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ANATOMICAL, RADIOGRAPHICAL AND ULTRASONOGRAPHICAL STUDY OF THE MALE URETHRA OF THE ONE HUMPED CAMEL (CAMELUS DROMEDARIUS)

(With 3 Tables and 7 Figures)

By

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دراسة تشريحية ، اشعة تشخيصية وبالموجات فوق الصوتية لقناة مجرى البول فى ذكر الجمل وحيد السنام

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الغرض من هذة البحث هو دراسة المجرى البولى للجمل وحيد السنم من حيث الشكل الخارجى، الشكل بالفحص بالاشعة التشخيصية والفحص بالموجات فوق الصوتيه. مما يساعد فى تشخيص بعض الاصابات الجراحية للمجرى البولى مثل انسداد المجرى البولى. تم فحص ثمانى عينات فى هذة الدراسة وستة حيوانات حية فى الفحص بالموجات فوق الصوتيه. بأستخدام طرق الفحص المذكورة فى هذة الدراسة تم عمل قياسات للاجزاء المختلفة للمجرى البولى للجمل وحيد السنم من حيث الطول والعرض. من خلال الدراسة بالموجات فوق الصوتيه تم الحصول على قياسات لاتساع تجويف المجرى البولى من الداخل. أظهرت نتائج الدراسة ان المجرى البولى للجمل وحيد السنام قصير ومنحنى انحناء بسيط عند منطقة انحناء المجرى البولى. كذلك فان اتساع تجويف مجرى البول يقل بالتدريج فى اتجاة النهاية. وبالتالى فانة من الصعوبة حدوث حصوات داخل المجرى البولى أو انسداد للمجرى البولى للجمل وحيد السنام. كذلك أظهرت نتائج الدراسة انة فى حالة حدوث انسداد لمجرى البول فان التشخيص باستخدام الموجات فوق الصوتية يفضل عن الأشعة التشخيصية أو باستخدام حقن صبغة داخل المجرى البولى. أظهرت نتائج الدراسة أيضا انة فى حالة اجراء جراحة فتح للمجرى البولى فان أفضل مكان لاجراء الجراحة هو عند مستوى نهاية عظمة الحوض حوالى ٣ سم تحت فتحة الشرج لاتساع المجرى البول قليلا فى هذة المنطقة.

SUMMARY

The aim of this work is to study the male dromedary camel urethra grossly, radiographically and ultrasonographically to use them in diagnosis and treatment of the urethral surgical lesions especially in cases of urolithiasis. Eight male dromedary camel urethra samples and

six living adult clinically healthy non castrated animals were used in this study. Through our investigation, the techniques mentioned above, give information about the shape and size of the different parts of the male dromedary urethra as well as the urethral length and width. The ultrasonography was used to get measurements of the urethral lumen along its length. The results of this study showed that the male dromedary urethra is relatively short and the width of the urethral lumen decreases gradually toward the tip of the penis as well as the sigmoid flexure in male dromedary urethra is gently curved forming a slight binding. The present study concludes that urethral obstruction occurs rarely in male dromedary urethra. The diagnosis of urethral lesions is impossible by using plane or contrast radiography and the use of ultrasonographic examination of the male dromedary urethra could be successfully used. On the other hand the results of this study showed that the best site for urethrotomy is at the level of the palpable ischial arch approximately 3 cm distal to the anus.

Key words: *Male dromedary urethra, urolithiasis*

INTRODUCTION

Peculiar anatomical knowledge of the lower urinary tract of the dromedary is very important for the clinician to carry out catheterization and surgical treatment of urolithiasis, and for other urethral obstructive lesions (Kock 1985). The available literatures lack any information about the anatomical, radiographical and ultrasonographical studies of the male dromedary urethra.

Urolithiasis is a common cause of urine retention in bull (Tantawy 1985, Gasthuys *et al.,* 1993, Larson 1996, Zabady 1996, Misk and Semieka 2003), male buffalo (Singh *et al.,* 1983, Misk and Semieka 2003), ram (Noordsy 1994 and Van Metre *et al.,* 1996), llamas (Kock and Fowler 1982). It is fairly rare in horse and pig (Lundvall, 1988 and Blood *et al.,* 1989). In dromedary camel there are few case reports of urethral calculi which were only observed at postmortem examination or in the amputated penile urethra, but never positively diagnosed in living animals (Kock 1985). Early diagnosis and rapid surgical treatment are essential in suspected cases of urolithiasis as obstruction can be quickly fatal (Kock 1985).

