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ORIGINAL ARTICLE

# Effect of testosterone on penile and urethral development in Black Bengal goat

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**Abstract**

**Background**: Testosterone is important for proper development, growth and functional maintenance of urogenital organs in animals. The objective of this study was to determine the effect of testosterone on penile and urethral development in Black Bengal goats.

**Methods**: Nine male Black Bengal goats (4 months old) were divided into three groups (n=3); Group-A: goats with testosterone deficient (castrated at 4 months of age), Group-B: control and Group-C: goats with excess testosterone (exogenous IM administration of testosterone enanthate; @ 125 mg/goat weekly for a period of 2 months). After getting puberty (8 months of age), goats were slaughtered and penises were collected with maximum precaution and hygienic practices, and morphometric examinations performed extensively.

**Results**: The penis of testosterone deficient (castrated) goats was significantly shorter and narrower in diameter/circumference compared to that of control goats (with adequate testosterone). Moreover, exogenous testosterone treated non-castrated goats resulted comparatively lager penis that the control goats. The urethral lumen was significantly larger in diameter in goats with adequate testosterone (control and exogenous testosterone-treated) than testosterone deficient goats.

**Conclusion**: The results of this study indicate that the level of testosterone positively affects the normal development of the penis and urethra in Black Bengal goats.

***Key words:*** Penis, Urethra, Development, Testosterone, Black Bengal goats.

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## Introduction

Goat is an important species of animals in respect of Bangladesh because it is considered as the poor man's cow (Kashem *et al*., 2011). Bangladesh has only one goat breed of its own, known as the Black Bengal (IAEA, 2007). Black Bengal goat is an important animal resource that plays an immense role in the development of livestock sector, to alleviate the poverty from Bangladesh and takes a great part in the increment of GDP of Bangladesh (Rahman *et al*., 2017).The goats' revaluation depends on various factors, including the great prevalence of diseases, poor management practices and extensive production systems (Babeker and Elmansoury, 2013). Acute shortage of genetically superior bucks throughout the country is one of the major constraints of goat production in Bangladesh (Husain, 2004). Superior buck selection seems tobe a very important and alternative approach to boost up the production potential. During the selection of breeding sire e.g., buck, bull special attention should be given to age, body weight, soundness of the reproductive organs (Gofur *et al*., 2007; Gofur *et al*., 2008; Gofur, 2015).

Development, growth and maintenance of urogenital organs in goats are under the influence of androgens, mainly testosterone hormone (Gofur *et al*., 2014; Traish *et al*., 2018). Androgens plays a role in the maintenance of penile tissue structural integrity, penile trabecular smooth muscle growth and function, integrity of penile nerve fiber network, signaling pathways in the corpora cavernosa, physiological penile response to stimuli, and facilitation of corporeal hemodynamics (Traish, 2010). Androgen deprivation leads to veno-occlusive dysfunction by causing structural, biochemical, and physiological alterations in cavernosal tissue of penis (Rogers *et al*., 2003). Studies have reported that testosterone replacement therapy might restore the alterations in cavernosal tissue (Traish *et al*., 2007).Testosterone, the principal androgen, secreted by Leydig cells, exerts both androgenic effects involving growth stimulation and functional maintenance of the male reproductive tract and anabolic effects involving growth stimulation of non-reproductive organs, such as muscle, kidney and liver (Barbara *et al*., 2006). Deficiency of testosterone can cause a wide range of signs and symptoms including decreased sex drive, reduced muscle mass and strength, weaker erections of penis, lower body weight, lowered sperm count and excess testosterone increase the risk of prostate cancer (Bassil *et al*., 2009; Bhasin *et al*., 2018 ).Testosterone plays a critical role in maintaining erectile function (Efesoy *et al*., 2018). Castration is the most common way to decrease the serum testosterone level, and a common practice in Bangladesh as it exerts profound effect on growth, feed conversion rates and meat quality in small ruminants (Bello and Adama, 2012). It is reported that smaller penis size and reduced diameter of urethra were associated with early castration in animals (Kibria *et al*., 2016; Ismail *et al*., 2007). Animal with undeveloped urethra make the animal more prone to urinary calculi and dysuria and predispose to obstructive urolithiasis (Rafee *et al*., 2016; Riedi *et al*., 2018). Moreover, the author found exogenous testosterone has a profound impact on development of male accessory sex glands in Black Bengal goats (Gofur *et al*., 2014).

