BOVINE UROLITHS ANALYSIS: A REVIEW OF 30 CASES.

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ABSTRACT

Calculi obtained from 30 clinical cases of obstructive urolithiasis in male calves during surgery were subjected to complete analysis including physical, microscopic and chemical examination. Cystic lumen and neck, jointly, were the commonest site of calculi retrieval (47%) cases, followed by cystic neck (33%) cases and cystic lumen (20%) cases. In majority (90%) of the cases small multiple calculi were retrieved. The calculi retrieved were usually as free sandy material mixed with blood and other tissue debris but in 3 cases a mass comprising of calculi embedded in blood clot and tissue debris was retrieved from cystic lumen. The urethral calculi were either loop shaped or impacted sandy material. Microscopic examination revealed that one or more well defined nuclei (nidus) were found in each concretion. The nuclei and the surrounding concentric layers of laminae were enclosed by a single capsule. The calculi were composed of magnesium ammonium phosphate, calcium phosphate, calcium carbonate, calcium oxalate, hippuric acid, tyrosine and uric acid. Twenty three (77%) calculi samples were composed of magnesium ammonium phosphate only.

Key words: *Urolithiasis, Calculi, Calf*

INTRODUCTION

Urolithiasis in countries like India presents an important economic repercussion where cattle - based agriculture is strongly linked with the livelihood of an important segment of the population. The primary objective of urinary calculus analysis was to determine the qualitative composition, as the prevention of urolithiasis and its treatment depends on a detailed knowledge of the composition and structure of the calculi (1). For complete analysis of calculi, a combination of methods was adopted: Microscopic, spectroscopic, chemical and X-ray diffractometry are complementary for the analysis of calculi and no one method is sufficient, as quantitative analysis are best obtained by X-ray diffractometry, while qualitative identification of depositional sequence and the quantitative determination of minor constituents can be determined by microscopic and chemical methods (2). The chemical composition of urinary calculi varies and depends largely on the dietary composition of individual elements, the geographical location and local management practices (3). Obstructive urolithiasis is very common in ruminants of Kashmir valley, however the highest incidence is found in calves. No report is available about the chemical composition of uroliths retrieved from the obstructive urolithiasis cases in the valley of Jammu and Kashmir state. This study was thus undertaken to understand the chemical composition of the uroliths retrieved from clinical cases so as to suggest the remedial measures for preventing the disease and its effective treatment.

MATERIALS AND METHODS

Thirty male cattle calves, suffering from complete retention of urine, presented for treatment at Teaching Veterinary Clinical Services Complex, Faculty of Veterinary Sciences and Animal Husbandry (F. V. Sc & A. H.), Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir (SKUAST-K), Srinagar, formed the material of the study. Ten bovine clinical cases of obstructive urolithiasis each were subjected to tube cystostomy using polyvinylchloride urinary catheter, tube cystostomy using Foleys catheter and cystotomy and normograde cystourethral catheterization (cystotomy with indwelling urethral catheterization).

Every effort was made to retrieve all the uroliths from cystic lumen in a sterile jar containing dextrose saline solution. For this purpose, bladder and its neck were irrigated many times to collect all the uroliths. The uroliths were cleaned and cleared of all tissue and blood, and dried in an incubator at 45°C for 24 hours. The uroliths were preserved at 4°C for further examination. During the operation, calculi were removed from urethra and/or bladder for re-establishing the patency of the urinary tract using different surgical techniques. These calculi were subjected to following examinations:

1. Physical characteristics

Calculi removed from the urethra and/or bladders were observed for their types (hard/pasty/sandy), shapes (round/irregular etc.), number and anatomical position. After washing the calculi and drying, the calculus mass was weighed and the largest ones measured.

2. Microscopic examination

The representative calculi were examined under dissection microscope. The number and geometrical location of the nidus within the calculus was recorded.

3. Chemical analysis

After recording physical characteristics, the calculi were stored at 4°C in the refrigerator untill further analysis of their composition. The chemical composition of the calculi was determined by the standard procedures (4).

RESULTS

1. Urolith analysis

Calculi of different number, shape and size were retrieved from various locations in the urinary tract of all the animals subjected to various surgical techniques including tube cystostomy and cystotomy with indwelling urethral catheterisation for correction of obstructive urolithiasis. These calculi were observed for their location, number, shape and composition (Table 1).

1.1 Location of calculi

Almost in all the cases calculi were retrieved simultaneously from multiple sites. Cystic lumen and neck jointly was the commonest site of calculi retrieval {14/30 (47%)} cases, followed by cystic neck {10/30 (33%)} cases and cystic lumen 6/30 (20%) cases. Calculi were retrieved from urethra from one site only in 8/10 (80%) cases and from 2 sites simultaneously i.e. pre- and post-scrotal region in 2/10 (20%) cases only.

1.2 Number of calculi

In one case only a single calculus (Fig 1) was retrieved from cystic lumen, and only two calculi were retrieved from cystic neck in 2 cases. Among the remaining 27/30 (90%) cases multiple small calculi (Fig 2) were retrieved from the cystic lumen (5), cystic neck (8) and cystic lumen and neck jointly in 14 cases.

