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Effects of Castration on Penile and Urethral Development in Black Bengal Goat

ASM Golam Kibria,* Mohammad Lutfur Rahman, ASM Lutful Ahasan, Mohammad Mejbah Uddin and Mohammad Abul Quasem

Department of Anatomy and Histology, Chittagong Veterinary and Animal Sciences University, Chittagong-4225, Bangladesh

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Authors' Contributions:

MMU conceived and designed the project. ASMGK executed experimental work, analyzed the data and wrote the article. ASMLA helped in experimental work and preparation of manuscript. MAQ and MLR supervised and co-supervised the work, respectively.

Key words:

Black bengal goat, castration, urethra, penis.

ABSTRACT

Thirty-six(n=36) healthy male kids of Black Bengal Goat were divided into six groups having six animals in each, to evaluate the influence of castration on the development of urethra. Proper urethral growth reduces urinary calculi formation and helps to determine the possible suitable age of castration. Group I, II, III, IV and V were castrated at the age of 4, 6, 8, 10, and 12 weeks, respectively and group VI was treated as control. After getting maturity, goats were slaughtered and collected all penises with maximum precaution and hygienic practices, and morphometric examinations performed extensively. The highest measurements of penile length, penile weight, penile circumference and urethral lumen perimeter were recorded as 23.67±1.29 cm, 16.85± 2.61 gm, 22.94±2.00 cm, and 6.25±0.38 mm in control bucks, respectively. Of the castrated groups, kids at 8 and 10 weeks of age were found to have similar parameters with that of control group. These observations indicate that castration at later age favors for adequate development of urethra and penis.

INTRODUCTION

Development, growth and maintenance of urogenital organs in goats are under the influence of androgens, namely testosterone hormone (Louca *et al.*, 1977; Wilson *et al.*, 1995). Castration has been demonstrated to exert profound effect on growth, feed conversion rates and meat quality in small ruminants (Louca *et al.*, 1977; Turton, 1969; Field, 1971). In addition, another study (Oheme and Tillman, 1965) reported that smaller penis size and reduced diameter of urethra were associated with early castration in animals. Castration is often performed on young male kids for better meat production as well as enhancing the growth of animals, resulting in taller animals and shorter body length (Brannang, 1971). Tariq *et al.* (2013) recorded better fitted meat composition in one to two years old in Mengai sheep. Castration has been showed to decrease many diseases and produce goaty smell free meat with more intramuscular fat (Stanton, 1999). It also makes the animals docile in terms of physical and mental behaviors (Bassett, 2009; Stanton, 1999). Although castration at an early age is less traumatic and easily performed, but this will make the male animals more prone to urinary calculi and dysuria as the urethra does not meet its normal anatomic size at this age. When the urethra is not properly developed, it is easier to clog up and predispose to obstructive urolithiasis (Oheme and Tillman, 1965) and may need surgical intervention (Radostits *et al.*, 2000). It can also cause stunted growth, resulting in a lack of desired muscle development and conformation, which eventually leads to the low market value (Oheme and Tillman, 1965) and economic loss (Kimberling and Arnold, 1983; Floyd, 1989; Smith and Sherman, 1994).

Most of the authors have given proposal to perform castration of the kid between 8-12 weeks of age based on information available in the current literature regarding the effect of castration on penile and urethral development in bucks and the potential role of castration in the incidence of this economically important disease (Stanton, 1999). To the best of our knowledge, no studies are available regarding the effects of castration and castration time in Buck of Bengal Goat (BBG). Therefore, it is necessary to explore and investigate the influence of castration and proper time of castration in male kids of BBG. Considering these facts, the present study was designed to evaluate the effect of castration at different age periods on penile and urethral development in BBGs and way out to reduce calculi formation in castrated kids.

MATERIALS AND METHODS

Study area and group of animals

A total of 36 healthy male kids of Black Bengal goats were reared from June 2010 to December 2011 and divided into six groups with six kids in each. Group I, II, III, IV and V were castrated surgically at age of 4, 6, 8,

* Corresponding author: asmgk1982@gmail.com
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10 and 12 weeks, respectively as described previously (Tibary and Van Metre, 2004). Group VI was treated as control with no castration. Both castrated and non-castrated bucks were kept for rising up to adult stage for a minimum of 12 months of age (Ismail *et al.,* 2007) with homemade and free browsing feeding facilities. During the rearing periods, all essential health care practices, such as vaccination, deworming, etc. were checked and performed in timely manner as described elsewhere (Radostits *et al.,* 2000).

Slaughtering of animals and collection of samples

Bucks were humanely slaughtered for meat consumption at adult stage after 12 months of age with proper animal safety procedures. The whole urogenital tract including urinary bladder, urethra and whole penis was carefully collected from all groups of animals with appropriate hygienic procedures. The collected samples were kept at-4°C until further processing.

