Transabdominal Ultrasonographic Examination of 26 Sheep with Suspected Urinary Tract Disease (2010-2012)
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Abstract
Transabdominal ultrasonography was undertaken in veterinary practice to examine 26 sheep reported by the farmer, to present with clinical signs consistent with obstructive urolithiasis. There was no evidence of calculi within the vermiform appendix, nor was the bladder imaged in 12 of these 26 sheep. Uroperitoneum was diagnosed in two of three growing male lambs, and resulted from urine leakage across the bladder wall not rupture. Gross hydronephrosis was identified ultrasonographically by the increased renal pelvis and thinner cortex, in six of eight adult male sheep with confirmed urethral obstruction. These six rams with gross hydronephrosis were euthanased for welfare reasons; two rams without signs of gross hydronephrosis made a full recovery after amputation of the vermiform appendage, which contained palpable calculi. Transabdominal ultrasonographic examination of the bladder and right kidney takes no more than 5 minutes, with the results immediately available which assist treatment decisions.

Keywords
Ultrasonographic examination; Urinary tract; Urolithiasis; Hydronephrosis

Introduction
While ultrasonography has been successfully employed in commercial flocks for the past 30 years to determine foetal number and gestation length, permitting more precise feeding and management during late gestation [1], ultrasonographic examination can also yield important clinical information of lesions within the chest [2], liver [3], bladder, and kidney [4].

Urethral obstruction occurs occasionally in mature rams, with most calculi lodging within the vermiform appendage [4,5], where they can be readily identified during the veterinary clinical examination. Excision of the vermiform appendage during the early stages of urethral obstruction results in full recovery. Urethral obstruction at the sigmoid flexure is less common, but more difficult to diagnose because the calculus cannot be seen or palpated. Delays in establishing a specific diagnosis of urethral obstruction and correction of this problem adversely affect prognosis. An accurate early diagnosis is essential to enable timely surgery, and usually relies upon analysis of blood samples for creatinine and urea nitrogen concentrations.

Prognosis is poor in advanced cases of obstructive urolithiasis, whereby only nine of 19 small ruminants referred to a veterinary hospital survived [6]; therefore, an accurate prognosis is essential for animal welfare reasons, such that surgery is not undertaken in sheep with a guarded prognosis. On-farm identification of urinary tract obstruction by demonstrating bladder distension during ultrasonographic examination [4] provides immediate information, without recourse to laboratory testing such that delays that could adversely influence prognosis are overcome. A further potential application of ultrasonography has been reported whereby ultrasonound-guided cystocentesis in combination with percutaneous infusion of Walpole’s solution was found to be a useful treatment in male goats with obstructive urolithiasis [7].

Trans-rectal examination of the bladder and rectum has been reported in both rams and ewes [8,9], but this examination approach has not proved necessary to determine bladder distension. Standard 5 MHz linear probes used for trans-rectal bovine pregnancy diagnosis can be used to determine bladder diameter trans-abdominally [4].

This article presents some transabdominal ultrasonographic images of the bladder and right kidney from 26 sheep, with suspected urinary tract disease presented to the author in general practice, over a two years period. Wherever possible, the ultrasound image is presented alongside the corresponding necropsy specimen to aid interpretation.

Materials and Methods
A full clinical examination was undertaken in 26 sheep with suspected urinary tract disease. Except for two immature lambs and a ram with severe subcutaneous urine accumulation along the ventral abdomen, the penis was extruded and the vermiform appendage carefully examined for calculi. Ultrasonographic examination of the ventral abdomen, bladder, and right kidney was then undertaken in all 26 sheep; three male lambs aged 3 to 6 months, 22 rams more than 15 month-old, and one ewe. Two of the three lambs had been castrated within the first week of life; all lambs were intensively reared with access to ad-libitum concentrates. Adult sheep, with the exception of three cases of suspected pelvic nerve dysfunction and the case of pyelonephritis, were housed and fed hay plus 0.5-1.5 kg of concentrates daily. The two youngest lambs presented with colic signs and frequent vocalisation. The adult sheep presented with inappetance and separation from the remainder of the group for 1-5 days before veterinary attendance, although the reported duration of illness could not be confirmed.

Ultrasonographic examination of the bladder and caudal abdomen was undertaken in the standing animal, using a 5.0 MHz sector scanner (Honda Electronics HS2000, BCF Technology, Livingstone, Scotland), and a linear array scanner in some cases (BCF Mini-Scan, BCF Technology, Livingstone, Scotland). The right inguinal region immediately cranial to the pubis was cleaned using a mild detergent solution diluted in warm tap water, to remove
superficial grease and debris. The right inguinal region was chosen because the left side of the abdomen is largely occupied by the rumen. Ultrasound gel (Henley’s Medical, Welwyn Garden City, England) was liberally applied to the wet skin to ensure good contact. The transducer head was firmly held at right angles against the abdominal wall. When using a 5.0 MHz linear scanner, an estimate of the bladder size was obtained by moving the probe head (field depth limited to 10 cm) cranially along the ventral midline, from the level of the pubic symphysis because the bladder has a cylindrical rather than spherical shape.

