# Laparoscopic-assisted cystotomy: an experimental study in male sheep

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**ABSTRACT**: Aim: To describe a technique of laparoscopic-assisted cystotomy in male sheep. Experimental animals: five healthy male sheep aged approximately nine months (mean weight: 39.6 ± 1.51 kg). Laparoscopy was performed on sheep placed under general anaesthesia in dorsal recumbency. A 10-mm laparoscope was inserted through the right paramedian region between the xiphoid and preputial orifice. After creation of a capnoperitoneum, grasping forceps were inserted through the left paramedian region close to the last pair of teats. The urinary bladder was elevated using grasping forceps and exteriorized through an abdominal incision. The bladder was opened extracorporeally, lavaged, closed, and then repositioned. A pigtail balloon catheter was subsequently inserted percutaneously under laparoscopic control and removed ten days later. A repeat laparoscopy was performed at 14 days after the first procedure to assess gross pathological changes. Laparoscopic-assisted cystotomy was successfully performed on all sheep. In one sheep, both the ventral and dorsal bladder walls were inadvertently perforated when placing the urinary catheter. The postoperative course was favourable: all sheep had a good appetite and showed no pathological findings during physical examination. During the repeat laparoscopy, it was observed that one sheep had developed a focal adhesion of the parietal peritoneum to the bladder catheter portal site. Laparoscopic-assisted cystotomy with catheter implantation is shown to be feasible in male sheep. This technique may be useful for removal of uroliths in patients suffering from obstructive urolithiasis opening the urinary bladder and for performing urinary diversion.

**Keywords**: minimal invasive surgery; urolithiasis; sheep; surgical treatment

Urinary tract surgery in small ruminants is mainly performed in cases of obstructive urolithiasis in order to re-establish normal urination (Haven et al., 1993; Rakestraw et al., 1995; Bostedt and Dedie, 1996; Palmer et al., 1998; Pearce et al., 2003; Gill and Sod, 2004). Urinary calculi formation (calcium carbonate, calcium phosphate, silica and struvite stones) usually results from a combination of physiological, nutritional and management factors, and is mainly attributed to excessive or imbalanced intake of minerals (Stratton-Phelps and House, 2004; Duhlmeier et al., 2007). Aggregation of minerals and development of uroliths can occur in the kidneys, the ureters, the urethra and the urinary bladder (Chow et al., 1982; Duhlmeier et al., 2007). In small ruminants uroliths most commonly lodge in the urinary bladder, in the urethral lumen at the distal portion of the sigmoid flexure and at the urethral process (Kimberling and Arnold, 1983; Hooper and Taylor, 1995; Rakestraw et al., 1995; Gill and Sod, 2004; Duhlmeier et al., 2007). Urinary obstruction with several consequences such as hydroureter or hydronephrosis, urethral or even bladder rupture may develop.

From the medical and in particular from the economic point of view successful treatment of

patients with obstructive urolithiasis is highly desirable for breeding animals. Furthermore, the growing number of goats and sheep kept as "pets" increases the need for prompt and precise therapy (Rakestraw et al., 1995; Stratton-Phelps and House, 2004; Ewoldt et al., 2006). Therapeutic methods currently consist of conservative therapy and surgical procedures (Haven et al., 1993; Kumper, 1994; Rakestraw et al., 1995; Bostedt and Dedie, 1996; Pearce et al., 2003; Gill and Sod, 2004).

Surgical cystotomy with subsequent implantation of a temporary urinary catheter is currently considered to be the most appropriate approach for obstructive urolithiasis in small ruminants (Rakestraw et al., 1995; Palmer et al., 1998; Iselin et al., 2001; Stratton-Phelps and House, 2004; Ewoldt et al., 2006; Van Metre and Fubini, 2006). This technique combines tube cystostomy with cystotomy under general anaesthesia (Iselin et al., 2001; Fortier et al., 2004; Ewoldt et al., 2006). Cystotomy allows removal of urine and stones localized in the urinary bladder and urethral flushing (Cockroft, 1993; Bostedt and Dedie, 1996; Palmer et al., 1998; Iselin et al., 2001; Pearce et al., 2003; Fortier et al., 2004; Ewoldt et al., 2006). The subsequent tube cystostomy establishes urinary diversion and facilitates the reestablishment of urethral patency (Cockroft, 1993; Rakestraw et al., 1995; Iselin et al., 2001; Fortier et al., 2004; Ewoldt et al., 2006).

