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Comparative studies on percutaneous Malecot catheter cystostomy, suprapubic cystostomy and Foley's catheter tube cystostomy with Litholytic Neeri® tablets for the management of obstructive urolithiasis in small ruminants: Occurrence, clinical signs, radiographic and ultrasonographic studies

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Abstract
The occurrence of obstructive urolithiasis in small ruminants was recorded for a period of two years from January 2022 to December 2023 presented to the Veterinary College Hospital, KVAFSU, Bengaluru. The variables like age, breed, gender and detailed anamnesis were recorded. A total of 1,17,565 cases were, among which 30,545 were presented to Dept. of VSR. Total large animal cases were 2,917, out of which 1661 were small ruminants. Of those, urolithiasis was found in 128 animals (0.1%). The urolithiasis was more seen in small ruminants of >3-6 months age, followed by 0 to 3 months, more than 12 months, >9 to 12 months and >6 to 9 months. Out of 128 small ruminants with obstructive urolithiasis, 100% of cases were males. Among the affected animals, urolithiasis was mainly seen in uncastrated or intact animals 123 (96.09%) than the castrated animals 5 (3.91%). Small ruminants with duration of illness of 3-6 days were more 63 (49.22%), followed by less than 3 days (38.28%) and more than 6 days (12.5%). Urolithiasis was more commonly seen in winter (49/128; 38.28%), followed by the summer season (44/128; 34.37%), and monsoon season (35/128; 27.34%). Majority of small ruminants were having intact urinary bladder 99 (77.34%) and 29 (22.66%) were with urinary bladder rupture. The clinical signs showed by the animal included anorexia, anuria, dysuria, straguria, hematuria, frequent urination attempts, bruxism, tail lifting, straining to urinate, maintaining urination posture for extended periods, abducted stance, abdominal distension, arched back, urethral thrills, kicking at belly, swishing of tail and restlessness in animals with illness. Plain lateral abdominal radiographic examination helped to determine whether the bladder was enlarged or not, but it did not identify any calculi or the location of blockage in any of the animals. To determine the location of blockage, a retrograde contrast radiograph was obtained following urethral process amputation by injecting contrast material through the infant feeding tube. Trans-abdominal ultrasonography showed hyper echoic calculi freely floating in hypoechoic or anechoic fluid inside the urinary bladder. Ultrasonographic examination was used for the confirmatory diagnosis.

Keywords: Small ruminants, occurrence, radiography, ultrasonography

Introduction
The most serious urinary tract illness that affects ruminants is urolithiasis, which is considered to be the sixth most prevalent cause of mortality in feedlots and results in large financial losses for the livestock sector (Makhdoomi and Gazi, 2013) [15]. Urolithiasis is a disease that affects all animal species equally in both sexes. Nevertheless, blockage was less prevalent in females due to their tiny and flexible urethra (Radostits *et al*., 2000) [21]. Urolithiasis was most common in goats (49.83%), then in cattle (32.87%), dogs (14.53%), horses (1.38%), sheep (1.04%), and cats (0.34%) as a species, according to Amarpal *et al*. (2004) [1]. Disease mostly found in companion animals fed in feedlots, such as sheep and goats (Scully, 2021). The disease is more prevalent in the winter (Firdous *et al*., 2021) [5] and in male small ruminants that are still whole and younger than six months old (Shivaraju, 2022) [28].

According to Halland *et al*. (2002) [7], radiography, ultrasonography, clinical signs, and the history of difficult urinating can all be used to diagnose urolithiasis in small ruminants. Fourier transform infrared spectroscopy may be used to analyze calculi in a precise, quick, and qualitative manner (Bhattacharyya *et al*., 2014) [3]. Urinary acidifiers and calculolytic drugs can be used medically to dissolve calculi in small ruminants (Singh *et al*., 2014) [3]. Surgical options for small ruminants with obstructive urolithiasis include urethral process amputation, tube cystostomy, cystotomy, phallectomy, modified proximal perineal urethrostomy (MPPU), prepubic urethrostomy, urethrotomy, percutaneous tube cystostomy, vesico-preputial anastomosis (VPA), bladder marsupialization (laparotomy or laparoscopy) (Applegate *et al*., 2019) [2]. Nair *et al*. (2022) [17] documented complications related to caprine obstructive urolithiasis with urethrotomies, including stricture of the urethra, urine scald, hemorrhage, delayed healing, tube obstruction, and redirected urine stream. The present study was undertaken to overcome the above complications in small ruminants with urolithiasis.

