Acquired obstructive urolithiasis in male *Camelus dromedarius* from southeast Algeria: Report of 11 cases

Dahmane Abdeldjalil

Higher National Veterinary School of Algiers, Issad Abbas Street, Oued Smar, Bab Ezzouar, Algeria

dahmanjalil@yahoo.fr; a.dahmane@etud.ensv.dz

Submitted February 23, 2020; Accepted July 8, 2020; Published November 14, 2020

Abstract

Urolithiasis is an important disease of farm animals and a few cases are reported in camels. Camel is an animal that anatomically and physiologically adapted itself to the weather condition of the desert. This investigation was undertaken to study the prevalence of urolithiasis, the clinical features and determination of prognostic factors in camel with acquired urinary obstruction in Djanet province from southeastern Algeria. Therefore, of the 62 male dromedary camels, 5 were intact and 57 were castrated; uroliths were found in 10 castrated and 1 intact male with urinary calculi incidence of 17.74%. Male dromedary camels were presented with a history of urine retention. Anamnesis revealed a 3 to 6-day history of lethargy, loss of appetite, oligodipsia and repetitive unsuccessful attempts at micturition. Six animals were completely obstructed, and clinical evolution was finished by death after anuria and coma. This survey showed 11 urinary stones in eleven 7-12 years old male camels. Six urinary stones of non-survivor camels were studied. The diameter of the stones varied between 0.2 × 0.3 to 0.8 × 0.9 mm, with average weight of 0.15 to 0.65-gram, rough or smooth surface and every stone was cream in color. Urinary stones might be known as calcite (Calcium carbonate). The degree of obstruction (partial / total) and the ruptured bladder (yes / no) increase the risk of mortality in clinically ill animals by presenting a statistically significant link. Other risk factors studied such as age, race, rupture of the urethra, treatment strategy and season of admission have no statistically significant relationship (P> 0.05) and do not affect the survival of animals. To our knowledge, this is the first description of urolithiasis in the dromedary camel from Algeria.

Keywords: Algeria, dromedary camel, obstructive, prognostic, urolithiasis.

Introduction

There is no verifiable evidence of obstructive urethral calculi in camels in their natural habitats. In zoological collections, causes such as urinary infections, metabolic disorders, malnutrition or climatic stress have been associated with urinary calculi in the dromedary (Kock, 1985).

Among farm animals, bladder and urethral diseases are more common and more important than diseases of the kidneys (Radostitis et al., 2007; Kojouri et al., 2014). Urinary retention in the dromedary was first reported by Liautard in 1879 (cited in Kock, 1985). As in ruminant species, the most common causes of this condition are uroliths and urethritis (Kock, 1985; Gahlot, 1992; Nigam, 1992; Divers and Van Metre, 2002). Infections, metabolic disorders, malnutrition, and climatic stress have been suggested as predisposing factors. Urinary obstruction is more common in temperate climates and occurs in both females and males (castrated and intact males), and there appears to be no age predisposition (Kock, 1985). However, as in other domestic species, it might be more common in castrated males than in intact males due to less urethral development, particularly when the castration is performed in very young males (Kock, 1985; Radostitis et

al., 2000).The urinary bladder in the camel is relatively small and it is limited in position within the pelvic cavity. Partial or complete obstruction of the urethra by urinary calculi are almost exclusively in male. The most common site of urinary stones is the outlet (external urethral orifice) of urine and penile sigmoid flexure especially at its tail end (Smith, 2009). In camelids, uroliths composition were described to be a large proportion of calcium (Kock, 1985), silica (Gutierrez et al., 1999), or amorphous and colloidal matrix without mineral constituents (Kock, 1985). Medical treatment of urolithiasis in small ruminants is unlikely to achieve long-term resolution of obstruction and therefore, surgical intervention is often required (Haven et al., 1993).

The prevalence rate of bladder stones and chemical composition in camels of Algeria has not been previously reported, hence the present study was to document the clinical and necropsy features and to identify the urinary calculi associated factors in male *Camelus dromedarius* examined in veterinary clinics from southeast Algeria.

