is acquired in the distal half of the body (corpus) of the epididymis. This may be the reason for the lower value observed for proximal cytoplamic droplets. This agreed with the report of Cole and Cupps (1977).

The corpus epididymis had more of the detached sperm heads than the caput epididymis and the cauda epididymis. The values of detached sperm heads in corpus epididymis differed significantly when compared with the other two segments of epididymis and this indicates that as the rate

of maturation increases from caput to cauda epididymis the rate at which spermatozoa lose their tails decreases. This is contrary to the report of Roberts (1977) that during aging, the acrosome and implantation region became loosened from the nucleus starting at the apical ridge in the bull. The report of Rao (1971) in the bull supports this finding.

The tail abnormalities showed that there were significant differences ($P<0.05$) in the incidence of tails coiled below and around the head in the caput epididymis than other segments or parts of epididymis. Other abnormalities (looped tail, simple bent tails) in this study may partly reflect tertiary abnormalities rather than the abnormalities that originated from spermatogenesis or epididymis. The results observed for detached sperm heads, in this study was significantly higher ($P<0.05$) in caput epididymis than the same values in corpus and cauda epididymis. The findings agreed with the report of Akusu *et al.* (1985) who stated that detached normal head, broken neck and tail coiled around the head are common and higher in the caput epididymis than other segments of the epididymis.

The increase in the incidence of tail abnormalities in the caput epididymis may be due to scrotal temperature of the animal prior to slaughter. This is in agreement with the report of Bishop *et al.* (1949) and Moss *et al.* (1988) that as the temperature increases or decreases from 37°C there is tendency for more tail abnormalities in this species despite its pendulous descended testes and or may be due to heat or cold shock during the experiment in the laboratory.

There was high correlation ($P<0.05$) between testicular weight and scrotal circumference. All the testicular parameters, weight of testes and epididymis (WTE), weight of testes (WT), length of testes (LT), testicular circumference (CT) showed high correlation with epididymal parameters, weight of epididymis (WE) and length of epididymis (LE) and scrotal circumference (SC) except the length of epididymis (LE) and length of testes (LT). These results conform to the observation of Willet and Ohm (1957) that lengths of epididymis and testes did not differ significantly ($P>0.05$), testicular and epididymal growth parameters should be correlated. The analysis of Land and Carr (1957) support these findings that testicular and epididymal parameters, are positively correlated.

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Table 1: Mean percentage values of morphlogical characteritics of spermatozoa in the epididymis

Parts of epididymis	Total number of epididymis	Abnormal sperm head	Abnormal acrosome	Proximal cyto-Plasmic droplet	Distal cyto-plasmic droplet	Abnormal mid-piece	Detached sperm head	Simple bent tail	Tail coiled around head	Tail coiled below head	Looped tail	Total abnormal sperm cell
Caput	40	2.175^{a}	0.375^{b}	6.025	0.775^{a}	.1.550	6.350^{a}	2.100^{b}	0.925	8.925^{a}	0.800^{c}	27.00^{a}
Corpus	40	1.400^{b}	0.400^{b}	1.200	3.075^{b}	1.475	4.250^{b}	3.400^{b}	0.325	4.650^{b}	0.950^{c}	21.125^{b}
Cauda	40	1.400^{b}	0.625^{a}	0.900	6.175^{a}	1.600	2.675^{c}	4.425^{a}	0.325	2.900^{b}	1.675^{a}	22.700^{a}

Means with different letters on vertical column differ significantly ($P<0.05$).

Table 2: Correlation Table for Testicular and Epididymal Parameters

	WTE	WT	WE	LE	LT	CT	SC
WTE	1						
WT	0.99	1					
WE	0.91	0.891	1				
LE	0.63	0.6044	0.709				
LT	0.78	0.8039	0.604	-0.29	1		
ST	0.96	0.9584	0.869	0.643	0.8	1	
SC	0.92	0.9091	0.821	0.615	0.7	0.934	1

Key:

WTE - Weight of Testis and Epididymis
WT - Weight of Testes
WE - Weight of Epididymis
LE - Length of Epididymis
LT - Length of Testes
CT - Testicular Circumference
SC - Scrotal Circumference