Materials and Methods

The occurrence of obstructive urolithiasis in small ruminants was recorded for a period of two years from January 2022 to December 2023 presented to the Veterinary College Hospital, KVAFSU, Bengaluru. For clinical interpretations, the owners' histories of the animal's breed, age, sex, length of illness, and dietary habits were obtained and documented.

Results and Discussion

A total of 1,17,565 animals were brought to the Veterinary College Hospital in Hebbal, Bengaluru during the study's 24-month duration. A total of 30545 animals, including 2917 big animal cases, were reported to the Veterinary College Hebbal, Bengaluru's Department of Veterinary Surgery and Radiology. There were 1661 small ruminants in all, and 128 (0.1%) of those instances had urolithiasis (Table 1). Shukla (2016) [29] found that the total incidence of urine retention in bucks was 0.83 percent. An overall incidence of 5.04 percent of urolithiasis in Indian animals was observed by Amarpal *et al*. (2004) [1]. The incidence of urolithiasis in small ruminants was reported by Paul *et al*. (2010) [20] and Kumar *et al*. (2014) [11] to be 2.66% and 6.05%, respectively. In his study, Shivaraju (2022) [28] found that the incidence of urine retention in small ruminants was 12.5%.

The affected animals ranged in age from 20 days to 36 months (median age 6.7 months). The age group >3-6 months had the highest percentage of affected animals (43/128; 33.6%), followed in decreasing order by the age groups of 0 to 3 months (28/128; 21.9%), more than 12 months (23/128; 18%), 9 to 12 months (18/128; 14%), and 6 to 9 months (16/128; 12.5%) (Plate 1). According to Shukla (2016) [29], there can be a maximum of six occurrences of urine retention in bucks in the 0–6 months age range and a minimum of 12 months. According to Sarker *et al*. (2020) [26], native goats under the age of six months had a higher incidence of obstructive urolithiasis (63%), compared to goats older than six months (37%). On the other hand, Kumar (2017) [9, 10] indicated that the largest number of animals was 45.83 percent, or between 10 and 15 months of age. Animals who were transitioning from calfhood to maturity were more likely to have urolithiasis, which may be connected to the stage of rumen development at that age (between three and six months) (Thakur *et al*., 2020) [34]. In the present study most of the animals were raised in the urban areas which were mainly raised on concentrate diet and the managemental practice might be the cause of higher incidence in the age group less than six months of age.

During the research period, 128 instances of urolithiasis were discovered in animals. Of these cases, 100 percent were male, and no female animals were found to have obstructive urolithiasis. Amarpal *et al*. (2014) [11, 13], Chigerwe *et al*. (2016) [4], Shukla (2016) [29], Mahajan *et al*. (2017) [14], Sutradhar *et al*. (2018) [32], and Shivaraju (2022) [28] all reported findings that were similar. On the other hand, urolithiasis in male goats was reported to be 96.73% and 95.67% by Thakur (2017) [34] and Sarker *et al*. (2020) [26]. According to Videla and Amstel (2016) [36], female obstructive urolithiasis was uncommon because of their broader, shorter urethras, which make it easier for uroliths to pass through.

Of the 128 urolithiasis patients that were detected throughout the research period, 123 (96.09%) were male cases that were uncastrated or intact, and 5 (3.91%) were castrated (Plate 2). These results were consistent with Shivaraju (2022) [28] and Kushwaha *et al*. (2014) [13]. Tamilmahan *et al*. (2014) [33] found, in contrast to these results, that goats who were castrated had a higher incidence of urolithiasis (73.21%) than goats that were not castrated (26.08%). Males that were still whole were just as vulnerable to urolithiasis as those who had been castrated, particularly when other risk factors such as a diet high in concentrates were present (Riedi *et al*., 2018) [24]. Males that were intact were more common in this research than those that were castrated.