Cases series study

Sampling and data collection

The present study was conducted in the veterinary clinics (District of Djanet) from June 2013 to September 2014. Sixty-two (62) male camels (*Camelus dromedarius*) were inspected. Complete medical records of camelids diagnosed with acquired urinary obstruction were reviewed.

Patients were confirmed to have stranguria or unable to void urine. Animals were included for this study if the record indicated that this was associated with urethral obstruction based on diagnostic surgical or postmortem findings (distension of the bladder or proximal urethra). Data collected from medical records included: age, sex, diet, month and year of admission, duration of clinical signs before admission, presence of complete or partial urethral obstruction. The presenting clinical signs were collected including heart and respiratory rates, rectal temperature, necropsy findings. The age of the animals was recorded according to the dental formula (Al-Ani, 2004). The camels were classified in two different age groups 7 to 10 years and up to 10 years old. All camels were studied in terms of bladder or urethral stones. Urethra and bladder were then incised to see the presence of calculi, ulceration, and hyperemia. Stones or calculi were placed in plastic containers with lids. The samples were air dried and its colour and weight were noted, and size was determined using Vernier caliper.

Treatment strategy was categorized as a surgical treatment only or surgical treatment combined with medical treatment. Type of surgery performed (removal of urolith at the tip of the urethra, detection of uroliths at surgery or necropsy (yes/no), location of uroliths based surgery or necropsy, were extracted from records. Data management and analysis were carried out using Stata version 12 (StataCorp, College Station, TX, USA).

History and physical examination

There were 62 camels: 57 camels (91.9%) were castrated (at about 6 months of age) and five intact, 20 animals to Mehari race (32.3%) and 42 to Tergi race (67.7%). The median age was 9.5 years (range 7–12 years).

In total, uroliths including bladder stones were found in 10 castrated and one intact male camel. In this study, the incidence of urinary calculi was 17.7%. More cases presented in December–May (n = 8, 72.7%) then in June–November (n = 3, 27.3%), but this was not statistically significant (P = 0.624). Also, the results of a descriptive analysis of the samples with urinary calculi were summarized in Table 1.

Table 1. Categorical data for the risk of non-survival of camelids with acquired urinary obstruction in Djanet, Algeria.

Categories		Cases	Survivors	Non-survivors	Prevalence of non-survivors (95% CI)	Odds ratio of non-survival	P value	Significance
Sex	Castrated	10 (90.90%)	04 (40%)	06 (60%)	29.63-90.36	0.231 0.0076 to 7.04682	0.4006	NS
	Intact	01 (9.09%)	01 (100%)	00 (0%)	0.00-0.00			
Age	7-10 Years	05 (45.45%)	03 (60%)	02 (40%)	0.00-82.94	3.00 0.2547 to 35.3356	0.3826	NS
	10-12 Years	06 (54.54%)	02 (33.33%)	04 (66.66%)	28.94-100.00			
Race	Mehari	06 (54.54%)	03 (50%)	03 (50%)	9.99-90.00	1.50 1360 to 16.5430	0.7406	NS
	Tergi	05 (45.45%)	02 (40%)	03 (60%)	17.05-100.00			
Degree of obstruction	Partial	05 (45.45%)	05 (100%)	00 (0%)	0.00-0.00	143 2.4150 to 8467.6409	0.0172	S
	Complete	06 (54.54%)	00 (0%)	06 (100%)	100.00-100.00			
Bladder rupture	Yes	03 (27.27%)	00 (0%)	03 (100%)	100.00-100.00	0.008 0.0001 to 0.5136	0.0228	S
	No	08 (72.72%)	08 (100%)	00 (0%)	0.00-0.00			
Urethra rupture	Yes	05 (45.45%)	01 (20%)	04 (80%)	44.93-100.00	0.125 0.0078 to 1.9985	0.1415	NS
	No	06 (54.54%)	04 (66.66%)	02 (33.33%)	0.00-71.05			
Treatment strategy	Surgical	04 (36.36%)	03 (75%)	01 (25%)	0.00-67.43	7.500 0.4584 to 122.7028	0.1576	NS
	Surgical-Medical	07 (63.63%)	02 (25%)	05 (75%)	37.96-100.00			
Season	Cold (Oct.-April)	08 (72.72%)	04 (50%)	04 (50%)	15.35-84.64	2.00 0.1251 to 31.9766	0.6240	NS
	Hot (May-Sept.)	03 (27.27%)	01 (33.33%)	02 (66.66%)	13.32-100.00			