A few scientists (Kumar and Majumder, 1995; Tyagi *et al*., 1999; Hassan, 2010; Zha *et al*., 2013 etc.) observed the effect of testosterone in rats, rabbits and monkeys but there is no study conducted on the effect of testosteroneon penile and urethral development of domestic animals especially of the Black Bengal goat. So, the presentstudy was designed to observe the changes on penile and urethral development of male Black Bengal goat during the postnatal development (around the puberty) due to the deficiency (castration) and excess (exogenous administration) of testosterone which is necessary to know for the evaluation of breeding soundness of a breeding buck.

## Materials and Methods

### Animals

Nine male Black Bengal goats (4 months old) were used in this experiment. The goats were purchased from local market and rearedin a well ventilated house. The goats were administered

with the board spectrum anthelmintic (Albencid®) to free them from parasites. They were divided into three groups (n=3); Group-A: goats with testosterone deficient (castrated), Group-B: control and Group-C: goats with excess testosterone (exogenous IM administration of testosterone enanthate). Goats of group-A were castrated immediately after purchase and maintained post-operative hygienic care. Before 7 days of castration, goats were vaccinated with Vaxitet® (0.5 ml absorbed Tetanus Toxoid/buck, IM; Incepta Vaccine Limited, Dhaka) to prevent tetanus. Goats of group-C were administered testosterone enanthate (Testosterone Enanthate injection®, 250 mg/ml, Rotexmedica, Trittau, Germany) intramuscularly @ 125 mg/goat weekly for a period of 2 months. All goats were kept for rising up to 8 months of age as Black Bengal goats attain puberty around 8 months of age (Halim *et al*., 2011).

**Slaughtering of animals and collection of samples**

Goats were humanely slaughtered at 8 months of age (i.e., after 4 months of experimental duration) 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.

**Penile length examination**

The penile length was measured using a calibrated roller in centimeter (cm).

**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 cm with the help of calibrated ruler and girth/diameter was expressed. Finally, the penile circumference was calculated using the formula: $C = \pi d$; C represents the circumference of the penis, $\pi$ (3.143) and d represents its diameter.

**Tissue sample collection and microscopic examination**

Urethral samples of approximately $1cm^3$ size were collected and processed through 10% buffered formalin fixative (100 ml formalin, 900 ml distilled water, 4 g monobasic NaH2PO4, 6.5g dibasic Na2HPO4) for 48 h. After fixation, samples were prepared for routine histological examination stained with hematoxylin and eosin according to Gridley (1960).

**Urethral lumen diameter measurement**

The urethral histological sections were viewed under microscope at 4x objectives and images were captured with Kruss microscope (Kruss, Germany) with digital camera. The images were imported into Adobe Photoshop CS2 (Adobe System, San Jose, CA, USA). Image of calibration scale (4x) also imported into Adobe Photoshop and measured the diameter of lumen of urethra. The diameter 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.

**Statistical analysis**

Data were expressed as arithmetic mean ± standard deviation (X± SD). Penile length, penile circumference, and urethral lumen diameter were compared and analyzed statistically between the control and castrated or testosterone-treated groups using student's *t* test to observe any significant variation between the groups.

**Results**

Table 1 shows the penile length, circumference and urethral lumen diameter of goats. Penile length of control goats was 26.80 ± 0.30 cm. The penile length of testosterone deficient (castrated) goats was significantly ($p<0.01$) lower than the control goats. Although the penile length of testosterone-treated goats showed very close to control goats, the testosterone-treated group had higher ($p<0.05$) length than the control group.

The penile circumference of testosterone deficient (castrated) goats was significantly ($p<0.01$) lower than the non-castrated (control and testosterone treated) goats (Table 1). The

circumference of the penis was similar between control and testosterone-treated goats and there was no significant difference between the groups. The urethral lumen diameter of control and testosterone-treated goats were similar to each other and there was no significant difference between them (Table 1). However, the urethral lumen diameter of testosterone deficient (castrated) goats was significantly ($p<0.001$) lower than the control goats (Fig. 1a-c).