A total of 63 small ruminants (63/128; 49.22%) were reported to have urolithiasis between 3-6 days, followed by less than 3 days (49/128; 38.28%) and more than 6 days (16/128; 12.5%) (Plate 3). According to Gugjoo *et al*. (2014) [33], around 93.90% of goats had an illness lasting shorter than three days. According to Shukla (2016) [29], the retention duration was less than two days for about 80.64 percent of the dollars and more than two days for 19.35 percent of the bucks. This might be due to a number of factors, including early issue recognition, owners' ignorance about urethral obstruction treatments, owners' rejection of early surgical surgery for urethral blockage, and owners' preference for medical care.

Of the 128 instances of urolithiasis that were documented throughout the research period, the greatest number occurred in the winter (49/128; 38.28%), followed by the summer (44/128; 34.37%) and monsoon (35/128; 27.34%) seasons (Plate 4). These results were consistent with the findings of Radostitis *et al*. (2000) [21]. According to Shivaraju (2022) [28], small ruminants are more likely to get urolithiasis in the summer (42.62%). The majority of the instances, however, were recorded in the summer months by Sarker *et al*. (2020) [26] and Kumari (2018) [12]. Peak wintertime temperatures may cause animals to consume less water overall, which might result in super-saturation of the solutes in their urine. This could cause precipitation and the formation of calculi, which could obstruct the urinary system (Parrah *et al*., 2010) [19].

Of the 128 instances of urolithiasis that were identified during the research period, 99 cases (77.34%) had an intact bladder, whereas 29 cases (22.66%) had a ruptured bladder (Plate 5). In his research on urolithiasis in goats, Kumar (2017) [9, 10] discovered that whereas 7 (19.44%) of the 29 small ruminants had ruptured bladders, the rest 29 (80.56%) had intact bladders. According to Shulka (2016) [29], most bucks with urolithiasis (91.93%, or 57 instances) had intact bladders, whereas 8.07 percent (5 cases) had cystorrhexis. Tamilmahan *et al*. (2014) [33] reported that 26.08 percent of the bucks had a

ruptured bladder, whereas 73.91 percent of the bucks had an intact bladder. In contrast, Shivaraju (2022) [28] found that small ruminants with intact urinary bladders were 66.7% impacted by urolithiasis. Early case presentation at the teaching veterinary clinical complex for the early relief of the animal's suffering might be the reason for the increased incidence of urolithiasis in small ruminants with intact urine bladders.

Most small ruminants who had urolithiasis were given vegetables, green leaves, straw, bran, and concentrates (boosa and KMF pellets). Milk, napier, maize, GNC cake, corn dry, grass, leaves (cotton, people, jack, banana, mulberry, etc.), fruits (apple, banana), dry fruits (badam, kaju, kismis, etc.), chapati, and biscuits were also provided to the animals in addition to these. Samal *et al*. (2011) [25], Rafee *et al*. (2015) [22], Mahajan *et al*. (2017) [14], and Shivaraju (2022) [28] reported similar findings of increased urolithiasis occurrence in small ruminants fed primarily concentrates. Shukla (2016) [29] found that small ruminants fed more cereals and concentrated feeds, which had higher levels of phosphorus and magnesium and comparatively lower levels of calcium and potassium, were more likely to develop urinary blockage. Thakur (2017) [34] noted that animals with a history of receiving high concentration diets, primarily consisting of large amounts of bran and little green vegetables, may be at risk of developing urolithiasis.

Anorexia, dysuria, straguria, hematuria, frequent urination attempts, bruxism, tail lifting, straining to urinate, holding the urine position for prolonged periods of time, abducted stance, abdominal distension, arched back, urethral thrills, kicking at the belly, swishing of the tail, and restlessness were among the clinical signs of the illness in the affected animals. Amarpal *et al*. (2010) [31], Makhdoomi and Gazi (2013) [15], Videla and Amstel (2016) [36], Mahajan *et al*. (2017) [14], Riedi *et al*. (2018) [24], and Shivaraju (2022) [28] also reported similar clinical findings in small ruminants with urolithiasis. Shukla (2016) [29] noted clinical symptoms such as dullness, inappetence to anorexia, reluctant both hindlegs with starched backward and lateral, getting up and lying down, and repeated attempts to urinate in bucks with urinary retention due to urolithiasis.