A previous experimental study has shown that a urinary catheter may be easily inserted in male sheep also under laparoscopic control (Franz et al., 2008).

The purpose of this study was to develop a minimal invasive laparoscopic surgical technique for combining opening of the urinary bladder (for rinsing and removing of debris or uroliths) with laparoscopic-assisted urinary catheter placement.

## MATERIAL AND METHODS

This study was performed at the Clinic for Ruminants, University of Veterinary Medicine, Vienna, Austria on five healthy male sheep from four different breeds (Suffolk-cross: $n$ = 2, Black headed mutton sheep: $n$ = 1, White mountain sheep-cross: $n$ = 1, Friesian milk sheep: $n$ = 1). All animals were approximately nine months of age. Mean weight (± standard deviation) was 39.6 ± 1.51 kg. Normal health status was determined preoperatively by physical examination, blood chemistry (according to the methodology of the ISO certified Central Diagnostic Unit of the University of Veterinary Medicine, Vienna, Austria: complete blood count and serum biochemical profile), and biochemical testing of urine using dry reagent strips (Combur Test, Boehringer Mannheim, Vienna, Austria). All procedures performed in this study have been approved by the Institutional Ethics Committee at the University of Veterinary Medicine, Vienna, Austria. Government approval was also obtained (BMBWK-68.205/0168-BrGT/2006).

### Surgical procedure

Food was withheld from the sheep for 24 h before surgery. All animals were provided water *ad libitum*. Amoxicillin-clavulanic acid (8 mg/kg [3.64 mg/lb], *i.m.*, q 24 h) plus marbofloxacin (2 mg/kg [0.91 mg/lb], *i.m.*, q 24 h) and carprofen (1.4 mg/kg [0.64 mg/lb], *s.c.*, q 24 h) were administered preoperatively. General anaesthesia was induced with sodium thiopental (7 mg/kg intravenously [3.18 mg/lb], *i.v.*), and tracheal intubation was performed in all sheep. Anaesthesia was maintained with isoflurane in 100% oxygen, and normal saline solution (10 ml/kg/h

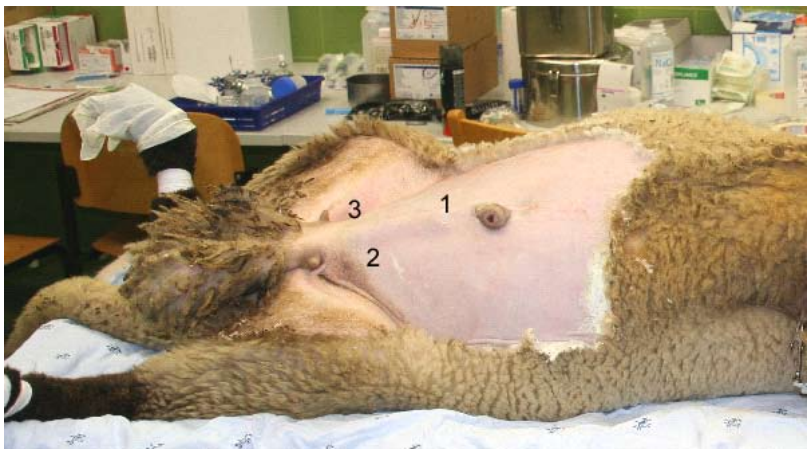


Figure 1. Portal locations for the optic (1) and the grasping forceps (2) and location of parainguinal incision of the abdominal wall (3)

intravenously [4.5 ml/lb/h], *i.v.*) was administered intraoperatively. Volume-controlled intermittent positive-pressure ventilation was performed up to the end of anaesthesia. For intraoperative analgesia the sheep received lidocaine hydrochloride (2 mg/kg [0.9 mg/lb], *i.v.*).