1.3 Gross morphology of calculi

The calculi retrieved from the cystic lumen and neck were usually in the form of free sandy material (Fig 2) mixed with blood and other tissue debris but in 3 cases a mass comprising of calculi embedded in blood clot and tissue debris was retrieved from the cystic lumen. These masses measured from 3.7 – 5.9 cm and weighed between 35 to 65 gm (Fig 3). On ultrasonographic examination these calculus masses yielded acoustic shadows typical for sonographic evaluation of bladder stones.

Calculi from most of the cases {20/30 (67%)} were sandy, irregular in shape with smooth surfaces and edges. Of these, calculi were creamy white in 17 cases and off-white in 3 cases (Fig 2). All these calculi were soft and easily broken. Calculi from seven cases were pasty in nature and dark brown in colour. The individual calculi (Fig 1) single or double obtained from 3 cases were dendritic in shape, white in colour and hard to break.

The urethral calculi were either loop shaped (Fig 5) or impacted sandy material (Fig 4). These calculi were yellow in colour and easy to break.

1.4 Microscopic examination of calculi

Surface morphology of intact representative calculi was studied under dissection microscope. One or more well defined nuclei (nidus) were found in each concretion. The nidus appeared dense and homogenous, and was not necessarily in the geometrical centre of the uroliths. The nidus was surrounded by concentric layers of crystals from precipitating minerals without clear demarcation between the adjacent layers of concentric laminae. The nuclei and the surrounding concentric layers of laminae were enclosed by a single capsule (Fig 6).

1.5 Chemical composition of calculi

The calculi were composed of magnesium ammonium phosphate, calcium phosphate, calcium carbonate, calcium oxalate, hippuric acid, tyrosine and uric acid. Twenty three (77%) calculi samples were composed of magnesium ammonium phosphate only; while in other (23%) samples magnesium ammonium phosphate (major component) was accompanied by any one of the other chemical components listed above.

DISCUSSION

1.1 Location of calculi

The calculi may be lodged in any part of the urinary tract i.e., starting from renal pelvis to glans penis. But the lodgement of the urolith in the bladder neck and urethra may lead to complete obstruction to urine flow thereby enhancing the acuteness and severity of the condition. The longer length of urethra and presence of sigmoid flexure make the urethra more prone to the lodgement of calculi as compared to other parts of the urinary tract in ruminants. In this study cystic lumen and neck jointly was the commonest site of calculi retrieval, followed by the cystic neck. Calculi were retrieved from the sigmoid flexure of urethra in 60% cases of animals where cystotomy with indwelling urethral catheterization was performed. The findings are in agreement with those of other researchers (5) who recovered about 68% of calculi in the sigmoid flexure of the bovines. In another study (6) a high incidence of bovine urinary calculi were found in the distal portion of the sigmoid flexure. Distal sigmoid flexure in cattle and the urethral process in sheep are the commonest sites of urethral obstruction by urolith, as the diameter of lumens at these sites are the narrowest in the urethral canal, thus calculi could easily be trapped at these sites (7).

1.2 Number of calculi

In most of the cases (90%) multiple small calculi without any distinct morphology were seen, while in 3.3% cases single and in 6.6% cases two distinct calculi were found. Generally a single distinct calculus is responsible for urethral obstruction in cattle (8), which is in agreement with the findings of the present study.

1.3 Gross morphology of calculi

Physical characteristics, including size, shape, colour and texture of uroliths, may serve as a preliminary and tentative indicator of the composition of the calculi and thereby assist in establishing the aetiological factors (9). Calculi may be of varying sizes, commonly described as sand, gravel or stone. Most common type of calculi was sandy (66%), pasty (23%) or assuming the shape of urethra. These findings are in accordance with those of other researchers, who reported that phosphate calculi e.g. calcium phosphate and triple phosphate are usually white, smooth, numerous, chalky and friable (6). Hard and discrete uroliths in cattle but friable and sandy masses in fattening lambs are usually present (10). The individual single or double struvite calculi retrieved from the clinical cases of obstructive urolithiasis in calves were usually white but dendritic in shape. These findings are in total consonance with those of the previous studies, who reported that struvite may also occur as a single urocystolith with sharp facets traumatizing the bladder wall and causing the marked haematuria (11).

1.4 Microscopic view of calculi

Microscopic examination clearly showed a central homogenous nidus easily differentiated from the outer concentric laminae. Formation of nidus is usually the first phase in the formation of the urolith. Any foreign material or cellular debris may act as nidus, however the nidus may be formed spontaneously due to supersaturation and oversaturation of the urine with lithogenic crystalloids (12). Further precipitation of crystalloids around the central nidus lead to the formation of concentric laminae. There were no clear demarcations between adjacent layers as also reported by other researchers (13, 14).

Slight eccentric location of the nidus suggested that the calculus was not equally accessible to precipitating minerals from all sides so that the growth proceeded at variable rates around the calculus. The nucleus represents the starting point of the stone and it need not be in its geometrical centre (15). Moreover, after formation of the nidus, calculi may grow into a urolith of same or different composition depending on the condition of urine saturation. The presence of a second eccentric nidus might be due to abrupt changes in the conditions of supersaturation of the urine thus resulting in precipitation of another nidus.