A simple plain lateral abdominal radiography examination (Plate 6A) helped detect whether the bladder was enlarged (Plate 6B) prior to surgery, but it was unable to locate the obstruction or identify any calculi in any of the animals. After urethral process amputation, a retrograde contrast radiograph was taken by administering Urografin® (Plate 7) into the baby feeding tube to identify the blockage's position. The transit of contrast material up to the obstruction was seen when the urethra was totally blocked, preventing the contrast agent from entering the bladder (Plate 8A). On the other hand, in the case of partial obstruction, urethral filling defects that could point to the presence of amorphous miliary calculi allowed the contrast material to reach the bladder (Plate 8B). Radiography on the 30th post-operative day likewise showed no evidence of radio-dense urinary calculi (Plate 9). Studies by Palmer *et al*. (1998) [18], Shukla (2016) [29], and Shivaraju (2022) [28] came to similar results on the limited diagnostic utility of plain radiography in cases of radiolucent calculi. In contrast, Kinsley *et al*. (2013) [8] said that plain radiographs were essential for the identification, treatment, and recovery of small ruminants suffering from obstructive urolithiasis following surgery. Singh *et al*. (2010) [19] identified the goat urethral calculi by positive contrast cystourethrography utilizing Diatrizote meglumine and Diatrizote sodium (Urograffin®). To identify the site of urethral blockage and confirm whether the obstruction is full or partial, Shivaraju (2022) [28] also employed Urograffin® as a positive contrast for cystourethrography in sheep and goats with urinary obstruction. Numerous floating miliary hyperechoic calculi were seen on pre-operative trans-abdominal ultrasonography (Plate 10A) in the anechoic/hypoechoic fluid. The bladder thickened in animals with cystitis (Plate 10B). Caudal to the urethral blockage, trans-urethral sonography revealed a distended, anechoic, fluid-filled, dilated urethral lumen (Plate 11). Urine and anechoic fluid filled the main and minor calyx on trans-renal ultrasonography (Plate 12), suggesting renal stasis related to urinary retention. Trans-abdominal and/or per-rectal ultrasonography on the 30th post-operative day indicated a deflated bladder with anechoic fluid inside the urine bladder (Plate 13). Shukla (2016) [29], Mejia *et al*. (2022) [16], Nair *et al*. (2022) [17], and Shivaraju (2022) [28] corroborated the current study by suggesting that ultrasonography was a superior imaging modality for identifying urinary blockage in sheep and goats. Makhdoomi and Gazi (2013) [15] proposed that ultrasonography may be utilized as the primary diagnostic method for the diagnosis of urolithiasis, stating that sonography was safer for patients and operators since it does not require ionizing radiation. When it came to uroliths, bladder growths, and cystitis detection, ultrasonography outperformed both plain and negative contrast cystography (Rafiqee, 2020) [23]. In cases of urine retention owing to obstructive lesions, ultrasound can be effectively employed as a diagnostic tool alone or in conjunction with contrast cystourethrography.

Table 1: Occurrence of urolithiasis in small ruminants

Sl. No.	Total number of cases presented	Number of animals	Percent
1.	Veterinary College Hospital, Hebbal	1,17,565	
2.	Dept. of Veterinary Surgery and Radiology	30,545	25.98%
3.	Large animal cases	2917	2.48%
4.	Small ruminants	1661	1.41%
5.	Small ruminants with urolithiasis	128	0.109%