OR–Odds Ratio; CI–Confidence Interval at 95 %; S: Significant, $P \leq 0.05$; NS: Not significant, $P > 0.05$.

In total, 6 animals (54.5%) were completely obstructed and 5 (45.4%) were partially obstructed. They were described as either dribbling urine or able to void small amounts of urine when straining. A physical examination, the animals showed good body condition and were normothermic (37.5–38.9°C) on presentation (median 38.2°C), with variable heart and respiratory rates (40–47 beats/min and 6–9 breaths/min).

Clinical signs and uroliths examination

Seven to 12 years old male dromedary's camels were presented with a history of urine retention, on a tourist camel farm in the province of Djanet. No antecedents of urinary retention had been observed in the herd. The daily diet was composed of 2 kg of grains (particularly barley) and 4 kg wheat straw per head. Salt was not added to the diet. These animals had access to water every 5 days.

The first case presented with a 4-day history of lethargy, loss of appetite, oligodipsia, and anuria. The other cases were diagnosed two months later and showed the same signs and clinical manifestations. Globally, Anamnesis revealed a 3 to 6-day history of clinical manifestations of urinary obstruction with repetitive unsuccessful attempts at micturition. Careful rectal palpation revealed a distended urinary bladder in all cases.

The most described clinical signs on presentation were straining to urinate (n = 10), dribbling urine (n = 6), anorexia or decreased appetite (n = 8) and frequent posturing to urinate (n = 9). The animals were initially treated with 0.9% saline or Ringer's solution, flunixin–meglumine and Amoxicillin (6 mg/kg intramuscularly every 24 h for 5 days).

In six cases, within a few centimeters of the aperture, we found a hard stone, and the animal could urinate after it was removed using a small catheter (0.3 cm). In three cases, several small hard stones were found after urethral surgery. The animal started voiding urine normally a few hours later. After surgery, the animal fully recovered within one to two weeks.

During surgery or at necropsy, one or more uroliths were found in 9 out of 11 cases (81.81%), with the most commonly reported location being the urethra (n = 8). Other reported locations included the bladder (n = 1) and kidney (n = 1). Calculi were reported in multiple locations in three cases. No perceptible uroliths were found in two cases (18.18%). The characteristic of each stone presented in non-survivor camels is recorded in Table 2.

Table 2. The physical characteristics of stones obtained of urinary tract in six camels from Algeria.

Sample	N° of calculi	Colour	Size (mm)	Surface	Weight (g)
1	One	Cream	0.5 × 0.7	Rough	0.35
2	One	Cream	0.8 × 0.9	Smooth	0.65
3	Two	Cream	0.2 × 0.3	Rough	0.15
4	Two	Cream	0.2 × 0.5	Rough	0.25
5	One	Cream	0.2 × 0.4	Smooth	0.23
6	One	Cream	0.4 × 0.6	Rough	0.31

Seven animals (n = 7, 63.6%) were managed medically with surgical intervention, including intravenous administration of 0.9% saline or Ringer's solution (n = 5), flunixin–meglumine (n = 4), Amoxicillin (n = 4) and diazepam (n = 2), surgery management including removal of a urolith from the distal tip of the urethra in all animals (n=7, 100%) were performed. Without no medical follow up needed for 4 animals (36.4%). Surgical observations included necrosis at the tip of the penis (n = 2), inability to pass a urinary catheter (n = 4) and presence of a urolith at the distal end of the urethra (n = 5).