The aim of the present study is to highlight on the normal shape and the lumen diameter of the male dromedary camel urethra by using gross anatomy, casting of the urethra, radiography and ultrasonography.

MATERIALS and METHODS

The present study was carried out on eight urogenital specimens of non-castrated adult male dromedary and six clinically healthy adult non castrated dromedaries. The specimens were obtained from Cairo slaughterhouse.

The course, length, width and shape of different parts of the urethra were studied by doing the gross anatomical dissection, cast and radiography using 6 fresh specimens, four specimens for each group. For the cast preparation Kemapoxy 150/CNB-Egypt was used. Radiographical observations were made by using of 75% urographin. Initially, trials were made to catheterize the urethra, for retrograde injection of the cast material, and the contrast radiographic material, but these trials failed due to the very narrow diameter of the penile urethra at its distal end. The injection was then made through the neck of the urinary bladder using an 18-gauge needle after evacuation of urine.

The cast material was injected slowly under constant hand pressure till complete filling of the urethral cavity. To allow complete solidification of the casting material, the specimens were left at room temperature for 24-48 hours. This was followed by dissection and careful picking up of the cast from the urethral cavity, which was then photographed.

Concerning the contrast radiographic study the injection of 75% urographin was continued till complete filling of the urethral lumen and extravasations of the contrast material from the urethra.

Ultrasonography was carried out on six living clinically healthy adult non castrated dromedary. The animals were cast in setting position and were sedated with 8 ml of 2% xylazine Hcl (hydrochlorite) injected intravenously. The examination was done by using of 6/8 MHz linear transducer PIE medical 100 L.C., Holland. The length, diameter and shape of the urethra at neck of the urinary bladder, colliculus seminalis, level of ischial arch, bulb of the penis, sigmoid flexure, free part of the penis and tip of the penis were measured directly in the transducer using integrated scale and recorded. The ultrasonographic pictures were printed by video graphic printer (Sony up-890 mD, Australia).

All measurements were statistically analysed using a one way-ANOVA. Descriptive statistics are given as means ± SD (standard deviation). The statistical analysis was carried out with Microsoft® Excel 2002 program.

RESULTS

Anatomy of the urethra

The male camel urethra is a long musculomembranous tube, approximately 72 cm in length and extends from the internal urethral orifice at the neck of the urinary bladder to the external urethral orifice at the tip of the penis.

The urethra can be divided into proper urethra and urogenital canal (Table 1). The proper urethra through which passes the urine only, extends from the internal urethral orifice to the colliculus seminalis and its length is approximately 3.5 cm. The urogenital canal is longer than the proper urethra, reaches approximately 68.5 cm, through which passes the urine and seminal fluid. It extends from the colliculus seminalis to the external urethral orifice (Fig. 1A). The colliculus seminalis is indistinct in male camel and represented by two slightly elevated areas on the roof of the urethra.

Table 1: Showing the length of the male urethra according to the first division

Total length of the urethra	Proper urethra	Urogenital canal
72± 0.41cm	3.5± 0.28 cm	68.5± .035 cm

The most dilated part of the urethra was observed at the level of the colliculus seminalis. The ductus difference opens by a narrow orifice on the colliculus seminalis while the prostate gland opens by narrow orifices on the other side of the colliculus (Fig. 2). The bulbourethral gland opens by an orifice on either side of midline of the roof of the urethra, approximately 1-2 cm cranial to the level of the ischial arch (Fig. 3). The urethra can be further subdivided into pelvic and penile urethra according to its position (Table 2, Fig. 1A). The pelvic urethra is located within the pelvic cavity and extends from the internal urethral orifice to the level of the ischial arch. This arch which is clinically palpated located approximately 3 cm distal to the anus and dorsal to the scrotum by approximately 9 cm. The pelvic urethra is shorter and wider than the penile urethra. Its length is approximately 15 cm, and its mucus membrane appears pale in color at the level of the colliculus seminalis while the remaining part is dark red in color. The penile urethra which, is located inside the penis; is longer and narrower than the pelvic part and extends from the level of the ischial arch to the external urethral orifice, where its length is approximately 57 cm. Its mucus membrane appears rose in color along its length.

The penile urethra can be subdivided into proximal bulbic, middle sigmoid and distal free part (Fig. 4). The bulbic part which is approximately 7 cm length is the direct continuation of the pelvic urethra at the ischial arch. It extends cranially between the two crura of the penis forming together the root of the penis. The sigmoid part is slightly bending and extends from the bulbus of the penis to the insertion of the retractor penis muscle; its length reaches approximately 29 cm. The sigmoid part of the penile urethra is located prescrotal and the scrotum is situated in the perineal region approximately 12 cm distal to anus. The lumen of this part is narrower than that of the pelvic part and decreases in diameter distal ward. The free part is shorter than the sigmoid part and extends from the insertion of the retractor muscle of the penis to the external urethral orifice where its length reaches approximately 21 cm. This part represents the narrowest part of the urethra.