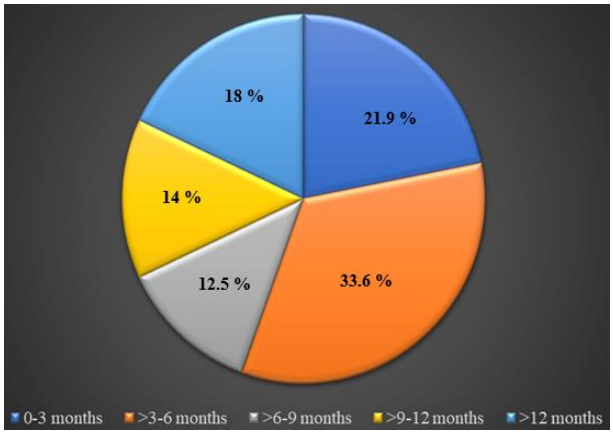


Plate 1: Age-wise occurrence of urolithiasis in small ruminants

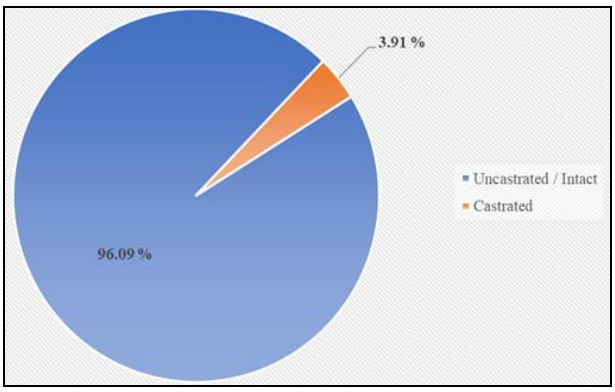


Plate 2: Castration status-wise occurrence of urolithiasis in small ruminants

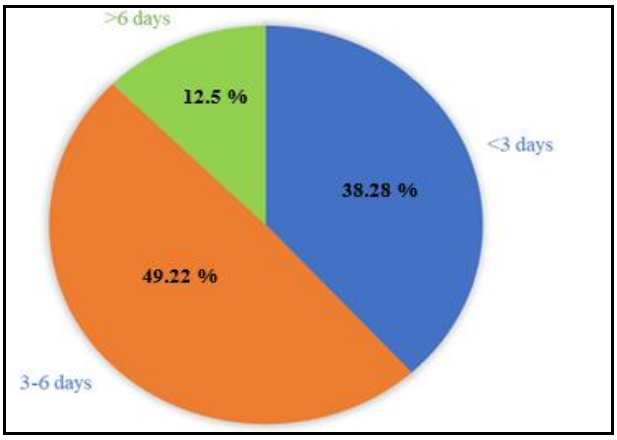


Plate 3: Duration of illness-wise occurrence of urolithiasis in small ruminants

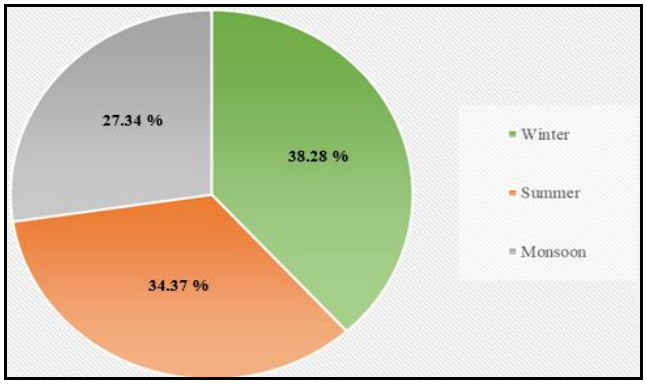


Plate 4: Season-wise occurrence of urolithiasis in small ruminants

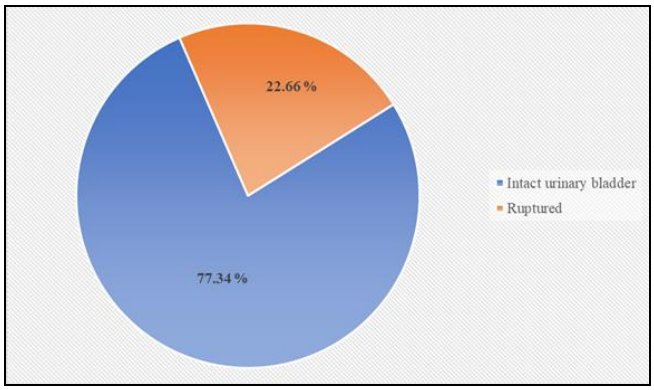
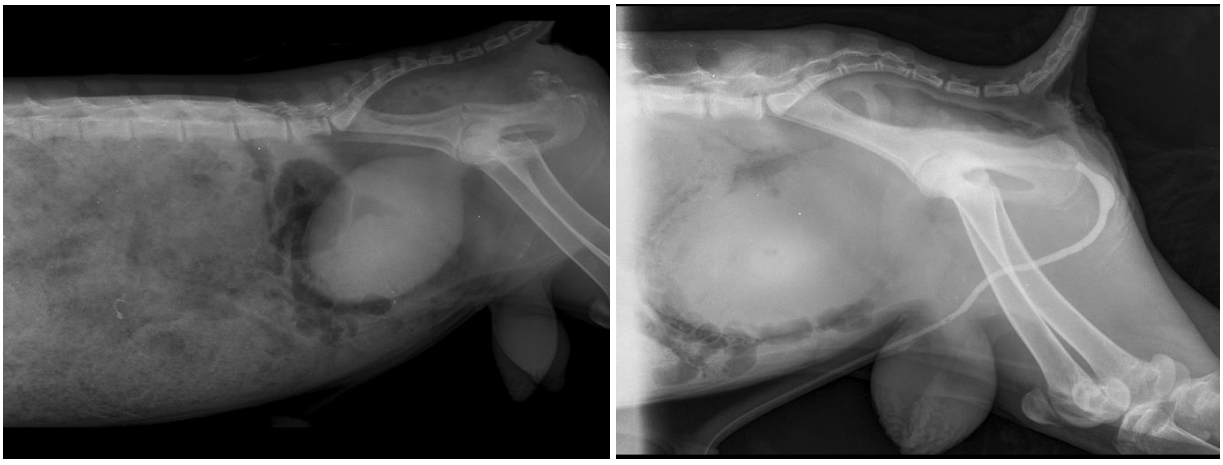


Plate 5. Urinary bladder status-wise occurrence of urolithiasis in small ruminants

6A 6B