Discussions

Urolithiasis is a common subclinical condition among ruminants raised in a management system where the ration is composed primarily of grain or where animals graze certain types of pasture (Radostits et al., 2000). In camels, urolithiasis has been reported in dromedaries (Kock, 1985), bactrianus (Kuntze and Mill, 1975) and llamas (Kock and Fowler, 1982; McLaughlin and Evans, 1989). Calculi are produced by an animal's disturbed metabolism, often resulting from dietary and vitamin deficiency or glandular imbalance (Duffin et al., 2013).The urethra, triangular-shaped area of the bladder wall (trigonum vesicae), ureter and pelvis are the most common sites of urinary stones. The aetiology of urinary stone disease is multifactorial and not completely well understood (Jeong et al., 2011). Some of the predisposing factors for the formation of urinary stones are high concentrations of urine, deprivation of water for a long time. Uroliths in male camelids most frequently lodge at the reflection of the urethra around the ischium or at the point where the penile urethra narrows to enter the glans penis (Van Metre and Divers, 2002). Camelids do not commonly have obstructions in the sigmoid flexure, as do cattle, and they do not have a urethral process (vermiform appendage), as do small ruminants (Ewoldt et al., 2014).

It is known that the camel can produce urine with a concentration of salt almost twice that of seawater (Dorman, 1984; Wernery and Kaaden, 2002), and that requires 6 to 8 times more salt for maintenance than other livestock (Nigam, 1992).

Urinary calculi appear to be more common in temperate climates, occurs in both females and males, castrated and intact, and there appears to be no age predisposition (Kock, 1985). However, as indicated by this study, obstructive urolithiasis is more common in castrated than in intact males due to less urethral development, particularly when the castration is performed in very young males (Gutierrez et al., 2008). Early castration is commonly thought to reduce the positive influence of testosterone on urethral diameter and diminish normal attachments of the prepuce to the penis, which are present in the neonate. In calves and goats, intact animals have shown to have the largest urethral diameters, followed by delayed and partial castrates, with early castrates having the smallest urethral diameters (Marsh and Safford, 1957; Kumar et al., 1982). Delaying castration may serve to increase urethral diameter and reduce obstructive rates. No data are available to guide camelid owners or veterinarians on the appropriate time to castrate camelids based on urethral diameter (Ewoldt et al., 20014).

Causes of obstructive urethral calculi in camels such as urinary infections, metabolic disorders, malnutrition or climatic stress have been reported (Kock and Chapman, 1986). In the current study, urolith calculus in camels was probably due to the fact that animals are intensively managed, and salt are not always present in the farms. One of the more important components of the diet and formation of urinary stone in camels is salt. The ingestion of salt can result in a higher ingestion of water and, consequently, a higher renal perfusion increasing the urine volume and avoiding the salt precipitation (Gutierrez et al., 2008). The role of urine pH in urolithiasis is well documented, and various sources recommend

urine pH goals of 5.5 to 6.5, based on the solubility of the common stone compositions. Because of an ability to alter the acid–base balance and body water balance, salts have been widely used and recommended for the prevention of urolithiasis. Anionic salts containing primarily chlorides have been popular and used extensively, as they reduce urine pH, increase urine output, and, ultimately, prevent urolithiasis (Hay, 1991; Pugh, 2002). Sodium chloride (1% – 4%), calcium chloride (1% – 2%) and ammonium chloride (0.5% – 2%) have been traditionally added as percentages of rations to increase water intake and produce acidic urine, with inconsistent results (Udall and Chow, 1965; Jones and Streeter, 2005).

Various calcium salts, phosphatic complexes, silica, and oxalates are all potential mineral sources causing uroliths (Gerros, 1998; Duffey et al., 2008; Negri et al., 2008; Asplin, 2009; Eisner et al., 2010). Camelids consuming rations high in phosphorus, such as grain-based feedlot rations, commonly develop phosphate calculi (Ewoldt et al., 2014). Increases in dietary phosphorus levels result in increased concentration of phosphate ion in urine, predisposing to develop phosphate urolithiasis (Bushman et al., 1965).