All sheep were positioned in dorsal recumbency for the surgical procedures. In order to prevent rumenal bloat, a stomach tube was inserted orally. The ventral abdomen was prepared and draped for aseptic surgery. A 1.5 cm stab incision was made in a paramedian right position caudal to the umbilicus (Figure 1). An open laparoscopy technique (opening the abdominal wall using a scalpel) was thus used to create an incision that allowed insertion of a 10-mm trocar-cannula system (Endopath, Ethicon Endo-Surgery, Johnson & Johnson Company, USA). The abdominal cavity was insufflated directly through the cannula with $CO_2$ to an intra-abdominal pressure of 13 mmHg. Then the surgical table was tilted to a 20° head-down position (Trendelenburg position) to displace the abdominal viscera cranially until the urinary bladder could be observed. A second portal was created under visual control at the left paramedian line close to the last pair of teats (Figure 1). Using a 5-mm trocar cannula system, an endoscopic grasping forceps (Karl Storz, Vienna, Austria) was inserted through this portal. The urinary bladder was grasped at its cranial aspect (Figure 2) and elevated to the ventral abdominal body wall. A 2–3 cm parainguinal incision was performed through all layers of the abdominal wall (Figure 1). The apex of the bladder, grasped by the forceps, was exteriorized during desufflation (Figure 3), and the sheep was returned to a neutral position. The bladder was held *in situ* with two traction sutures of 3-0 monofilament glycomer (Figure 4). Cystotomy was then performed, and the bladder was lavaged with sterile saline through an irrigation tube. The cystotomy was closed with 3-0 monofilament glycomer sutures in a simple nonperforating interrupted pattern. After repositioning the bladder into the abdominal cavity, the layers of the abdominal wall were closed by interrupted 3-0 monofilament glycomer sutures.

After positioning the sheep in a 20° Trendelenburg position, carbon dioxide gas was insufflated into the abdominal cavity until the bladder could be observed endoscopically. Determination of the optimal site for urinary catheter insertion into the abdomen was performed by pushing against the ventral abdominal wall with the fingers from the outside. The caudal, paramedian right region of the ventral abdominal wall was chosen as optimal. While grasping the bladder with the forceps, a pigtail-tip silicone balloon catheter (ch. 14, Uromed, Rüsch, Vienna, Austria) was inserted via a corresponding cannula into the bladder under endoscopic control. Inside the bladder lumen the balloon was filled with 5 ml of sterile normal saline and the cannula removed. There was no pulling of the urinary bladder with the catheter close to the ventral abdominal wall.

The abdomen was desufflated at the end of the procedure and all portal sites were closed in two

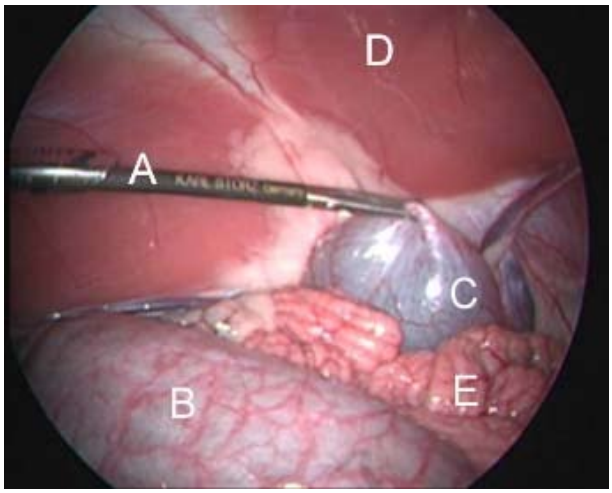


Figure 2. The urinary bladder was grasped at its cranial part for mobilization under endoscopic control. A = grasping forceps, B = cecum, C = urinary bladder, D = ventral abdominal wall, E = small intestine

