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# Comparison between two urethrotomy techniques for treatment of urethral obstruction by urolithiasis and  cystorrhexis in cattle calves (Field study on 50 calves)

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**Abstract**

The current study was designed to compare two urethrotomy techniques (ventral and dorsal urethrotomy) to find out the short and long-term complications that may occur with both techniques and their incidences, to record the success rates of both techniques and to give full description of the new dorsal urethrotomy technique. The study was carried out on 50 cattle-claves suffered from urine retention, due to urethral obstruction by uroliths and cystorrhexis. Affected calves were classified randomly into two equal groups and one urethrotomy technique was used in each group for extraction of the stones. The operated calves were followed up for one-year post-surgery and complications were recorded. Results revealed higher incidence of post-surgical complications in group A than B, as the minor short-term complications like cystitis, abscess formation at sigmoid flexure, and wound edema constituted 56% and 16%, in both groups respectively. At the same time, the major short-term complications like ruptured urethra and peritonitis represented 32% and 4% in both groups respectively, while the long-term complications including re-obstruction and adhesion of sigmoid flexure were 28% and 4% in both groups respectively. Consequently the dorsal urethrotomy technique had higher success rates and accordingly it is concluded that the dorsal urethrotomy technique is advised to be used as an alternative technique to the traditionally used ventral urethrotomy in cattle-calves, when preserving the breeding capacity of calves is in demand.

**Keywords:** Cystorrhexis, Dorsal Urethrotomy, Uroliths, Ventral Urethrotomy

## Introduction

Urine retention by uroliths is a world widely recorded common affection of large ruminants (Gasthuys et al., 1993; Loretti et al., 2003; Fortier et al., 2004; Ludovic et al., 2005; Weaver et al., 2005; Seif et al., 2007; Parrah et al., 2011; Fazili et al., 2012; Devadevi and Chandran, 2019). Uroliths formation is a multifactorial condition controlled by dietary, environmental, and managemental factors (Radostits et al., 2006; Simpson and Streeter, 2015).

Despite stones are formed in males and females, they mainly constitute a problem in males as a result of their relative long-narrow urethra and presence of sigmoid flexure (Van Metre, 2004; Weaver et al., 2005; Radostits et al., 2006; Simpson and Streeter, 2015), and these anatomical features predispose to stone lodgment in the urethra with subsequent trauma to urinary tract and obstruction of urine egress (Van Metre, 2004).

Treatment is primarily surgical because medical treatment usually fails to resolve the problem and the condition usually ends by cystorrhexis with subsequent uremia, peritonitis and death; or urethral rupture (Larson, 1996; Loretti et al., 2003; Radostits et al., 2006; Abdel-Fattah and Sedeek, 2005; Fazili et al., 2012).

Over the past few decades several studies were carried out either to establish new techniques, convenient for treatment of the greatly variable forms of urine retention cases, or to improve old techniques to overcome their reported complications. Urethrostomy is the oldest established technique to safe animal life, and it is applied at different levels like; ischial urethrostomy (Winter et al., 1987; Hickman et al., 1995; Hooper and Taylor, 1995; Larson, 1996; Van Metre, 2004; Simpson and Streeter, 2015; Saurabh et al., 2016); perineal urethrostomy (Walker, 1979; Hickman et al., 1995; Hooper and Taylor, 1995; Van Metre et al., 1996; Wolfe, 1998; Weaver et al., 2005; Hendrickson, 2007; Simpson and Streeter, 2015); and pre-scrotal urethrostomy technique, in selective cases, to avoid urine scalds observed with other urethrostomy techniques (Abdelrhman et. al, 2012).

Furthermore, temporary or permanent tube cystotomy were used to resolve urine retention in certain cases (Streeter et al, 2002; Pearce et al, 2003; Van Metre, 2004; Seif et al., 2005; Weaver et al., 2005; Fazili et al, 2012; Parrah et al., 2013; Kushwaha et al., 2014; Singh et al., 2017).

Urethrotomy is an alternative salvage operation that maintains breeding ability of the animal (Wolfe 1998; Hickman et al., 1995; Van Metre, 2004; Abdel-Fattah and Sedeek, 2005). Unfortunately, guarded-to-poor prognosis is warranted because of stricture that occurs as a complication of urethral incision, fibrosis and adhesion in tissues surrounding the penis that may limit penile extension during erection, and risk of recurrence if managemental changes needed for prevention are not consistently practiced (Van Metre, 2004; Simpson and Streeter, 2015). The technique is applied to ventral aspect of the urethra where the stone is superficial and can easily be located (Walker, 1979; Hooper and Taylor, 1995; Wolfe, 1998; Weaver et al., 2005; Hendrickson, 2007; Kushwaha et al., 2014; Simpson and Streeter, 2015); or to the dorsal aspect of penis to overcome urine leakage after ventral urethrotomy (Abdel-Fattah and Sedeek, 2005; Sedeek et al., 2009; Seddek and Bakr, 2013; Simpson and Streeter, 2015).