Table 1. Penile length, circumference and urethral lumen diameter of goats

| Parameter | Penile length (cm) | Penile circumference (cm) | Urethral lumen diameter (mm) |
|---|---|---|---|
| Castrated goats | 23.67 ± 0.55** | 10.58 ± 0.83** | 0.91 ± 0.09*** |
| Control goats | 26.80 ± 0.30 | 14.34 ± 0.95 | 1.47 ± 0.05 |
| Testosterone-treated goats | 27.60 ± 0.40* | 15.31 ± 0.73 $^{NS}$ | 1.53 ± 0.06$^{NS}$ |

*p<0.05, ** p<0.01 and *** p<0.001; $^{NS}$, Not significant(t-test)

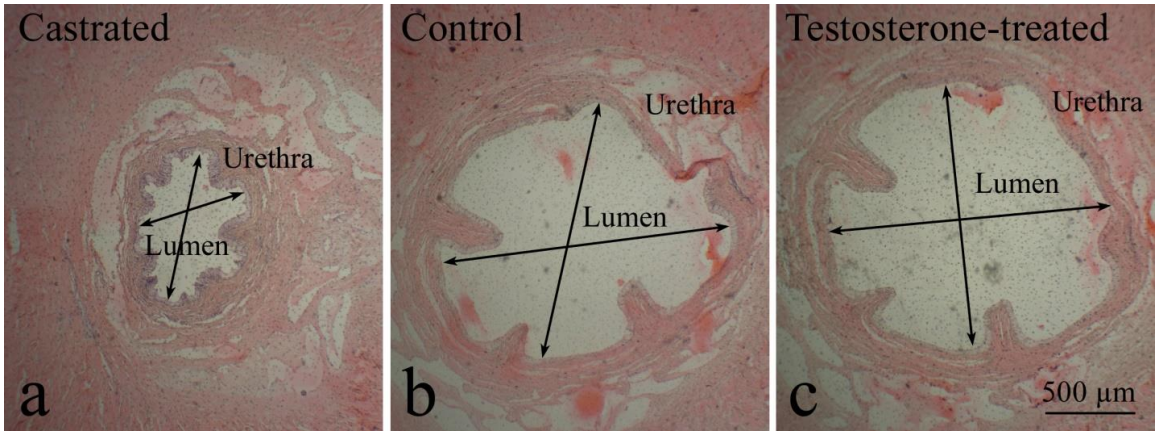


Fig 1. Microscopic measurement of diameter of urethral lumen.a, castrated goat; b, control goat; c, testosterone-treated goat. Lines with double arrows indicate the diameter.

**Discussion**

Testosterone, the principal androgen, exerts both androgenic effects involving growth stimulation and functional maintenance of the male reproductive tract and anabolic effects involving growth stimulation of non-reproductive organs, such as muscle, kidney and liver (Barbara *et al*., 2006). Deficiency of testosterone can cause a wide range of signs and symptoms including decreased sex drive, reduced muscle mass and strength, weaker erections of penis, and excess testosterone increase the risk of prostate cancer (Bassil *et al*., 2009; Bhasin *et al*., 2018 ). In this study, the author did both gross morphometric and microscopic examination to find out the effect of testosterone on penile and urethral development in Black Bengal goats. It was revealed that the penile length of testosterone deficient (castrated) goats was significantly ($p<0.01$) lower than the control goats. This finding is strongly coherent with the findings of earlier report (Ismail *et al*., 2007; Kibria *et al*., 2016), 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 other studies (Dyce *et al*., 1996; McAninch, 2013), where they mentioned that testosterone deficiency (castration) causes poor development of penis. The author found that exogenous testosterone administration exerted profound effect to increase ($p<0.05$) the penile length in Black Bengal goats. Similar to the present study, the author previously found that exogenous testosterone administration significantly affects the hemogram and serum biochemistry as well as the development of male accessory sex glands of Black Bengal goats (Gofur *et al*., 2014). It is also reported that

testosterone treatments increased pre-pubertal penile lengths (Ma *et al*., 2014) and play crucial role in maintaining erectile function (Efesoy *et al*., 2018). Studies have shown that topical application of 5% testosterone cream causes increased penile growth, but its effect is due to absorption of the hormone, which systemically stimulates genital growth (McAninch, 2013).

During puberty, the penis of young animals grows in length and diameter/circumference (Wolfe, 2018). Therefore, penile circumference is another important factor that describes the developmental condition of penis in goats. It has been revealed that penile circumference of testosterone deficient (castrated) goats was significantly ($p<0.01$) lower than the non-castrated (control and testosterone treated) goats. This finding is similar to the result observed by Oheme and Tillman (1965), where they described smaller penis size in early castrated buck. Kibria *et al*. (2016) also found lower penile circumference in castrated goats than control goats. The present findings showed the same trend but value was lower, may be due to age difference of Black Bengal goats. In addition, some studies(Ismail *et al*., 2007; Dyce *et al*., 1996) also reported similar findings.