Because calcium opposes phosphorus absorption from the gut, urinary excretion of phosphate is augmented by low dietary levels of calcium relative to phosphorus (Hay, 1991). Struvite (magnesium ammonium phosphate) and apatite (calcium phosphate) uroliths are known to precipitate in alkaline urine (Hay, 1991; Pugh, 2002). Struvite crystallization occurs only at a pH range of 7.2 to 8.4, whereas apatite stones develop at a urine pH of 6.5 to 7.5 (Elliot et al., 1985). Reduced consumption of water or dehydration may contribute to urolith formation by contributing to supersaturation of urine, precipitation of crystals, and formation of organic and inorganic crystalloids in urine (Ewoldt et al., 2014). In this study, water deprivation is part of the camel breeding practice in this region because of the lack of this vital resource which often comes from common wells between several breeders due to the difficulty of drilling wells of water. Breeders consider the camel to be an animal that tolerates heat well and consumes water periodically. This deprivation is 5 days in winter and 3 days in summer, which predisposes to the formation of urinary stones especially since salt supplementation was not common as a daily or periodic practice in these farms.

Khaki et al., (2006) studied the bladder of 140 camels in slaughterhouses around Tehran and announced in the bladder of an adult male camel had two stones and the incidence of urinary stones was reported to be 0.71%. The composition was calcium carbonate. Kock (1985) reported two cases of urinary stones in male camels and found that the infection, metabolic disease, malnutrition and climatic stress are involved in the formation of urinary stones. Gutierrez et al., (2002) examined the sensitivity of the six castrated male camels in four groups that each group received different amounts of salt in the diet, ten months later the control group animals did not show obstruction and retention, hence opined that supplementation of 52 g of salt in the daily ration can prevent formation of urinary stones in equatorial climates (Dorman, 1984). Two cases of urinary obstruction caused by silicate stones have been reported in camels at a farm in Iceland by Gutierrez et al., (1999) and opined that early castration and reducing salt in daily diet are causes of stone formation.

In desert areas of Tunisia, it seems that plants and water have large amounts of salt which are presumably causes of the low prevalence of urinary stones in dromedary camel. These animals fed with *Atriplex spp.* (Family: Amaranthaceae) kept on their much salt (Frandson et al., 2009; Laudadio et al., 2009). Grazing of females on pastures that have a high silica content of soil and plants is preferred to the grazing of males on these pastures. If males are to be grazed in these locations water intake

should be encouraged by maintaining desirable and accessible water sources and supplementation of ammonium chloride or sodium chloride, and reduction in the dietary calcium-to-phosphorus ratio (Stewart et al., 1990; Stratton-Phelps and House, 2004).

Both Old and New World camelids with acquired urinary obstruction present similar clinical and diagnostic findings with obstructive urolithiasis. The sex (castrated and intact males) and age of the animals reported in the current study were similar to previous reports in New World camelids and small ruminants (Rakestraw et al., 1995; Fortier et al., 2004). The most common clinical signs in New World camelids presented with urethral obstruction (dromedary camels in the current study), were straining to urinate, dribbling urine and anorexia which were, are also frequently observed in small ruminants with obstructive urolithiasis (Rakestraw et al., 1995).

Clinical signs associated with urolithiasis vary with the stage of the disorder the degree of blockage and severity of surrounding tissue reactions (Higgins, 1986). If the blockage is complete, retrograde pressure will build in the bladder to the point of rupture and subsequent death of the animal is inevitable. Two reports of bladder rupture secondary to a urethral blockage have been reported in both Old and New World camelids (McLaughlin and Evans, 1989; Dart et al., 1997; Gutierrez et al., 2008).