All of the mentioned techniques aimed to establishing patent pass-way for the urine and most of them fully discussed and described (Walker, 1979; Hooper and Taylor, 1995; Wolfe, 1998; Van Metre, 2004; Abdel-Fattah and Sedeek, 2005; Hendrickson, 2007; Sedeek et al., 2009; Seddek and Bakr, 2013; Simpson and Streeter, 2015) but the incidences of their short and long-term success rates and complications like urethral rupture; urethral stricture that eventually lead to blockage by smaller calculi; or peri-penile adhesions, didn't get enough attention and there is a scarcity in literatures discussing them (Abdel-Fattah and Sedeek, 2005; Weaver et al., 2005; Simpson and Streeter, 2015).

Consequently, the current study was carried out to spot light on a recently established urethrotomy technique, give full description of the technique, and to record the most common short and long-term post-surgical complications, their incidence and their effect on the short and long-term success rates of both techniques as well.

**Materials and methods**

The study carried out on 50 cattle-calves, 4-8 months old, suffered from urine retention since 2-5 days and cystorrhexis. They were randomly categorized into two equal groups and subjected to laparotomy with ventral urethrotomy in group (A) and dorsal urethrotomy in group (B).

Prior to surgery, full history was taken, the calves were thoroughly examined to confirm the preliminary diagnosis, stones were palpated and detected in the sigmoid flexure, and the general health condition was assessed to determine calf's suitability for surgery.

Operated calves were rehydrated by suitable amount of saline, prepared for aseptic surgery, sedated by reduced dose of intramuscular Xylazine HCl, 0.1 mg /kg IM (Xyla-Ject, Adwia), then epidural and local analgesia were induced by Lidocaine HCl 2% (Debocaine, Sigma-tec Pharmaceutical industrial Co.). The calf was secured in right lateral recumbency and the left hind limb was flexed, slightly abducted and pulled cranio-dorsally, and 10-15 cm skin incision was made obliquely at the prepubic region and advanced cranio-ventrally towards the midline. A blunt dissection was made at the ventral commissure of the incision to penetrate the preputial sheath and the penis was exteriorized and moistened with saline, then one of the following techniques was performed.

**Ventral urethrotomy technique (Group A)**

The ventral urethrotomy technique (Figs. 1-6) was applied according to (Wolfe, 1998; Hooper and Taylor, 1995) with modification. The stone was detected and urethral incision was made slightly proximal to the stone to exteriorize it then Ryles tube (No. 8-12), supported with multifilament flexible stainless-steel stylet, was advanced retrograde towards the urinary bladder (Sedeek et al., 2009; Seddek and Bakr, 2013) and distally to ensure absence of other stones. In case of no other stones were detected, the abdominal incision was advanced to open the peritoneal cavity, the urine was gradually evacuated, the bladder was cleaned from clotted blood and other stones, then the Ryles tube was advanced from the bladder wound towards the external urethral orifice. The stainless steel stylet was removed from the Ryles tube, the feeding port of the Ryles tube was cut and 10-cm of the Ryles tube was fenestrated and coiled inside the bladder then the peritoneal cavity was