Testosterone deficient (castrated) goats had significantly ($p<0.001$) lower urethral lumen diameter than goats (control and exogenous testosterone-treated) with adequate testosterone indicating testosterone exerts a significant effect on urethral development. Kibria *et al*. (2016) reported reduced diameter of urethra in early castrated goat.

Obviously, the lack of testosterone resulted in poor development in these androgen-dependent organs and a significant increase in penile and urethral luminal sizes were noted in non-castrated goats under the influence of testosterone indicating a beneficial effect of testosterone for growth and development of urogenital organs. In conclusion, the effect of testosterone on penile and urethral development in Black Bengal goat has been documented in this study. The exact mechanism by which testosterone and androgen receptors regulate the development of these organs during the postnatal life, especially around the puberty needs further investigation.

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**Conflict of Interest**

The author declares no conflict of interest.

**References**

1. Babeker EA, Elmansoury YHA. Observations concerning haematological profile and certain biochemical in Sudanese desert goat. Journal of Animal and Feed Research. 2013; 3(1): 80-86.
2. Barbara J, Sheri A, Hild A, Reel JR. A new potent orally active androgen with progestational activity. Endocrinology. 2006; 147(6): 3016-3026.
3. Bassil N, Alkaade S, Morley JE. The benefits and risks of testosterone replacement therapy: a review. Therapeutics and Clinical Risk Management. 2009; 5(3):427–448.
4. Bello AA, Adama TZ. Feed intake and nutrient digestibility of castrate and non-castrate savannah brown-goats. Asian Journal of Animal Science. 2012; 6: 38-41.
5. Bhasin S, Gagliano-Jucá T, Huang G, Basaria S. Age-related changes in the male reproductive system. In: Feingold KR, Anawalt B, Boyce A, et al., editors. Endotext. 2018; [Internet]. South Dartmouth (MA): MDText.com, Inc.; 2000. Available from: https://www.ncbi.nlm.nih.gov/books/NBK278998/.
6. Dyce KM, Sack WO, Wensing CJG. Textbook of Veterinary Anatomy, 2nd edition, WB Saunders Company, Philadelphia, USA, pp. 724.1996.
7. Efesoy O, Çayan S, Akbay E. The effect of testosterone replacement therapy on penile hemodynamics in hypogonadal men with erectile dysfunction, having veno-occlusive dysfunction. American Journal of Men's Health. 2018; 12(3):634–638.