Incomplete blockage results in variable stages of stranguria, exaggerated and prolonged urination posture, urine dribbling and blood-tinged urine (Gerros, 1998). Affected animals may be depressed and lethargic, grind their teeth and show signs of abdominal distention and pain (Van Saun, 2006). Signs prior to bladder rupture include colic, straining stance to urinate, dribbling urine, blood-tinge urine, anuria, distended bladder, and possible pulsation of the urethra. Signs after bladder rupture are the absence of colic, with depression, anorexia, anuria, uroperitoneum, and possible distention of the abdomen and uremia (muscular weakness, dehydration, dyspnea, tremors, uremic breath odour, tachycardia, recumbency, coma, death (Vishvarrdyalaya, 1992).

In the present study, similar clinical signs were reported in different previous investigations (Gutierrez et al., 1999; Gutierrez et al., 2002; Gutierrez et al., 2008; Duesterdieck-Zellmer et al., 2014). The therapeutic and surgical approaches will depend on the severity of the blockage, duration and secondary complications.

Conclusion

In conclusion, this study demonstrated for the first time, that in the southeastern geographic region in the desert of Algeria, the occurrence of bladder and urethral stones in the camels is low and appears to be associated with castration. Also, the obtained stones were composed of calcium carbonate which was linked to the grazing system and husbandry practices with the presence of high level in phosphorus and calcium in grain-based feedlot rations (no chemical analysis of the collected stones were performed). Potential causes of urinary retention were the early castration of the animals (at about 6 months of age) and the fact that salt was not added to the diet. These factors are well known in the pathogenesis of urinary retention in the dromedary and could be managed to minimize the prevalence and associated loss of this neglected disease in Algerian camels.

Acknowledgments

The author acknowledges the valuable help from other veterinary clinicians from Djanet district in southeast Algeria.

Conflict of interest

The author declares that there is no conflict of interest.

References

Al-Ani, F. K. 2004. Camel Management and Diseases. 1st Edn. Amman, Jordan: Al-Sharq Printing Press. pp. 263–268.

Asplin, J. R. 2009. Obesity and urolithiasis. *Adv. Chronic Kidney Dis.,* 16(1): 11-20.

Bushman, D. H., Emerick, R. J. and Embry, L. B. 1965. Effect of various chlorides and calcium, carbonate calcium, phosphorus, sodium, potassium, and chloride balance and their relationship to urinary calculi in lambs. *J. Animal Sci.*, 27: 490-496.

Dart, A. J., Dart, C. M. and Hodgson, D. R. 1997. Surgical management of a ruptured bladder secondary to a urethral obstruction in an alpaca. *Aust. Vet. J.,* 75(11): 793–795.

Divers, T. J. and Van Metre, D. C. 2002. Alterations in urinary function. In: Smith BP, editor. Large animal internal medicine. 3rd edn. Mosby, St Louis, 171–181.

Dorman, A. E. 1984. Aspects of the husbandry and management of the genus Camelus. *British Vet. J.,* 140: 616-633.

Duesterdieck-Zellmer, K. F., Van Metre, D. C., Cardenas, A. and Cebra, C. K. 2014. Acquired urethral obstruction in New World camelids: 34 cases (1995-2008). *Aust. Vet. J.,* 92(8): 313-319.

Duffey, B. G., Pedro, R. N., Kriedberg, C., Weiland, D., Melguist, J., Ikramuddin, S., Kellogg, T., Makhlouf, A. A. and Monga, M. 2008. Lithogenic risk factors in the morbidly obese population. *J. Urol.,* 179(4): 1401-1406.

Duffin, C. J, Moody, R. T. J. and Gardner-Thorpe, C. 2013. A history of geology and medicine. The Geological society, London. pp 146.

Eisner, B. H., Porten, S. P., Bechis S. K. and Stoller, M. L. 2010. The role of race in determining 24-hour urine composition in white and Asian/Pacific Islander stone formers. *J. Urol.,* 183(4): 1407-1411.