Examination of the right kidney necessitated shaving the fleece from an area of the right sublumbar fossa, immediately caudal to the last rib, and just ventral to the traverse lumbar processes. The sector transducer head was firmly held against the skin, to ensure good visualisation of the right kidney juxtaposed the caudal lobe of the liver.

Necropsies were performed on all sheep euthanased for welfare reasons.

Results and Discussion

There was no evidence of calculi within the vermisiform appendix, nor could the bladder be imaged in 12 adult rams presented for veterinary examination with suspected urolithiasis. A diagnosis of respiratory disease was reached in two rams, and trauma to the glans penis in a further two rams; no specific cause of reduced appetite was made in the remaining eight rams. These rams were being prepared for sale and were offered high levels of concentrates and temporary inappetance was not uncommon, but their potential high financial value prompted veterinary attendance. There was no further report of illness in these rams in the subsequent two months, therefore, the diagnosis of no significant urinary tract disease was assumed to be correct.

There was frequent tail swishing and foot stomping in the three growing lambs with obstructive urolithiasis. These sheep were inappetant and had an anxious, painful expression with the pelvic limbs held well behind the animal. There was frequent tenesmus, accompanied by painful bleating. Uroperitoneum was diagnosed in the two youngest lambs and these castrated sheep were euthanased for welfare reasons. No calculi were found in the vermiform appendix of the six month-old ram lamb, and obstruction was assumed to be at the sigmoid flexure. The owner declined surgery and this lamb was also euthanased. Calculi obstructing the urethra at the sigmoid flexure were confirmed at necropsy in all three lambs.

Excess fluid was not visualized during ultrasonographic examination of the peritoneal cavity, in either 12 rams with no obstruction or those adult sheep with urolithiasis. Uroperitoneum in the two young lambs with obstructive urolithiasis appeared as an anechoic area, with abdominal viscera displaced dorsally in the standing animal (Figure 1). The intestines were clearly outlined as hyperechoic (bright white) lines/circles containing material of varying echogenicity. By maintaining the probe head in the same position for 10 to 20 seconds, digesta could be visualised as multiple small dots of varying echogenicity forcibly propelled within the intestines. Uroperitoneum (Figure 1) could not be distinguished from ascites on transabdominal ultrasonographic examination (Figure 2), except that the urinary bladder wall could be imaged in the two lambs with uroperitoneum. Urine had leaked across the taut bladder wall rather than rupture of the bladder (Figure 1).

The clinical signs of urinary tract disease in eight adult male sheep with confirmed urethral obstruction included separation from other sheep in the group, with long periods spent in sternal recumbency and occasional teeth grinding. Nil or only a few drops of blood-tinted urine were voided. Calculi were present within the vermiform appendix in four rams; two rams with no evidence of gross hydronephrosis made a full recovery after excision of the vermiform appendage; two rams showed gross hydronephrosis identified ultrasonographically, one ram was euthanased immediately, the other ram failed to improve over 48 hours, and was euthanased for welfare reasons. Tube cystotomy [10] was not considered in the four remaining rams where urethral obstruction was suspected at the sigmoid flexure, because there were ultrasonographic findings of gross hydronephrosis. Obstruction proximal to the sigmoid flexure was confirmed at necropsy in three of these rams, where marked bladder distension and gross hydronephrosis had been identified. Necropsy revealed purulent material originating from a renal abscess, and associated pyelonephritis blocking the urethra in the remaining ram. Control measures [11] were recommended to prevent the occurrence of further cases in these flocks.
Two rams were observed to urinate, but the flow was estimated to be approximately half the normal rate and the duration was reduced to 5-10 seconds, then urine dripped from the prepuce for a further 10-20 seconds. The wool was wet for approximately 10 cm diameter surrounding the prepuce, which was thought to be caused by passage of urine, while the rams were lying down. One ewe was presented with extensive urine staining of the tail and perineum. There was no evidence of ataxia or pelvic limb weakness in these three sheep, and passage of faeces appeared normal.

The ultrasonographic examination was limited to 5 minutes, to mimic the clinical situation in farm animal veterinary practice. A 5.0 MHz linear transducer connected to a real-time, B-mode ultrasound machine was used for some transabdominal ultrasonographic examinations of the abdominal cavity and bladder (5.0 MHz linear transducers are extensively used for early trans-rectal diagnosis of pregnancy in cows). However, a sector transducer was necessary to ensure good contact between the concave flanks of the right sublumbar fossa, to image the right kidney. The field setting of 10 cm on the linear scanner identified bladder distension in all cases. However, the 20 cm field depth afforded by the 5.0 MHz sector scanner more accurately determined the extent of uroperitoneum and bladder diameter.

The bladder of normal male sheep is contained within the bony pelvis [8], therefore, the presence of the bladder extending for up to 10 cm or more over the pelvic brim in adult rams is abnormal, determination of the actual size of the bladder is of secondary clinical importance. In the present study, the distended bladder extended 6 to 8 cm in diameter cranial to the pelvic brim in 20 to 40 kg growing lambs, and 12 to 20 cm diameter in mature rams (Figure 3). The bladder wall appeared as a hyperechoic circle; oedema of the wall resulted in widening of this white line. Fibrin tags could sometimes be visualized within the uroperitoneum as fine hyperechoic filaments with the anechoic fluid.