lavaged by isotonic solution and the bladder and abdominal wounds were sutured in routine manner (Ludovic et al., 2005). The urethra was sutured over the Ryles tube by polyglactin 910 No. 2/0-5/0 in a simple interrupted manner, then the penis was washed by saline, lubricated by oily antibiotic, preplaced into its original location, and the preputial splitting was filled with saline and sutured by catgut, and finally the skin incision was sutured in routine manner and the distal end of the Ryles tube was fixed to the glans penis by one silk stitch.
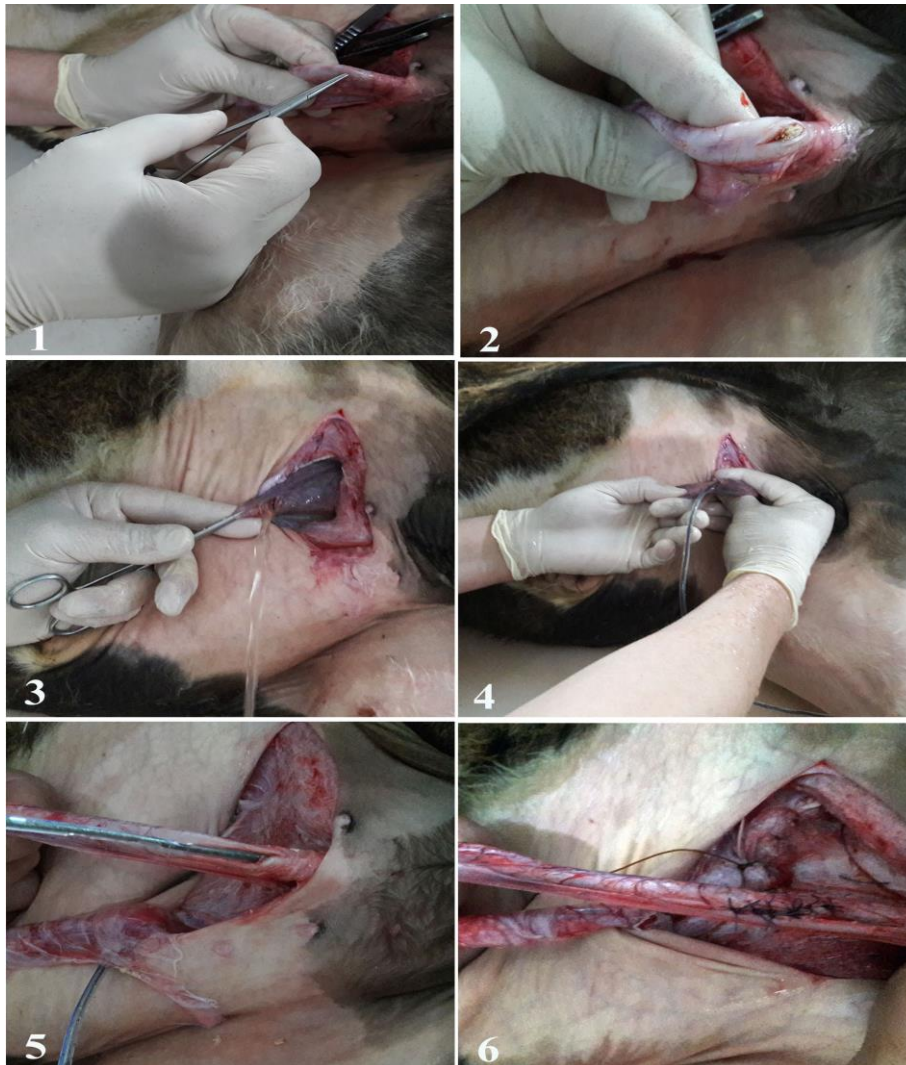


**Fig. 1: Ventral aspect of the penis prior to ventral urethrotomy, showing the stone inside the urethra, notice the darker color of urethra over the stone indicating necrosis**

**Fig. 2: Same animal in (Fig. 1) after ventral urethrotomy to capture the urolith**

**Fig. 3: The bladder showing leakage of urine through the wound at its ventral aspect**

**Fig. 4: Insertion of the Ryles tube, supported with multifilament flexible stainless-steel stylet, into the bladder wound**

**Fig. 5: Ryles tube passed from the bladder to the ventral urethral incision prior to advancing it towards external urethral orifice**

**Fig. 6: Directly after suturing the abdominal wound and the ventral urethral incision over the Ryles tube.**

**Dorsal urethrotomy technique (Group B)**

The dorsal urethrotomy technique **(Figs. 7-12)** was applied according to (Abdel-Fattah and Sedeek, 2005). A tourniquet was applied proximal to stone to induce engorgement of the dorsal penile veins followed by another tourniquet distal to the stone, then an incision was made on the dorsal penile surface to separate the engorged veins to expose and incise the tunica albuginea of corpus cavernosum, and advanced deeper to reaching the stone after incising tunica albuginea of corpus spongiosum and urethral mucosa. A mosquito forceps was inserted via the incision to capture the stone, the Ryles tube was advanced proximally and distally in the same manner as group (A). The abdominal wall and peritoneum were incised, the urine was evacuated gradually, the bladder was cleaned and the Ryles tube was advanced from the bladder wound towards the external urethral orifice. Then the dorsal penile incision was sutured by polyglactin 910 No. 0 - 3/0 by cross mattress pattern after removal of the two tourniquets, the peritoneal cavity was lavaged by isotonic solution, the stylet was removed and the feeding port of the Ryles tube was cut and 10-cm of the Ryles tube was fenestrated and coiled inside the bladder. Then after, the bladder was sutured (Ludovic et al., 2005) and the technique was continues as group (A) by suturing abdominal wound, preplacing the penis to its original location, suturing the preputial splitting, suturing the skin, and fixing the distal end of the Ryles tube to the glans penis.