Penile length examination

As at first, gross morphometric examination such as penile length, diameter, weight and circumference of the genitalia were performed. The penile length was measured using a calibrated roller in cm (Fig. 1A).

Weight of penis

Weight of whole penis was taken in grams by using digital balance. The associated structures like connective tissue, adipose materials were carefully removed to get accurate result.

Penile circumference

Circumference of the penis was measured using thread and scale. Briefly, a fine thread was encircled around the penis, and a sharp scissors was used with great care to cut the opposing ends. Then the thread was measured in centimeter with the help of calibrated ruler and data expressed.

Urethral perimeter

Perimeter of the penile urethra determined with the help of calibrated scale. The lumen was cut with a very sharp scissors. Then the lumen was carefully stretched and measured with the help of calibrated scale (Fig. 1B), and recorded in mm.

Tissue sample collection and microscopic examination

Tissue samples of approximately $1cm^3$ sizes were collected from three different regions – proximal sigmoid flexure (PsF), distal sigmoid flexure (DsF) and glans penis (GsP). Samples were processed through 10% buffered formalin fixative (100 ml formalin, 900 ml distilled water, 4 g monobasic NaH_2PO_4, 6.5g dibasic Na_2HPO_4) for 48 h. After fixation, samples were prepared for routine histo-pathological examination stained with hematoxycillin and eosin.

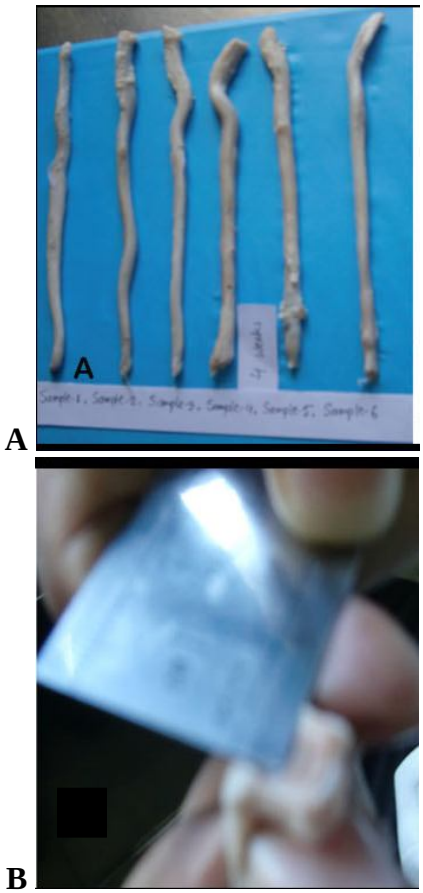

Fig. 1. A, Penises of buck; B, urethral perimeter determination.

Urethral diameter examination under microscope

Diameter of the urethral lumen was measured using ocular micrometer (X22, MeCan Imaging, Japan) and stage micrometer (OH2, MeCan Imaging, Japan). Ocular Micrometer Index (OMI) was determined, and the matching point between the ocular micrometer and stage micrometer was checked. It has been recorded as 90 divisions for stage micrometer and 87 divisions for ocular micrometer under 10 objectives in Olympus Binocular Microscope. In stage micrometer 1 (one) division = 10 µm. So, OMI = 90/87 x 10 µm= 1.034 µm.

Following the determination of OMI, individual slide of different segments was examined under microscope at 10 objectives, and measured the diameter of urethral lumen.The resulting value was put into record

sheet and multiplied by OMI. The length was taken twice between the wall of the urethral lumen as length and width to minimize the statistical error. Mean value of two measurements represents as diameter (Fig. 2). Finally, the urethral perimeter was calculated by multiplying factor with the value of π (3.143).

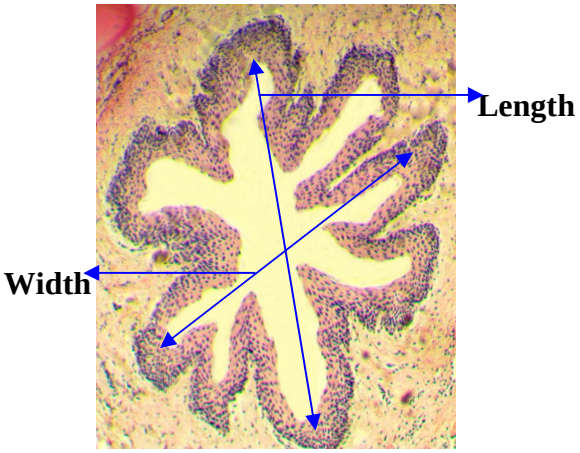

Fig. 2. Microscopic measurement of the urethral lumen.