Table 2: Showing the length of the male urethra according to the second division.

Total length of the urethra	Pelvic urethra	Penile urethra		
		Bulbic part	Sigmoid part	Free part
72± 0.41 cm	15± 0.43 cm	7 ± 0.57cm	29 ± .031 cm	21± o.75cm
		57 ± 1.13 cm		

Concerning the lumen of the urethra, the cast of the urethra shows that the most dilated part of the urethra is at the level of the colleculus seminalis (Fig. 1B), then it decreases gradually to reach its minimal diameter at the ischial arch. On the other hand concerning the penile urethra the widest lumen is at the bulb of the penis then decreases gradually towards the tip of the penis. Diverticula could not be observed along the course of the urethral lumen.

Radiography

Contrast radiographic study of the male dromedary urethra (Fig. 5) showed that the diameter of the lumen of the penile urethra is narrower than that of the pelvic urethra. The proper urethra appears narrow while the remaining part of the pelvic urethra reaches maximal dilatation at the level of the prostate, and then it becomes gradually narrower towards the bulbourethral gland. The initial part of the penile urethra (bulb of the penis) is the most dilated part; it diminishes gradually in its diameter towards the tip of the penis and forms a hock like shape at its end.

Ultrasonography

Table (3) and Figurer (6, 7) showing the diameter of the male urethral lumen.

Table 3: Ultrasonographic measurements of the diameter of the different parts of the urethral lumen (m±SD).

	Measured part	In mm (n=6)
Pelvic urethra	1- At neck of the urinary bladder	35±1.22
	2- At colliculus seminalis	78±0.80
	3- Remaining part of pelvic urethra	46±1.20
	4- At the level of ischial arch	25±1.22
Penile urethra	5- At the bulb of the penis	35±1.90
	6- At the sigmoid part of the penis	31±1.21
	7- At the free part of the penis	28±1.19
	8- At the tip of the penis	17±1.23

LEGENDS OF FIGURES

Fig. 1: A: Showing male camel urethra extends from the internal urethral orifice (IU) at the neck of the urinary bladder (U B) to the external urethral orifice (Arrow head) at the tip of the penis. The urethra can be subdivided into proper urethra (PU) extends from the internal urethral orifice to the colliculus seminalis (CS) and urogenital canal (UGC) extends from the colliculus seminalis to the external urethral orifice. Note the urethra can be further subdivided into pelvic urethra (PVU) and penile urethra (PNU).

B: Cast of the male camel urethral lumen showing the most dilated part of the was observed at the level of the colleculus seminalis (arrow head) then decrease gradually to reach its minimal value at the ischial arch (curved arrow). Note the widest part of the penile urethra was observed at the bulb of the penis (arrow).

Fig. 2: Showing the colliculus seminalis (CS) was observed at the level of the pelvic urethra. The prostate gland opens by narrow orifices (Arrows) on other side of the colliculus seminalis.

Fig. 3: Showing the opening (Arrows) of the bulbourethral gland on either side of midline of the roof of the urethra.

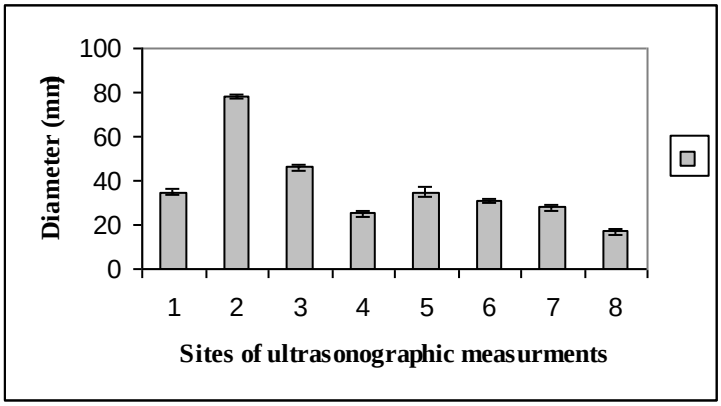
Fig. 4: Showing the main three parts of the penile urethra; proximal bulbic (B), middle sigmoid (S) and distal free part (F) The bulbic part is the direct continuation of the pelvic urethra (PVU) at the ischial arch. The sigmoid part extends from the bulbus of the penis to the insertion of the retractor penis muscle (RM). Note urinary bladder (UB).