**Post-operative care and follow up**

Directly after surgery, animals were injected intravenously with adequate amount of fluid therapy, and intramuscularly by one dose of oxytetracycline (200 mg/ ml) 1 ml/ 10 kg b.wt. and meloxicam 0.5 mg/kg b.wt. for two consecutive days. The owner was advised to give the animal orally 5 gm of salt, and 200 mg/ kg ammonium chloride (for a month) and advised that the calf should be allowed to access freely to water.

The Ryles tube was removed after 6 days in ventral urethrotomy group and 3 days in dorsal urethrotomy group, and the silk stitches were removed after 10-12 days. Operated calves were followed up at least for one year, either by visits for the near cases or phone call for those from rural areas and both of the short and long-term complications were recorded and dealt with according to their nature.

Statistical analysis was carried out using the Statistical Package for the Social Sciences software program (Stata® 16). Differences between the mean values of groups were evaluated by using compare the mean of two variables with two-sample t-test and all data in the current study were expressed as mean ± standard deviation with P value ≤ 0.05 was considered significant.
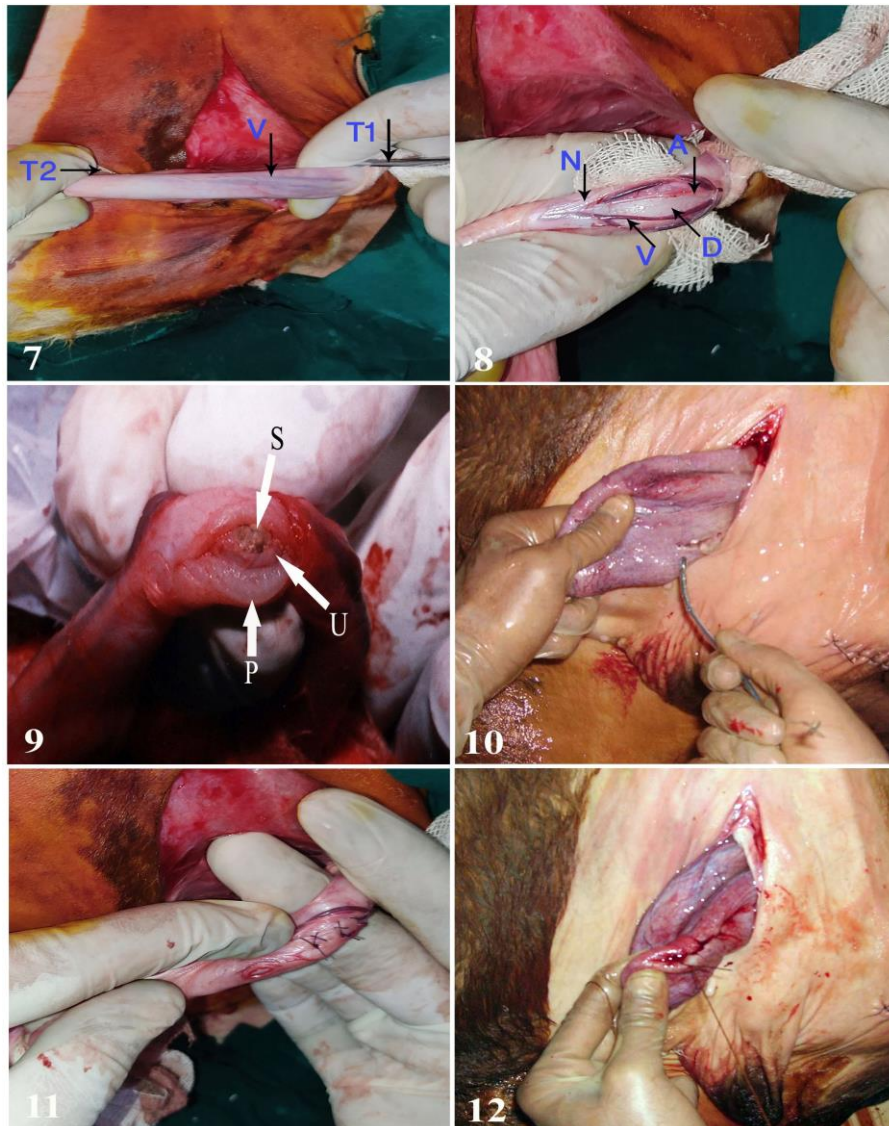
**Fig. 7: Dorsal aspect of the penis of the calf prior to dorsal urethrotomy technique, T1: Proximal tourniquet, T2: Distal tourniquet, and V: Dorsal penile veins**