Data recording and statistical analysis

Data were entered into spreadsheet program (Microsoft Office Excel 2007), and analyzed statistically using different statistical tools and means. Descriptive analysis was performed using mean and standard deviation for each outcome variable, and results were expressed as arithmetic mean ± standard deviation (X± SD). Mean values of the penile length, penile weight, penile circumference, and urethral diameter were compared between the groups. The results also compared according to the age of castration and urethral diameter within castrated and non-castrated bucks, and tried to figure out the relationship within these two specific characters.

RESULTS

Penile length and weight

To determine the penile length and weight, bucks were grown up and slaughtered at specified age, and estimated the penile length and weight (Tables I, II). Penile length in group I observed the lowest level compared to all other six groups in the study ($p>0.05$). Although the penile length in group I-III showed very close to each other, but the control group exhibited higher than the castrated groups ($p>0.05$). In addition, the average gross weight of penis was the highest in group VI (Table II). It amounted to 16.85 ±2.61 gm that was two times more than that of the castrated at 4 weeks of age. The second highest value (13.01±3.28 gm) for penile weight was found in group V which was two times greater than the earlier time castrated bucks.

Penile circumference

The circumference of the penis was revealed to close proximity among the groups of bucks (Table III). The highest circumference was recorded as 22.94±2.00 cm for control buck and the lowest circumference was 18.50 ±1.86 cm for 6 week old castrated kids of BBG.

Penile urethral perimeter

The gross examination of the penile urethral perimeter showed highest in the control group, which was accounted for 6.25±0.38 mm whereas the lowest value was recorded as 4.25±0.30 mm, for group-II kids that were castrated at 6 weeks of age (Table IV). In addition, Table V represents the result of microscopic examination of urethral perimeter for thirty-six male BBGs. As shown in Table V, the urethral lumen perimeter seemed very close among early castrated male kids. Moreover, castrated goats with the age of 10 weeks and 12 weeks possessed the urethra that has been shown closely related with the girth of the bucks of control group.

DISCUSSION

It is assumed that castration at early age results in narrower urethral lumen development than those of late castrated kids that are 8 to 12 weeks of age. In this study, we did both gross morphometric and microscopic examination to find out and resolve the research hypothesis and questions. It was revealed that the highest penile length was recorded in control group whereas the lowest ($p>0.05$) was in 4^{th} week castrated bucks (group I). However, the penile length of early castrated bucks documented very similar to each other which was 18.17±0.98 cm for 6^{th} week castrated buck and 18.25±0.76 cm for 8^{th} week castrated buck. There was little or no variation in the length of penile urethra between late castrated goats and control kids of BBG, and the values were 19.42±0.1.63 cm and 20.83±0.88cm, respectively for 10^{th} week and 12^{th} week castrated bucks. The length of penis in bucks was observed to increase with the age of castration. This finding is strongly coherent with the findings of earlier report (Ismail *et al.*, 2007), who showed that non-castrated buck had significantly higher penile length than that of castrated in 2 week and 3 months of age. This is also supported by the opinion of another study (Dyce *et al.*, 1996), who mentioned that castration had relation with poor development of penis.

Table I.- Penile length (cm) of the castrated bucks.

Buck No.	4 weeks Gr.-I	6 weeks Gr.-II	8 weeks Gr.-III	10 weeks Gr.-IV	12 weeks Gr.-V	Control buck Gr.-VI
1	19	18.5	18.5	20	21	23
2	17.5	17.5	17.5	17	20.5	21.5
3	18.5	19.5	18	19	22	25
4	16.5	17.5	19.5	19	20.5	23.5
5	17.5	17	18.5	19.5	19.5	24.5
6	18.5	19	17.5	22	21.5	24.5
Mean	**17.92±0.82**	**18.17±0.98**	**18.25±0.76**	**19.42±1.63**	**20.83±0.88**	**23.67±1.29**

Gr., Group; SD, Standard deviation.

Table II.- Penile weight (gm) of the castrated bucks.

Buck No.	4 weeks	6 weeks	8 weeks	10 weeks	12 weeks	Control buck
1	7.64	9.68	7.85	9.85	10.35	13.35
2	7.49	7.15	9.13	8.7	11.24	14.24
3	7.07	8.41	7.64	10.47	15.91	16.91
4	8.5	7.26	7.21	10.87	17.8	19.8
5	8.02	8.86	8.41	11.65	13.25	19.25
6	6.01	5.9	7.22	8.54	9.52	17.52
Mean	**7.46±0.86**	**7.88±1.37**	**7.91±0.75**	**10.01±1.23**	**13.01±3.28**	**16.85±2.61**

SD, Standard deviation

Table III.- Penile circumference (cm) at different segments of both castrated and control buck of BBG.