Fig. 5: Contrast radiography showing the lumen of the male camel urethra. Note the lumen of the penile urethra is narrower than that of the pelvic urethra. The pelvic urethra reaches maximal dilatation at the level of the prostate gland (PG), and then it is gradually become narrower towards the bulbourethral gland (BUG). The bulb of the penis (BP) is the most dilated

part of the penile urethra; it diminishes gradually in its diameter towards the tip of the penis.

Fig. 6: Ultrasound images of the male camel urethra: **(a)** showing the connection between the urinary bladder (UB) and pelvic urethra (PVU). **(B)** Showing the pelvic urethra (PVU) and Prostate gland (PG). **(C)** Showing the initial part of the penile urethra (PNU). (D) Showing the terminal part of the penile urethra (PNU).

Fig. 7: Histogram showing sites of ultrasonographic measurements of the urethral lumen (1-8 as in the Table1).



DISCUSSION

Anatomical, radiographic and ultrasonographic descriptions of the male dromedary urethra are of greet importance clinically in diagnosis and treatment of cases of urethral obstruction (Kock, 1985). The length of the urethra in the dromedary is about 72 cm. It is shorter than that of the ox which is about 112 cm (El-Hagri, 1976; Sisson, 1975). The length of the urethra plays a major role in the incidences of the urethral calculi. Therefore the urethral calculi are common in ox but rarely occur in dromedary where the length of ox urethra about 1½ times of the dromedary. On the other hand the urethral calculi are more common in male animals than female because of the difference in size and length of the urethra (Aldridge and Garry, 1992; Walker and Vaughan, 1980).

Monoghan and Boy, (1990) and Walker and Vaughan (1980), mentioned that the sharp bending of the ox urethra at the sigmoid flexure has been suggested to be a reason of the common lodge of urethral calculi at the distal part of the sigmoid flexure. On the contrary to the ox urethra the sigmoid flexure in the dromedary is less bending therefore lodgment of urethral calculi at the sigmoid flexure is not possible.

In comparison to the ox urethra in which the sigmoid part of the urethra is highly bending, shorter than the free part and is post-scrotal. (El-Hagri, 1976 and Sisson, 1975), the sigmoid part of the urethra in the dromedary is less bending, longer than the free part and is prescrotal.

Bezuidenhout and Coetzer (1982) and Semieka (1999) described the urethral diverticulum in bull. This diverticulum has a great clinical

importance during catheterization of the urethra in bull as the catheter passed from the tip of the penis usually lodge in the diverticulum instead of passing into urinary bladder (Garret, 1987; Monoghan and Boy, 1990). Therefore the catheterization of the urinary bladder in male ruminant usually requires performing an ischial urethrostomy or exploratory laparotomy and cystotomy (Walker and Hull, 1984). In the present study, although the urethral diverticulum was not seen in dromedary camel, and catheterization of the urinary bladder through the tip of the penis is thought to be safely done without fear from rupture of this diverticulm during the false passage of the catheter, catheterization of the male dromedary urethra was found to be impossible due to the very narrow free part of the urethra, this necessitate performing catheterization by making an ischial urethrotomy. This same results were obtained from Kuntze and Mill (1974) as well as Tibary and Anouassi (2000). Therefore injection of the urethra with the cast and/or the contrast materials for the anatomical and radiographic study was performed an 18-gauge needle inserted in the neck of the urinary bladder. On the contrary to our results Kock (1985) could catheterize the camel urethra with a size 3 French gauge, 1 mm diameter catheter but he found that complete catheterization of the male dromedary urethra is not possible due to the presence of the sigmoid flexure.

The result of the present work indicated that the predilection seat of urolthiasis is the free part of the urethra, this in accordance with that stated by (Kock, 1985). On the other hand Tibary and Anouassi (2000) mentioned that the predilection seat of the urolithiasis is at the level of sigmoid flexure.

Diagnosis of urolithiasis can be performed either by plane or contrast radiography. The use of plain radiography in diagnosis of urolithiasis is not always practicable as it failed sometimes to reveal the presence of calculus (Kuntze and Mill, 1974). On the other hand Palmer *et al.* (1998) used contrast radiography in diagnosis of cases of urolithiasis in swine and small ruminants. The present work shows that the use of contrast radiography for diagnosis of urethral lesions in the male dromedary is impossible because injection of the contrast material through the free part of the urethra is difficult. Therefore ultrasonography could b considered the most suitable method for diagnosis of urethral lesions in camel.

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