**Fig. 8: Dorsal aspect of the penis of the calf during dorsal urethrotomy technique before incising the tunica albuginea of corpus cavernosum. A: Dorsal penil artery, N: Dorsal penil nerve, V: Dorsal penile veins, D: Dorsal surface of the penis (tunica albuginea of corpus cavernosum)**

**Fig. 9: Dorsal aspect of the penis of the calf during dorsal urethrotomy technique after incising the tunica albuginea of corpus cavernosum and exposure of the stone. S: Stone, C: Corpus cavernosum wall after incision, U: Urethral wall**

**Fig. 10: Insertion of the Ryles tube through bladder wound towards the urethra**

**Fig. 11: Directly after suturing the dorsal penile incision by polyglactin 910 No. 3/0 in a cruciate suture pattern**

**Fig. 12: Suturing of bladder by chromic catgut**

**Results**

With regard to the minor short-term complications **(Table 1)**, they included; slight edema and infection at incision line or stitches dehiscence, by the time of stitches removal (12 days post-surgery); abscess formation at sigmoid flexure (12 days post-surgery) and cystitis (5-10 days post-surgery). Although the total incidence of minor complications was higher in group (A) than (B), (56% and 16% respectively), they had no adverse effect on the short-term success rates in both groups as they caused no deaths or urinary diversion.

On the other hand, the major short-term complications included rupture of the urethra (within 24 hours after removal of Ryles tube) and Peritonitis. Rupture of the urethra was noticed in group (A) only with an incidence of 28%. The condition was noticed as swelling at scrotal base, pits on digital pressure, and gradually extended cranially over the ventrum. All recorded 7 calves were treated surgically by urethrostomy in addition to skin scarification to provide the urine an exit to escape. Fortunately, the 7 calves started to urinate through the created fistula, but the owners complained till the end of the study about urine scald of the thighs and reduced body gain in the 7 calves. Furthermore, 4 of these calves required widening of the urethrostomy fistula, 5 months post-surgery while the other 3 calves required the widening after 7 months.

The other major short-term complication was peritonitis and it had the same incidence in both groups (4%). The condition was observed intra-operatively in 2 calves suffered from urine retention and cystorrhexis since 4 days, and the operation continued under request of the owner after washing of the peritoneum by warm isotonic solution, dissection of adhesions and injection of massive dose of antibiotic after surgery, unfortunately, these two calves were euthanized 2-3 days post-operatively.

The major short-term complications, controversial to the minor ones, had negative effect on the short-term success rates in both groups, as group (A) had 68% short-term success rates while group (B) had 96%.

Long-term complications were re-obstruction and peri-penile tissue adhesion at the sigmoid flexure. Re-obstruction by other stones constituted 12% and 4% in both groups respectively. These 4 animals were treated by perineal urethrostomy. The 3 claves of group (A) already had cystitis as minor complication, while the calf of group (B) had slight wound edema and infection. However, this re-obstruction occurred earlier in group (A), 1-2 months post-surgery, than group (B), 5 months post-surgery. The other long-term complication was peri-penile tissue adhesion at the sigmoid flexure that acted as an obstacle against normal protrusion of the penis. This complication was noticed in group (A) only with an incidence of 16%, and three calves of them already had abscesses formation at the sigmoid flexure (12 days post-surgery). Accordingly, the long-term success rate of group (A) went down to 40% while group (B) long-term success rates dropped to 92%.