Elliot, J. S., Quaide, W. L., Sharp, R. F. and Lewis, L. 1985. Mineralogical studies of urine: the relationship of apatite, brushite and struvite to urinary pH. *J. Urol.,* 80(4): 269-271.

Ewoldt, J. I., Baird, A. N. and Anderson, D. E. 2014. Urogenital surgery in camelids. In: Cebra C, Anderson DE, Tibary A, Van Saun RJ, Johnson LaRue W, editor. Lama and Alpaca Care. St. Louis, Elsevier, 702-709.

Fortier, L. A., Gregg, A. J., Erb, H. N. and Fubini, S. L. 2004. Caprine obstructive urolithiasis: requirement for 2nd surgical intervention and mortality after percutaneous tube cystostomy, surgical tube cystostomy, or urinary bladder marsupialization. *Vet. Surg.,* 33: 661–667.

Frandson, R. D., Wilke, W. L. and Fails, A. D. 2009. Anatomy and Physiology of Farm Animals. 2nd Edn. Wiley-Blackwell. pp 528.

Gahlot, T. K. 1992. Urethral rupture and subcutaneous infiltration of urine in camels (Camelus dromedarius). In: Proceedings of the 1st International Camel Conference, Dubai, Emirate Arabia United, 353-355.

Gerros, T. C. 1998. Recognizing and treating urolithiasis in llamas. *Vet. Med.,* 93(6): 583–590.

Gutierrez, C., Corbera, J. A., Doreste, F., Padrón, T. R. and Morales, M. 2002. Silica urolithiasis in the dromedary camel in subtropical climate. *Vet. Res. Commun.,* 26(6): 437-442.

Gutierrez, C., Corbera, J. A. and Faye, B. 2008. Obstructive phosphate urolithiasis in a dromedary camel: a case report. *J. Camel Pract. Res.,* 15(1): 1-5.

Gutierrez, C., Padrón, M., Bañares, A. and Palacios, M. P. 1999. Urinary retention in two male dromedaries due to silica uroliths. *J. Vet. Med.,* 46(9): 523-526.

Haven, M. L., Bowman, K. F., Engelbert, T. A. and Blikslager, A. T. 1993. Surgical management of urolithiasis in small ruminants. *Cornell. Vet.,* 83(1): 47–55.

Hay, L. 1991. Prevention and treatment of urolithiasis in sheep. *Vet. Record.,* 12: 87-91.

Higgins, A. J. 1986. The camel in health and disease, London, Bailliere Tindall. pp. 205-209.

Jeong, J. Y., Doo, S. W., Yang, W. J., Lee, K. W. and Kim, J. M. 2011. Differences in urinary stone composition according to body habitus. *Kor. J. Urol.,* 52(9): 622-625.

Jones, M. and Streeter, R. N. 2005. Dietary cation anion balancing for the reduction of urine pH in goats. *J. Vet. Intern Med.,* 19(3): 412-417.

Khaki, Z., Khazraeinia, P. and Bokaei, S. 2006. Prevalence rate of bladder stones in slaughtered camel around Tehran. In: Proceedings of the 14th Iranian Veterinary Congress in Tehran, Iran, 250-251.

Kock, M. D. and Fowler, M. E. 1982. Urolithiasis in a three months old llama. *J. Am. Vet. Med. Assoc.,* 181: 1411-1418.

Kock, R. A. 1985. Obstructive urethral calculi in the male camel: report of two cases. *Vet. Rec.,* 117: 494-496.

Kock, R. A. and Chapman, M. J. 1986. Management, feeding and health of camels kept under intensive husbandry. In: Higgins AJ, editor. The camel in health and disease. London, Bailliere Tindall, 161-178.

Kojouri, G. A., Nourani, H., Sadeghian, S., Imani, H. and Raisi, R. 2014. Pathological findings of slaughtered camels' (Camelus dromedarius) kidneys in Najaf-Abad, Iran. *Vet. Res. Forum.,* 5(3): 231-235.