Plate 6: Positioning of animal for radiography (6A) and radiograph of lateral abdomen showing distended urinary bladder with no radio opaque calculi (6B)

Plate 7: Urografin® used for contrast study



8A 8B

Plate 8: Retrograde contrast urethrography showing blockage of contrast material at the level of ischial arch (8A) and distended contrast filled urinary bladder (8B)

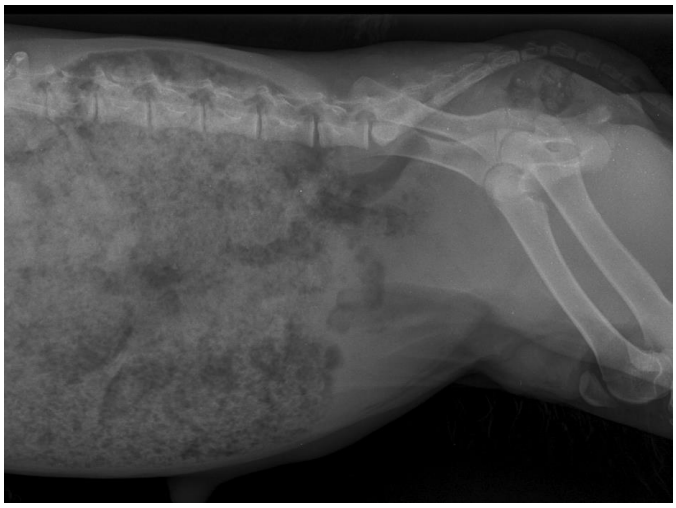


Plate 9: Lateral abdominal radiograph on 30th post-operative day showing no visible radio dense calculi with invisible urinary bladder contour.

Plate 10: Positioning of animal for ultrasonography (10A) and distended urinary bladder with multiple miliary hyperechoic urinary calculi along with urinary sediments (10B)