1.5 Chemical composition of calculi

Magnesium ammonium phosphate was present in every urinary calculus either alone or with other chemicals. Magnesium ammonium phosphate was alone in 77% of cases and as major component in combination with other chemicals in 23% of cases. The findings seem to fall in line with those of previous studies, who reported 61% of calculi were composed of a single mineral substance (16).

Calculi composition is affected by the factors like geography, species, age, sex, composition of feed, pH of urine, urinary tract infection, etc. During this study, composition of feed and urine pH seemed to be the profound predisposing factors, as wheat bran alone or in combination with other feeding stuffs was given to the maximum number of calves (77%). Rations high in grain but with limited amount of roughage leads to ammonium phosphate urolithiasis in feedlot cattle. Considering the feeding habits of calves of this study mostly phosphate calculi observed, were as expected. The findings are in agreement with those of previous studies, who reported that highly digestible, low roughage ration having more phosphorus than calcium (i.e. high grain feeding) leads to the formation of insoluble struvite calculi (17, 18, 19). These observations also in agreement with those of other workers, who observed that diet having more wheat bran, predisposed animals to phosphate stones (20, 21).

Phosphate calculi are formed rapidly in alkaline urine but are more soluble in acidic urine (22). In the present study, base values of urine pH were alkaline in all the groups, so the formation of phosphate calculi was to be expected. The findings substantiate the observations of previous researchers who found the most common pH for precipitation of magnesium ammonium phosphate, calcium phosphate and ammonium urate crystals to be 7 (13, 23).

Presence of calcium phosphate deposits between the struvite crystals represented the epitaxial growth, which signifies the growth of one type of crystal upon another type (24). Chances of occurrence of struvite and calcium phosphate occurring together is more likely as both types of crystals are formed and precipitated at alkaline urine pH (25). Epitaxial growth of calculus may provide a plausible explanation of why uroliths are frequently of mixed composition. It could also explain a heterogenous form of nucleation.

CONCLUSIONS

From the findings of the present study, it is evident that gross morphology besides chemical and microscopical examination aids in the identification of calculi, thereby assisting in the establishment of the etiological factors. Furthermore, the feeding habits have been found to have a profound predisposing effect on the development of particular calculi. The incidence of obstructive urolithiasis, is mostly found in winter under temperate conditions, pointing towards the inadequate water intake as another predisposing factor for the development of disease. Obstructive urolithiasis, a dreadful disease in ruminants especially in cattle, can therefore be prevented if precautionary measures like balanced feeding and encouraging the animals to take adequate amounts of water in order to induce diuresis, by addition of sodium chloride to their feed especially during the chilly winter season.

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TABLE AND FIGURES

Table 1: Distribution of urinary calculi in calves of different groups

Location of calculi	Group AI		Group AII		Group B		Total	%age
	No. of animals	No. of calculi	No. of animals	No. of calculi	No. of animals	No. of calculi		
Cystic lumen	1	1	-	-	5	M	6/30	20
Cystic neck	3	M	3	M	2	M	11/30	37
	1	2	1	2	0	0		
Cystic lumen and neck	5	M	6	M	3	M	14/30	47
Urethral lumen	-	-	-	-	10		10/10	100
DSF	-	-	-	-	4		4/10	40
PSF	-	-	-	-	2		2/10	20
Pre and post scrotal region	-	-	-	-	2		2/10	20
Between DSF & Glans penis	-	-	-	-	2		2/10	20

DSF = distal sigmoid flexure, PSF = proximal sigmoid flexure

Figure 1 - Single dendritic calculus

Figure 2 - Off white multiple concretionsFigure 3 -

Figure 3 - Single calculus mass

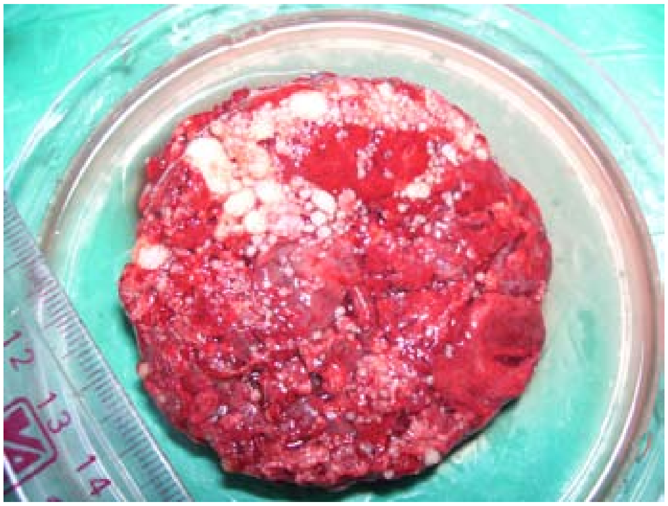

Figure 5 - Single calculus mass

Figure 6 - Single loop shaped calculus in urethra

Figure 5 - Calculi showing nidus in the centre