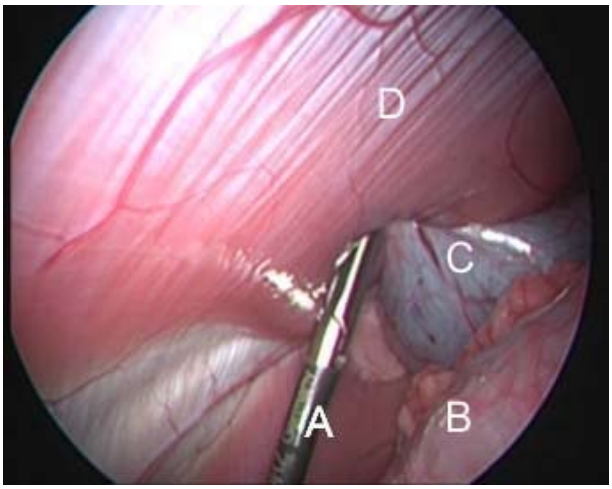


Figure 3. The urinary bladder was exteriorized through an incision in the ventral abdominal wall. A = grasping forceps, B = cecum, C = urinary bladder, D = ventral abdominal wall

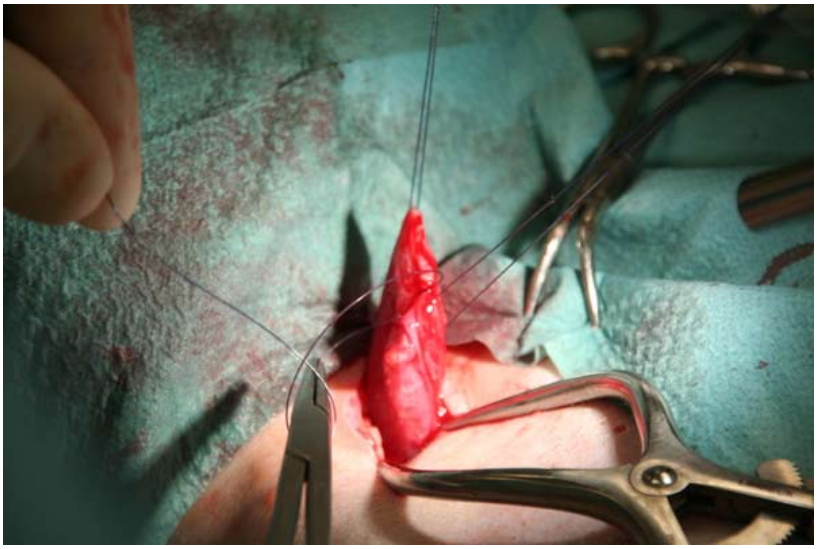

Figure 4. The bladder was held *in situ* with 2 traction 3-0 monofilament glycomer sutures for the opening, rinsing and extracorporeal suturing

layers (skin, muscle layer) using a simple interrupted suture pattern with 3-0 monofilament glycomer. The urinary catheter was fixed with a Chinese finger trap suture to the ventral abdominal wall. The open end of the urinary catheter was covered with an open plastic protection sheet so that the catheter was allowed to drain spontaneously (Figure 5).

### Postoperative care

All sheep were treated with tetanus antitoxin (3 000 units, *s.c.*) postoperatively. Antibiotics were administered for 10 days until the urinary catheter was removed. Analgesic and anti-inflammatory therapy was continued for three days. Daily, the protection sheet fixed at the open end of the urinary catheter was removed, the open end cleaned, disinfected and controlled for patency by collecting urine drained off the urinary catheter. Urine was examined daily using dry reagent strips for hematuria (degree of hematuria was expressed as means ± standard deviations (SD)).

Figure 5. The open end of the urinary catheter was covered with an open protection sheet from plastic so that the catheter was allowed to drain spontaneously

A second-look laparoscopy was performed under general anaesthesia through a portal created in the right paramedian area next to the first laparoscopy access 14 days after the first surgery. Signs of intra-abdominal inflammation (reddening, fibrinous coverings, adhesions, ascites) were documented. The bladder was observed for leakage and adhesions. The bladder was then mobilized with the grasping forceps inserted into the abdominal cavity via a second portal left paramedian next to the first access.

## RESULTS

### Surgical procedure

Laparoscopic-assisted cystotomy followed by insertion of a urinary catheter was feasible in all sheep. No complications occurred during the creation of portal sites. Location of the portal access for the optic trocar and the grasping forceps allowed grasping of the bladder and its elevation to the ventral abdominal body wall under visual control. There were no complications related to the extracorporeal dislocation of the urinary bladder, neither to its opening, closure, and subsequent repositioning into the abdominal cavity.