**Table (1): The short- and long-term complications and number of affected animals in both groups**

| | Complications | Group (A) | | Group (B) | |
|---|---|---|---|---|---|
| | | **No. of affected calves** | **Incidence** | **No. of affected calves** | **Incidence** |
| | *Short term* | | | | |
| **Minor** | **Cystitis** | **8 calves (1st, 3rd, 6th, 14th, 19th, 21st, 22nd,** | **0.32** | **1 calf (10th)** | **0.04** |
| | **Abscess at sigmoid** | **3 calves (1st, 5th, 25th)** | **0.12** | **0** | **0** |
| | **Wound edema** | **3 calves (2nd, 18th, 20th)** | **0.12** | **3 calves (10th, 17th, 22nd)** | **0.12** |
| **Major** | **Ruptured urethra** | **7 calves (4th, 9th, 10th, 13th, 16th, 17th, 24th)** | **0.28** | **0** | **0** |
| | **Peritonitis** | **1 calf (15th)** | **0.04** | **1 calf (4th)** | **0.04** |
| | *Long Term* | | | | |
| | Re-obstruction | **3 calves (3rd, 6th, 21st)** | **0.12** | **1 calf (10th)** | **0.04** |
| | Sigmoid adhesion | **4 calves (1st, 5th,18th, 25th)** | **0.16** | **0** | **0** |
| M ± SD | | | **0.166 ± 0.099ᵃ** | | **0.034 ± 0.043ᵇ** |
| *Total Short –term* minor | | **14** | **0.56** | **4** | **0.16** |
| *Total Short –term* major | | **8** | **0.32** | **1** | **0.04** |
| *Total Short term* | | **22** | **0.88** | **5** | **0.20** |
| *Total Long term* | | **7** | **0.28** | **1** | **0.04** |
| *Total complications* | | **29** | **1.16** | **6** | **0.24** |
| M ± SD | | | **0.64 ± 0.38ᵃ** | | **0.14 ± 0.09ᵇ** |

**Different letters in the same row indicates significant differences between groups (p ≤ 0.05). M ± SD: mean ± standard deviation.**

**Discussion**

The recorded short and long-term complications in the present study were few and occurred with both techniques, and some of calves had more than one complication. Furthermore, some of these complications were minor and responded well to treatment, while others were major and either threaten the calf life or had adverse effect on the technique's success rates.

Despite the higher incidence of minor short-term complications in group (A) than (B), they had no adverse effect on success rates of both techniques, as the calves were

treated according to nature of the affection, and all of them returned normal without mortality or urinary diversion.

The most important complication of ventral urethrotomy was rupture of the urethra after removal of the Ryles tube (Abdel-Fattah and Sedeek, 2005). Accordingly, while we design this study, we planned to prolong the catheterization duration in group (A) to 6 days to permit better healing of urethral incision to reduce the chance of urethral rupture. Although our catheterization period was longer than the reported 1-2 days in a literature (Simpson and Streeter, 2015), but it was within the range of catheterization periods recorded with tube cystotomy (Streeter et al., 2002; Pearce et al., 2003; Seif et al., 2005; Weaver et al., 2005; Fazili et al., 2012; Parrah et al., 2013; Singh et al., 2017), and we were encouraged to use this longer duration as cystitis didn't reported as one of complications of prolonged catheterization in these studies. Unluckily, a higher incidence of cystitis was observed in group (A) than (B), and it might be due to the longer period of bladder catheterization controversial to the shorter period of catheterization of the urethra only, in other literatures (Weaver et al., 2005; Simpson and Streeter, 2015).

The other major short-term complication that had adverse effect on success rates was the peritonitis, and it might be related to the affection itself rather than being related to the used technique, as it was detected intra-operatively, and similar finding were observed in previous studies (Loretti et al., 2003; Biswas and Saifuddin, 2015).

The major short-term complications, controversial to minor ones, represented the main reasons of short-term technique failure, as they constituted 32% in group (A) and 4% in (B), consequently the success rates dropped to 68% and 96% in both groups respectively. Occurrence of ruptured urethra in group (A), its incidence, and absence of such complication in group (B), coincide with a previous study (Abdel-Fattah and Sedeek, 2005). It should be noted that this complication couldn't be avoided in the present study even by both of the longer period of catheterization and incision of the urethra at proximal level than the uroliths, through a relatively healthy urothelium as advised in literatures (Van Metre, 2004; Simpson and Streeter, 2015). This complication is suspected to be related to; the devitalized urethra, as 4% urethral rupture was recorded with tube cystotomy without urethral surgical interference (Singh et al., 2017), or the fact that suturing of the urethral wall is awkward because the surgeon usually attempts to apposite narrow urethral canal to preserve its maximal diameter to achieve the least possible stenosis. This frequently resulted in urinary seepage through the incision (Abdel-Fattah and Sedeek, 2005; Weaver et al., 2005; Simpson and Streeter, 2015). Another one more explanation is the friction between the sharp edges of wholes created in the internal end of Ryles tube and the sutured thin devitalized urethra during removal of the Ryles tube after 6 days.

Despite that long-term complications were less frequent than short-term ones; their negative effect on the success rates was nearly the same as major short-term complications, moreover they predisposed to lowering the overall success rates to 40% in group (A) and 92% in group (B). Failure of the technique as a result of early urethral re-obstruction (1-2 months post-surgery) by

new uroliths in group (A) constituted 12%, and it should be noted that this early re-obstruction, despite the daily use of ammonium chloride and sodium salt for a month, may be related to the previously observed cystitis in these animals, because inflammation, cellular cast, or tissue debris may provide a nidus for calculi to form (Hardisty and Dillman, 1971; Simpson and Streeter, 2015); or related to fibrosis and chronic stenosis after ventral urethrotomy that eventually causes recurrence of blockage by smaller calculi (Van Metre, 2004; Abdel-Fattah and Sedeek, 2005; Weaver et al., 2005).