8. Gofur MR, Khan MZI, Karim MR, Islam MN. Biometry of testis of indigenous bull (*Bos indicus*) of Bangladesh in relation to body weight and scrotal circumference. Journal of the Bangladesh Society for Agricultural Science and Technology. 2007; 4 (1&2): 205-208.
9. Gofur MR, Khan MZI, Karim MR, Islam MN. Histomorphology and histochemistry of testis of indigenous bull (*Bos indicus*). Bangladesh Journal of Veterinary Medicine. 2008; 6 (1): 67-74.
10. Gofur MR, Hossain KMM, Khaton R, Hasan MR. Effect of testosterone on physio-biochemical parameters and male accessory sex glands of Black Bengal goat. International Journal of Emerging Technology and Advanced Engineering. 2014; 4(9): 456-465.
11. Gofur MR. Anatomy and histomorphometry of accessory reproductive glands of the Black Bengal buck. European Journal of Anatomy. 2015; 19 (2): 171-178.
12. Gridley MF. Manual of Histologic and Special Staining Technique. 2nd edition, McGraw-Hill Book Company. USA. pp. 28-31. 1960.
13. Halim MA, Kashem MA, Mannan A, Ahmed SSU, Hossain MA. Reproductive and productive performances of Black Bengal goats reared by the NGO beneficiaries under semi intensive system in Bangladesh. International Journal of Natural Sciences. 2011; 1(2):39-43.
14. Hassan AA. Effect of castration on some physiological aspect in rats: Effect of testosterone hormone. Journal of Education and Science. 2010; 23(3): 28-39.
15. Husain SS. Preservation of buck semen and their use in Artificial Insemination for rapid genetic improvement of rural goats' population. Project paper of Bangladesh Agricultural University Research Systems, Mymensingh, Bangladesh. 2004.
16. IAEA (International Atomic Energy Agency). Black Bengal goats, Bangladesh. http://www.iaea.org/ newscenter/news/prized. 2007. Accessed on 12-09-2019.
17. Ismail ZAB, Al-Zghoul MF, Al-Majali AM, Khraim NM. Effects of castration on penile and urethral development in Awassi lambs. Bulgarian Journal of Veterinary Medicine. 2007; 10(1): 29-34.
18. Kashem MA, Hossain MA, Ahmed SSU, Halim MA. Prevalence of diseases, morbidity and mortality of Black Bengal Goats under different management systems in Bangladesh. University Journal of Zoology, Rajshahi University. 2011; 30: 01-04.
19. Kibria ASMG, Rahman ML, Ahasan ASML, Uddin MM, Quasem MA. Effects of castration on penile and urethral development in Black Bengal goat. Pakistan Journal of Zoology. 2016; 48(2): 501-506.
20. Kumar VL, Majumdar PK. Prostate gland: Structure, functions and regulation. International Urology and Nephrology. 1995; 27(3): 231-243.
21. Ma YM, Wu KJ, Dang Q, Shi Q, Gao Y, Guo P, Xu S, Wang XY, He DL, Gong YG. Testosterone regulates keratin 33B expression in rat penis growth through androgen receptor signaling. Asian Journal of Andrology. 2014; 16: 817-23.
22. McAninch JW. Disorders of the penis and male urethra. In: McAninch JW and Lue TF. Smith & Tanagho's General Urology. 18th edition. The McGraw-Hill Companies, Inc., USA. 2013.
23. Oheme FW, Tillman H. Diagnosis and treatment of ruminant urolithiasis. Journal of the American Veterinary Medical Association. 1965; 147: 1331-1339.
24. Rafee MA, Suvarna A, Baghel M, Zama MMS. Obstructive urolithiasis in kids: A study on pattern of occurrence, aetiology, age, clinical symptoms and conditions of bladder and urethra. Veterinaria. 2016; 4: 1-3.
25. Rahman MM, Hossain MM, Miah MAM. Poverty reduction and livelihood improvement of women through goat rearing. Asian Journal for Poverty Studies. 2017; 3(1): 59 – 66.
26. Riedi AK, Knubben-Schweizer G, Meylan M. Clinical findings and diagnostic procedures in 270 small ruminants with

obstructive urolithiasis. Journal of Veterinary Internal Medicine. 2018; 32(3): 1274–1282.
27. Rogers RS, Graziottin TM, Lin CS, Kan YW, Lue TF. Intracavernosal vascular endothelial growth factor (vegf) injection and adeno-associated virus-mediated vegf gene therapy prevent and reverse venogenic erectile dysfunction in rats. International Journal of Impotence Research. 2003; 15(1): 26–37.
28. Traish AM, Goldstein I, Kim NN. Testosterone and erectile function: From basic research to a new clinical paradigm for managing men with androgen insufficiency and erectile dysfunction. European Urology. 2007; 52(1): 54–70.
29. Traish AM, Vignozzi L, Simon JA, Goldstein I,Kim NN. Role of androgens in female genitourinary tissue structure and function: implications in the genitourinary syndrome of menopause. Sexual Medicine Reviews. 2018; 6(4):558-571.
30. Traish AM. Role of androgens in modulating male and female sexual function. Hormone Molecular Biology and Clinical Investigation. 2010; 4(1): 521–528.
31. Tyagi A, Rajalakshmi M, Jeyaraj DA, Sharma RS, Bajaj JS. Effects of long-term use of testosterone enanthate. II. Effects on lipids, HDL and LDL, cholesterol and liver function parameters. International Journal of Andrology. 1999; 22(6): 347-55.
32. Wolfe DF. Review: Abnormalities of the bull – occurrence, diagnosis and treatment of abnormalities of the bull, including structural soundness. Animal. 2018; 12 (Supplement s1): s148-s157.
33. Zha C, Moon DG, Park JK. Effect of testosterone undecanoate on hematological profiles, blood lipid and viscosity and plasma testosterone level in castrated rabbits. Canadian Urological Association Journal. 2013; 7(3-4): E221-5.