In one sheep both the ventral and dorsal bladder walls were inadvertently perforated by the placing of the urinary catheter. The cannula was then removed

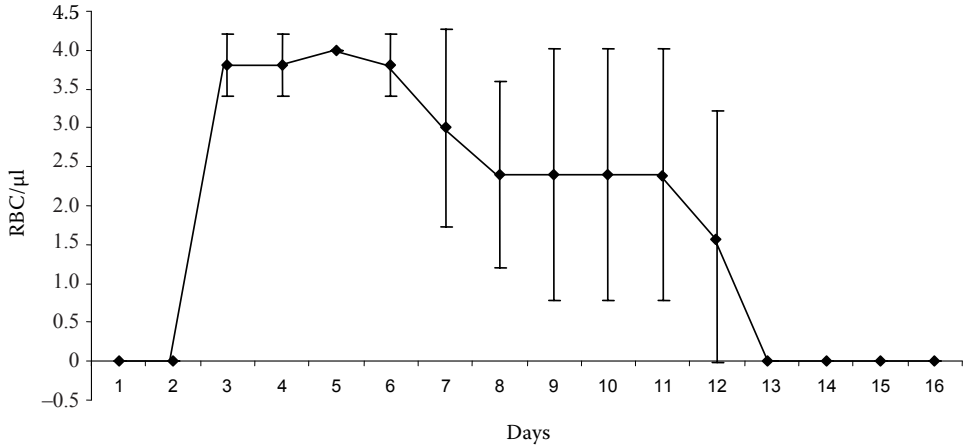


Figure 6. Mean values ($n$ = 5 sheep) of hematuria determined by chemical reagent strips. Degree of hematuria: 1 = 5–10 red blood cells (RBC)/µl; 2 = 25 RBC/µl; 3 = 50 RBC/µl

from the dorsal wall, and the balloon catheter placed in the bladder cavity filled with sterile normal saline. Since no leakage was observed at the perforation site, sealing was not performed.

There were no postoperative complications. All sheep recovered normally and demonstrated no abnormal findings on physical examination. All laparoscopic portals healed without complications, the only exception being the development of subcutaneous emphysema occurring at the portal for the optic trocar in one sheep. During the time between first surgery and tube removal in all sheep urine drained off the urinary catheter. After removal of the urinary catheter, the sheep all urinated normally.

During the repeat laparoscopy, it was observed that one sheep had developed a focal adhesion in the pelvic region of the parietal peritoneum to the bladder catheter portal site. Another sheep showed a hematoma at the cystotomy site. No uroperitoneum or bladder leakage was laparoscopically observed. Peritoneal healing was good on all trocar sites.

### Urinalysis

The presence of severe hematuria was evident between the first surgery and the removal of the catheter (Figure 6).

## DISCUSSION

Laparoscopic assisted cystotomy with subsequent catheter implantation is a feasible technique in male sheep.

Several laparoscopic techniques – either extracorporeal or intracorporeal – have been described for cystotomy and urolith removal as alternative to laparotomy in horses and small animals (Ragle, 2000, 2002; Rawlings et al., 2003; Rocken et al., 2006). The use of minimal invasive surgery decreases the size of the laparotomy incision needed and obviates the need for extensive manual traction on the bladder (Rocken et al., 2006). As described in the literature intracorporeal cystotomy requires experience in endoscopic suturing technique, specialized instruments, a longer surgical time, and carries a higher risk of peritoneal contamination (Ragle, 2002; Rocken et al., 2006). Extracorporeal opening of the bladder minimizes the risk of peritoneal contamination and allows secure sealing (Rocken et al., 2006).