Simultaneously, the other 16% of failure in group (A) was related to peri-penile adhesion at the sigmoid flexure and inability to protrude the penis, which means that these animals can't be used for breeding (Van Metre, 2004), and it should be noted that 3 out of these 4 calves, had abscesses at sigmoid flexure as short-term complication. Formation of such abscesses; their treatment by maturation, evacuation and application of drains that stimulates granulation tissue formation, and the subsequent local fibrosis after their resolution; in addition to the devitalized urethral wall, explain formation of such adhesions. At the same time, abscesses formation might be due to the devitalized urethral mucosa (Simpson and Streeter, 2015) and seepage of the contaminated urine though the sutured necrotized urethra.

Taking in account the negative effect of complications, that either cause death of the animal or urinary diversion, on the overall success rate, or excluding peri-penile adhesion as a failure of the technique, may increase the success rate of ventral urethrotomy maximally to 52 % compared to 92% for dorsal urethrotomy.

## Conclusions

As a result of the less frequent short and long-term complications of dorsal urethrotomy and its higher success rate, it can be concluded that the technique is better than the traditionally used ventral urethrotomy and its use is advised to preserve the breeding capacity of calves.

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## References

Abdel-Fattah, M., Sedeek, A.M. (2005). Dorsal versus ventral urethrotomy technique for treatment of obstructive urethrolithiasis in cattle calves. Assiut Veterinary Medical Journal 51(106), 198-209.

Abdelrhman, M.A., Seddek, A.M., Bakr, H.A. (2012). Perineal versus prescrotal urethrostomy for treatment of obstructive urethrolithiasis in calves. Indian Journal of Veterinary Surgery 33(2), 120-123.

Biswas, D., Saifuddin, A.K. M. (2015). Death of non-descriptive male calf due to urolithiasis followed by rupture of urinary bladder. Bangl. J. Vet. Med. 13(2), 63-66.

Devadevi, N., Chandran, S. (2019). Urolithiasis and mineral profile in Gir calves and its control measure. International Journal of Chemical Studies 7(4), 1787-1790.

Fazili, M. R., Bhattacharyya, H. K., Buchoo, B. A., Malik, H. U. and Dar, S.H (2012). Management of obstructive urolithiasis in dairy calves with intact bladder and urethra by Fazili's minimally invasive tube cystotomy technique. Vet. Sci. Dev. 2(1), 50-53.

Fortier, L.A., Gregg, A.J., Erb, H.N., 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(6), 661-667.

Gasthuys, F., Steenhaunt, M., DeMoor, A., Sercu, K. (1993). Surgical treatment of urethral obstruction due to urolithiasis in male cattle: a review of 85 cases. Vet. Rec. 133(21), 522-526.

Hardisty, J., Dillman, R. (1971). Factors predisposing to urolithiasis in feedlot cattle. Iowa State University Veterinarian 33, 77-81.

Hendrickson, A.D. (2007). Bovine Urogenital Surgery. Chapter14. In: Techniques in large animal surgery. 3rd ed. Blackwell Publishing, pp 239-272.

Hickman, J., Houlton, J.E., Edwards, B. (1995). Surgery of the genito-urinary system Section 4 In: An atlas of veterinary surgery. 3rd ed. Blackwell Science, pp 85-112.

Hooper, R., Taylor, T. (1995). Urinary surgery. Vet Clin North Am Food Anim Pract. 11(1), 95-121.

Kushwaha, R.B., Amarpal, Aithal, H.P., Kinjavdekar, P., Pawde, A.M. (2014). Clinical appraisal of 48 cases of obstructive urolithiasis in buffalo calves treated with tube cystostomy and urethrotomy. Advances in Animal and Veterinary Sciences 2(2), 106-110.

Larson, B. L. (1996). Identifying, treating, and preventing bovine urolithiasis. Vet Med. 91, 366-377.

Loretti, A.P., de Oliveira, L.O., Cruz, C.E. and Driemeier, D. (2003). Clinical and pathological study of an outbreak of obstructive urolithiasis in feedlot cattle in southern Brazil. Pesquisa Veterinária Brasileira 23(2), 61-64.