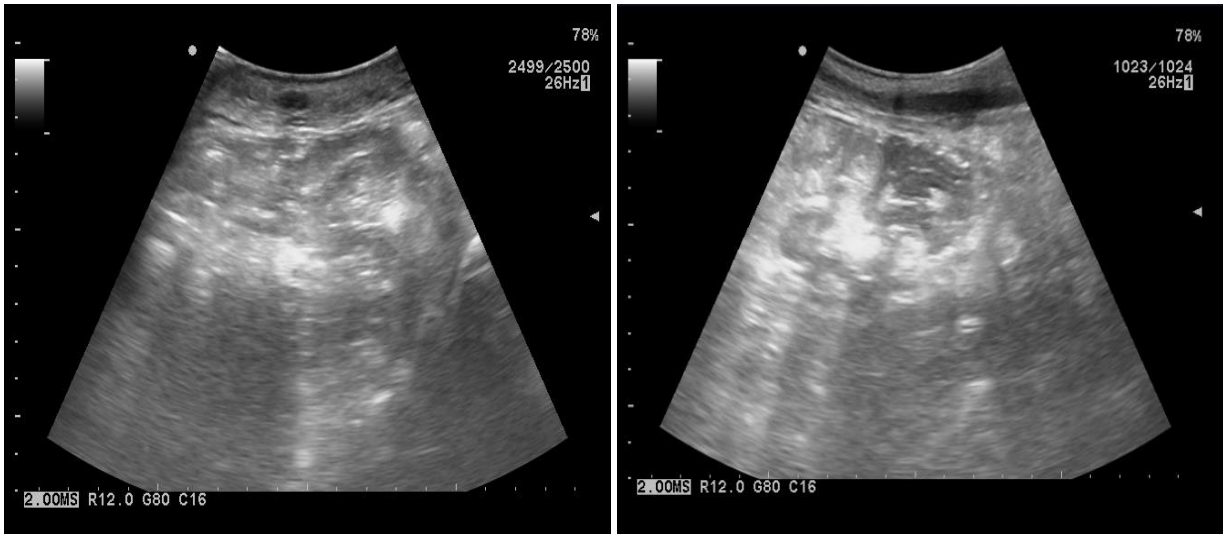


Plate 11: Ultrasonography showing distended urethral lumen with anechoic urine

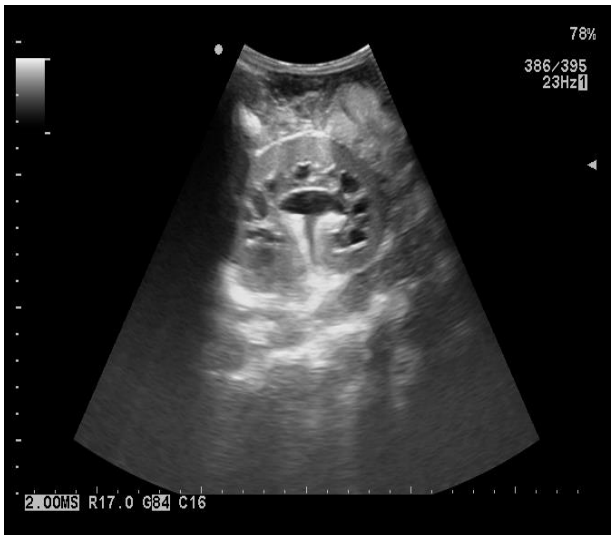


Plate 12: Transabdominal renal ultrasonography showing distended renal pelvis and anechoic fluid filled major and minor calyx

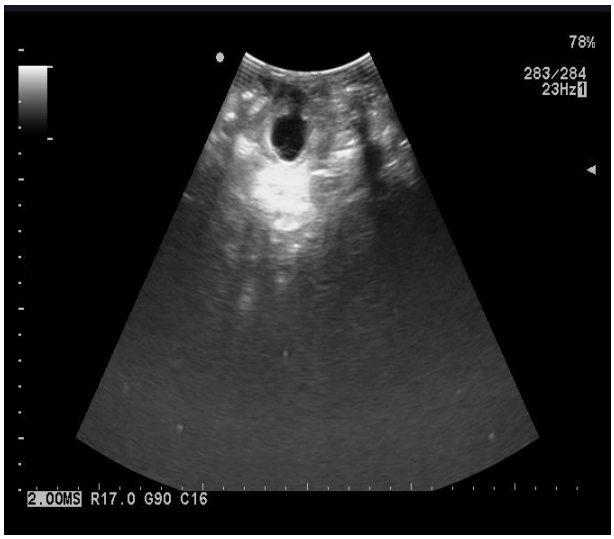


Plate 13: Transabdominal ultrasonography showing collapsed urinary bladder with anechoic fluid inside the lumen

Conclusion

Ultrasonography and contrast radiography can be used to confirm the diagnosis of obstructive urolithiasis in small ruminants. A higher success rate can be achieved with early diagnosis and therapy.

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