In our experimental study we chose the extracorporeal technique for cystotomy. The selected locations of the portal access for the optic trocar and the grasping forceps allowed grasping of the bladder and its elevation to the ventral abdominal body wall under visual control without any complications. Extracorporeal cystotomy allowed flushing of the urinary bladder. Although not documented in this study the trigone region is accessible and it is also possible to use instruments such as a gallstone spoon to remove calculi from the urinary bladder and to insert a catheter in order to perform orthograde flushing of the urethra (Iselin et al., 2001; Ewoldt et al., 2006). In the literature on small ruminants several studies deal with the question of urethral flushing during cystotomy in order to remove urethral obstruction (Iselin et al., 2001; Fortier et al., 2004; Ewoldt et al., 2006). Until now, however,

this issue has not been well evaluated (Van Metre and Fubini, 2006). Several studies report the relief of urethral obstruction after performing bidirectional (normograde and retrograde) urethral flushing (Bostedt and Dedie, 1996; Iselin et al., 2001; Fortier et al., 2004). The most noteworthy concern regarding this technique seems to be the high risk of iatrogenic urethral rupture (Fortier et al., 2004; Ewoldt et al., 2006; Van Metre and Fubini, 2006). Some studies document an even better prognosis and long-term survival of small ruminants without urethral flushing (Ewoldt et al., 2006).

In the literature the suturing of the cystotomy site is described using a continuous pattern in two layers (Iselin et al., 2001; Ewoldt et al., 2006). Following the results of the repeat laparoscopy no complications arose from the technique (sutures in a simple non perforating pattern) used in this study.

The authors decided not to implant the urinary catheter at the cystotomy site while the urinary bladder was exteriorized, but chose to install the catheter when the bladder was repositioned into the abdomen. This allowed the control of the cystotomy site for leakage.

A previous experimental study has shown that a urinary catheter may be readily inserted in male sheep under laparoscopic control (Franz et al., 2008). In one sheep of this study the dorsal bladder wall was inadvertently perforated during placement of the urinary catheter. In this situation optical control allowed immediate diagnosis and assessment. The technique of laparoscopic assisted catheter implantation differs from the surgical tube cystostomy procedure described in the literature. Several reports describe the insertion of the catheter in the urinary bladder through a stab incision within a purse string suture, which afterwards is tied tightly so that the catheter is fixed in the urinary bladder wall (Iselin et al., 2001; Ewoldt et al., 2006). The urinary bladder is then pulled close to the ventral abdominal wall and the catheter outside is fixed to the skin with a chinese finger trap suture (Iselin et al., 2001; Ewoldt et al., 2006). In our study the catheter was directly inserted into the urinary bladder using the corresponding cannula without fixing the catheter with a suture and the bladder was not pulled close to the ventral abdominal wall but also fixed outside with the same technique described before. Catheter fixation seems to be an important factor due to possible complications such as catheter dislodgement (Iselin et al., 2001; Ewoldt et al., 2006). As reported, pulling the bladder close to the abdominal wall can be disadvantageous and even facilitates dislodgement of the catheter (Iselin et al., 2001).

During the repeat laparoscopy, it was observed that one sheep had developed a fibrous adhesion of the ventral abdominal wall in the pelvic region to the bladder catheter portal site. This adhesion probably could have been avoided by placing the trocar and its corresponding catheter more cranially.

Altogether our current data showed a favourable postoperative course: all sheep had a good appetite and showed no pathological findings during postoperative physical examination. The occurrence of hematuria between the first surgical procedure and the removal of the catheter may be caused either by the placement of the catheter or by mucosal irritation from the urinary catheter tip.

Laparoscopic assisted cystotomy with subsequent tube cystostomy can be helpful in removing uroliths and debris from the urinary bladder of male small ruminants suffering from obstructive urolithiasis, thereby avoiding obstruction to urine outflow (Kumper, 1994; Streeter et al., 2002). Candidates for this technique (cystotomy) include patients with calculi too large to be expelled through a percutaneously implanted urinary catheter. Even when calculi are small enough to be removed by hydropulsion through the catheter, there may be complications such as incomplete removal of uroliths (Rawlings et al., 2003).

In light of the results of our study we propose that this technique is feasible in removing uroliths from the urinary bladder of patients suffering from obstructive urolithiasis and also at the same time in establishing urinary diversion. However, further evaluation of this technique in sheep affected with urolithiasis is warranted.

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