When using a 5.0 MHz linear scanner, an estimate of the enlarged bladder was obtained by moving the probe head (field depth limited to 10 cm) cranially along the ventral midline, from the level of the pubic symphysis because the bladder has a cylindrical rather than spherical shape (Figure 4).

Gross hydronephrosis was identified by the increased renal pelvis, which is represented by the anechoic (fluid-filled) centre of the kidney (Figures 5 and 6); no kidney measurements were recorded, but can be estimated by reference to the scale on the sonograms. It is not always possible to scan the left kidney in sheep via the flank, but such examination is not necessary because the urinary tract obstruction is distal to the ureters, therefore, the condition affects both kidneys equally. These findings are consistent with previous reports of advanced hydronephrosis [4,12], where the condition was identified by the increased renal pelvis, represented by the enlarged anechoic (fluid-filled) centre of the kidney and the reduced renal cortex (Figure 7).

The findings of this study support previous reports of obstructive urolithiasis in rams that rupture of the bladder is rare [4], except for neglected cases [5], and gross hydronephrosis develops over several days as a consequence of high urinary backpressure.

Urinary bladder distension extending to 15 cm diameter and marked hydronephrosis causing enlargement of the right kidney, were identified ultrasonographically in the two rams, and one ewe with suspected pelvic nerve dysfunction. There was also 3-8 cm of fluid accumulated imaged immediately outside the capsule of the right kidney in both rams, and this anechoic area was bridged by fine hyperechoic filaments; the ultrasonographic findings were confirmed at necropsy (Figures 8 and 9).

Ultrasonographic examination of one ram, with a reported illness of less than 48 hours, failed to locate the right kidney. Instead there was anechoic area extending for up to 8 cm from the abdominal wall containing a poorly-defined hypechoic area (Figure 10), which was revealed at necropsy to be a large blood clot following rupture of the kidney capsule (Figure 11).

One ram presented with pyelonephritis, which was thought to have arisen following bacteraemia and development of an abscess within the renal cortex, rather than ascending infection of the urinary tract. The bladder wall appeared much thicker than normal in this ram, and two large diameter hypechoic areas containing hyperechoic dots were imaged in the bladder revealed to be large fibrin clots at necropsy.

Rupture of the penile urethra had occurred in one ram before veterinary examination, and resulted in 8 cms’ deep subcutaneous swelling extending along the ventral abdominal wall to the prepuce and into the scrotum (Figures 12 and 13). Ultrasound examination of the ventral abdominal wall swelling alongside the penis revealed multiple fluid pockets representing urine within subcutaneous tissue. Urethral perforation or urinary bladder rupture has been reported in neglected cases of urethral obstruction [5].

Biricik et al. [12] concluded from their studies on young lambs
with obstructive urolithiasis that B-mode and colour-coded Doppler sonography might provide useful information for detection of changes in kidneys like hydronephrosis and renal swelling, as well as elevated resistance in the renal interlobar artery. Such equipment would not normally be available in veterinary general practice. However, the results from the present study confirm that bladder distension is a reliable indicator of urinary tract dysfunction, and early diagnosis and treatment are more important than defining renal changes. Excision of the vermiform appendage was successful in both rams with obstruction at the vermiform appendage, where there was no concurrent evidence of gross hydronephrosis, emphasising the critical importance of prompt recognition of clinical signs by the farmer.

Two adult rams with obstruction of the urinary tract, but no gross hydronephrosis were successfully treated by excision of the vermiform appendage; all other sheep were euthanased for welfare reasons, because of ultrasonographic evidence of gross hydronephrosis, subsequently confirmed at necropsy. Tube
Cystotomy was not undertaken in five rams because sheep with gross hydronephrosis were considered to have a poor prognosis; one ram with gross hydronephrosis that urinated normally after excision of the vermiform appendage was euthanased after two days. Further work is necessary to determine whether rams with ultrasonographic findings of gross hydronephrosis should undergo tube cystotomy. However, the most important factors are prompt identification of suspected cases by the owner, with immediate veterinary treatment because irreversible hydronephrosis quickly results from high urinary backpressure [5,6,12].

**Conclusion**

The bladder was not imaged during transabdominal ultrasonography in 12 of 26 sheep presented as suspected obstructive urolithiasis cases by farmers. These 12 sheep remained healthy for the next two months, confirming the absence of urinary tract disease at the time of veterinary examination, and the potential application of this ancillary test in farm animal practice. Gross hydronephrosis was identified ultrasonographically by the increased renal pelvis and thinner cortex in six of eight adult male sheep with confirmed urethral obstruction. These six rams with gross hydronephrosis were euthanased for welfare reasons; two rams without signs of gross hydronephrosis made a full recovery after amputation of the vermiform appendage, which contained palpable calculi. Work is necessary to decide whether tube cystotomy is effective when sheep present with ultrasonographic evidence of gross hydronephrosis, however, the animal welfare implications of such study must be carefully considered.

**References**


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