Ludovic, P.B., Carolyn, L.K., Simon, G.P., John, R., Jennifer, L., Jeff, L.C. (2005). Comparison of two laparoscopic suture patterns for repair of experimentally ruptured urinary bladders in normal neonatal calves. Vet Surg. 34(1), 47-54.

Parrah, J.D., Moulvi, B.A., Hussain, S.S., Bilal, S., Athar, H. (2011). Aetiopathogenesis of bovine obstructive urolithiasis. Indian Journal of Animal Research 45(1), 10-17.

Parrah, J.D., Moulvi, B.A., Hussain, S.S., Makhdoomi, D.M., Athar, H., Dedmari, F.H., Hamadani, H. (2013). Evaluation of different

surgical techniques for the management of bovine obstructive urolithiasis. Veterinary Practitioner 14(2), 515-522.

Pearce, S., Dearo, A., Howard, B., Brisson, B. (2003). Management of obstructive urolithiasis and concurrent urethral rupture in a goat. Aust Vet J. 81(5), 268-270.

Radostits, O.M., Gay, C.C., Hinchcliff, K.W., Constable, P.D., (2006). Diseases of the urinary system. In: VETERINARY MEDICINE A textbook of the diseases of cattle, horses, sheep, pigs and goats. 10$^{th}$ ed. SAUNDERS, ELSEVIER, Edinburgh, pp 561-570.

Saurabh, Bisla, R.S., Tayal, R., Ganguly, A. (2016). Evaluation of sub-ischial urethrotomy for the treatment of obstructive urolithiasis in male buffalo calves. Haryana Vet. 55 (2), 224-228.

Seddek, A.M., Bakr, H.A. (2013). New surgical technique for treatment of obstructive penile urethrolithiasis without interference with breeding capability: Clinical study on 25 calves. Pakistan Veterinary Journal 33(3), 385-387.

Sedeek, A.M., Bakr, H.A., Hassan, S.M. (2009). Retrograde catheterization of the urinary bladder of calves. Assiut Veterinary Medical Journal 55(121), 411-422.

Seif, M.M., Abd Elfattah, M., Sedeek, A.M. (2005). Permanent urinary diversion

in ruminants. Assiut Veterinary Medical Journal 51(106), 210-223.

Seif, M.M., Sedeek, A.M., Abd Elfattah, M., Bakr, H.A. (2007). Obstructive urethrolithiasis in cattle calves (A review of 319 cases). 9$^{th}$ Scientific Congress Egyptian Society for Cattle Diseases, 2-4 Dec., Assiut, Egypt. pp 306-323.

Simpson, K.M., Streeter, R.N. (2015). Bovine Urolithiasis In: Bovine Reproduction, Hopper, R.M. (ed), 1$^{st}$ ed, Wiley-Blackwell, pp 175-180.

Singh, R., Sharma, S., Tiwari, D.K., Chaudhary, R.N., Saharan, S., Pandey, A.K. (2017). Management of urinary obstruction in buffalo calves by tube cystostomy. Buffalo Bulletin 36(2), 307-312.

Streeter, R. N., Washburn, K. E., and McCauley, C. T. (2002): Percutaneous tube cystostomy and vesicular irrigation for treatment of obstructive urolithiasis in a goat. J A V M A 221(4), 546-549.

Van Metre, D., (2004). Urolithiasis, chapter 19, Surgery of the sheep and goat reproductive system and urinary tract. In: Farm Animal Surgery. Fubini, S., Ducharme, N. (eds), 1$^{st}$ ed. W. B. Saunders, Elsevier, pp 527-547.

Van Metre, D.C., House, J.K., Smith, B., George, L.W., Angelos, S.M., Angelos, J.A., Fecteau, G. (1996). Obstructive urolithiasis in ruminants: medical treatment and

urethral surgery. Comp. Cont. Educ. Pract. Vet. 18(3), 317-327.

Walker, D. (1979). Penile surgery in the bovine: Part I. Mod. Vet. Pract. 60(10), 839-843.

Weaver, A.D., Jean, G.S., Steiner, A. (2005). Male urinogenital surgery, chapter 6, In: Bovine surgery and lameness. 2nd ed. Blackwell Publishing, pp 168-198.

Winter, R., Hawkins, L., Holterman, D., Jones, S. (1987). Catheterization: an effective method of treating bovine urethral calculi. Vet. Med. 82, 1261-1266.

Wolfe, D. (1998). Urolithiasis. In Wolfe, D.F., Moll, H.D. (eds): Large Animal Urogenital Surgery. 2nd ed. Baltimore, Williams & Wilkins, pp 349-354.