Buck category	Penile segments			Average±SD
	Root	Body	Glans	
4 wk	19.83	19.17	16.67	18.56±1.67
6 wk	20.17	18.83	16.5	18.50±1.86
8 wk	22.5	21.33	18	20.61±2.33
10 wk	22.17	21	19.17	20.78±1.51
12 wk	24	22.67	20.33	22.33±1.86
Control	25	22.83	21	22.94±2.00

SD, Standard deviation.

Table IV.- Gross urethral perimeter (mm) of castrated and noncastrated BBG buck.

Buck category	Penile segments			Average±SD
	Root	Body	Glans	
4 wk	4.58	4.25	4.08	4.30±0.25
6 wk	4.58	4	4.17	4.25±0.3
8 wk	4.58	4.42	4.33	4.44±0.13
10 wk	5.17	4.75	4.5	4.81±0.34
12 wk	6.17	5.75	5.5	5.81±0.34
Control	6.67	6.17	5.92	6.25±0.38

SD, Standard deviation.

Table V.- Microscopic urethral perimeter (mm) of castrated and control BBG buck.

Buck category	Penile segments			Average±SD
	Root	Body	Glans	
4 week	2.04	2.04	2.03	2.04±0.006
6 week	2.06	2.05	2.05	2.05±0. 006
8 week	2.06	2.05	2.05	2.05±0. 006
10 week	2.07	2.12	2.12	2.10±0.023
12 week	2.16	2.13	2.12	2.14±0.021
control	2.21	2.19	2.19	2.20±0.012

SD, Standard deviation.

During this experiment, the penile weight of these six groups, such as 4th week castrated, 6th week castrated, 8th week castrated, 10th week castrated, 12th week castrated and non-castrated buck was recorded as being 7.46±0.86 gm, 7.88±1.37 gm, 7.91±0.75 gm, 10.01±1.23 gm, 13.01±3.28 gm and 16.85±2.61 gm, respectively. Although the weights of the penis in early castrated kids were almost similar, but a gradual upward trend in the weight of penis ($p>0.05$) was observed in the late castrated male kids. These findings are corroborated by the previous findings in a number of studies (Oheme and Tillman, 1965; Ismail *et al.,* 2007; Wilson *et al.,* 1995),

where they highlighted that less developed male genitalia due to the castration was coupled with androgen deficiency. In addition, the data on 12 weeks old castrated goats are nearly two times higher than the 4-and 6 weeks old castrated kids, which is supported by the observation of previous study (Stanton, 1999), who mentioned that better castration period for bucks ranges between 8 and 12 weeks of age from stand point of all other factors.

The penile circumference is another important factor that describes the developmental condition of penis in goats. It has been revealed that penile circumference of control group was the highest (22.94±2.00 cm). On the contrary, the lowest circumference was measured 18.50±1.86 cm at earlier time castrated kids of 6 weeks age. The other values were 18.56±1.67 cm, 20.61±2.33 cm, 20.78±1.51 cm, and 22.33±1.86 cm for 4th week castrated, 8th week castrated, 10th week castrated and 12th week castrated male goats, respectively. These values showed slight increasing pattern, corresponding to later age castration with higher penile circumference for 12th week castrated bucks among castrated groups. This finding is similar to the result observed by Oheme and Tillman (1965), where they described smaller penis size in early castrated buck. In addition, the findings of there were many report that (Ismail *et al.,* 2007; Dyce *et al*., 1996) correlate with our findings of present study. Both gross and microscopic examination of urethral lumen perimeter also revealed highest values for control group. It was recorded as being 6.25±0.38 mm and 2.2±0.012 mm, respectively. On the contrary, perimeter was lowest (4.25± 0.30 mm) at 6th week castrated kids in gross examination. At the 12th weeks, castrated animal showed closely related result such as 5.81±0.34 mm with control BBG. There was also slow and gradual upward trend of urethral lumen girth fitted with the data illustrated elsewhere (Oheme and Tillman, 1965) and reported reduced diameter of urethra in early castrated goat. These findings analogous with previous report (Ismail *et al*., 2007) recorded as significantly larger penile diameter in control bucks than that of early castrated animal. These findings also hold up by recorded proof (Dyce *et al*., 1996), reporting early castration culminates in poor development of urinary passage.

CONCLUSION

It is recommended that castration at later age, like 10 weeks and 12 weeks of age has very similar development with non-castrated buck. This record underpinned the importance of castration at later age for the better development of urethral passage and to reduce the urolithiasis in male kids. However, a detailed and more descriptive investigation is needed to define the appropriate time of castration in male kids of Black Bengal Goat.

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