Kumar, R., Kumar, A., Singh, H., Singh, B. and Prakash, P. 1982. Effect of castration on urethra and accessory sex glands in goats. *Indian. Vet. J.,* 59: 304-308.

Kuntze, A. and Mill, J. 1975. Urethral urolithiasis in a camel (Camelus bactrianus). Diseases of zoo animals. In: Proceedings of the XVIIth International Symposium, Tunis, Tunisia, 61-64.

Laudadio, V., Tufarelli, V., Dario, M., Hammadi, M., Seddik, M. M., Lacalandra, G. M. and Dario, C. 2009. A survey of chemical and nutritional characteristics of halophytes plants used by camels in Southern Tunisia. *Trop. Ani. Health. Pro.,* 41(2): 209-215.

Marsh, H. and Safford, J. W. 1957. Effect of deferred castration on urethral development in calves. *J. Am. Vet. Med. Assoc.,* 130: 342-346.

McLaughlin, B. G. and Evans, N. C. 1989. Urethral obstruction in a male llama. *J. Am. Vet. Med. Assoc.,* 195(11): 1601-1602.

Negri, A. L., Spivacow, F. R., Del Valle, E. E., Forrester, M., Rosende, G. and Pinduli, I. 2008. Role of overweight and obesity on the urinary excretion of promoters and inhibitors of stone formation in stone formers. *Urol. Res.,* 36(6): 303-307.

Nigam, J. M. 1992. Surgical disorders of the male urogenital system in the dromedary camel. In: Proceedings of 1st International Camel Conference, Dubai, Emirate Arabia United, 361-364.

Pugh, D. G. 2002. Lower urinary tract problems. In: Pugh DG, editor. Sheep and goat medicine. 1rst edn, Philadelphia, PA, Saunders, 201-210.

Radostitis, O. M., Gay, C. C., Hinchcliff, K. W. and Constable, P. D. 2007. Veterinary Medicine, A text book of disease of cattle, horses, sheep, pigs, and goats. 10th Edn. W.B Saunders, Madrid, Spain. pp. 550-567.

Radostits, O. M., Gay, C. C., Blood, D. C. and Hinchcliff, K. W. 2000. Veterinary Medicine, 9th Edn. pp. 479-500.

Rakestraw, P. C., Fubini, S. L., Gilbert, R. O. and Ward, J. O. 1995. Tube cystostomy for treatment of obstructive urolithiasis in small ruminants. *Vet. Surg.,* 24: 498–505.

Smith, B. P. 2009. Large Animal Internal Medicine. 4th Edn. Mosby Elsevier, USA. pp. 415-1024.

Stewart, S. R., Emerick, R. J. and Pritchard R. H. 1990. High dietary calcium to phosphorus ratio and alkali-forming potential as factors promoting silica urolithasis in sheep. *J. Anim. Sci.,* 68(2): 498-503.

Stratton-Phelps, M. and House, J. K. 2004. Effect of a commercial anion dietary supplement on acid-base balance, urine volume, and urinary ion excretion in male goats fed oat or grass hay diets. *Am. J. Vet. Res.,* 65(10): 1391-1397.

Udall, R. H. and Chow, F. H. C. 1965. Studies on urolithiasis VII. The effects of sodium, potassium, or chloride ions in the control of urinary calculi. *Cornell Vet.,* 55: 538-544.

Van Metre, D. C. and Divers, T. J. 2002. Diseases of the renal system: urolithiasis. In: Smith BP, editors. Large animal internal medicine. 3rd edn, St. Louis, MO, Mosby, 853-860.

Van Saun, R. J. 2006. Nutritional diseases of South American camelids. *Small Rum. Res.,* 61: 153–164.

Vishvarrdyalaya, H. P. K. 1992. Surgical disorders of the male urogenital system in the dromedary camel. In: Proceedings of the 1st International Camel Conference, Dubai, Emirate Arabia United, 361-362.

Wernery, U. and Kaaden, O. R. 2002. Infectious Diseases in Camelids. 2nd Edn. Blackwell Science, Germany. pp. 14-120.