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ARTICLE

Is there still a role of balloon dilatation of benign ureteric strictures in 2019?

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ABSTRACT

Introduction and Objectives: Reconstructive surgery for benign ureteric strictures and long term nephrostomy are often invasive and lead to poor quality of life. Balloon dilatation has the potential to bridge this gap. We present the outcome of our series and examine the risk factors of stricture recurrence.

Materials and Methods: There were 109 strictures in our series from August 2012 to July 2018 in our single center retrospective cohort analysis. All strictures were dilated retrogradely or antegradely and followed by stenting. Follow-up imaging was done to assess stricture recurrence.

Results: Mean patient age was 57.7-years-old (SD ± 12.6). Mean follow-up was 20.2 months (SE ± 1.8). All strictures were successfully dilated and stented. Overall, mean patency rate was 63.7% at mean follow-up of 20.2 months (SE ± 1.8). Strictures caused by stone/inflammation had 28.0% (21/75) risk of recurrence compared to iatrogenic causes, 63.6% (7/11), and radiotherapy, 100.0% (5/5) ($p = 0.001$). Non-incidental strictures also had significantly higher risk of recurrence at 57.4% (27/47) vs. incidental strictures at 13.6% (6/44) ($p = 0.000$). The mean length of strictures was 12.5 mm (SE ± 1.7) in the recurrence group vs. 9.6 mm (SE ± 0.7) in those without recurrence ($p = 0.001$). The presence of ipsilateral atrophic kidney was associated with 72.2% (13/18) risk of recurrence vs. non-atrophic kidney 27.4% (20/73) ($p = 0.000$). The mean age of stricture was 14.5 months (SE ± 4.6) and 5.2 months (SE ± 2.1) in the recurrence and non-recurrence groups, respectively ($p = 0.013$).

Conclusions: Balloon dilatation of benign ureteric stricture is a feasible option. Its effect can be long-lasting in selected patients, that is, non-irradiated, incidental, short strictures with normal kidneys. This will benefit patients unfit for reconstructive surgery.

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Introduction

Benign ureteric stricture is a common condition reported in 3–11% patients undergoing ureteroscopy for stone management. Chronic impaction of ureteric stones is found to cause ureteric strictures in 24% of patients [1]. Definitive management of benign ureteric strictures often involves reconstructive surgeries that may not be suitable for patients with multiple co-morbidities. Other option such as long-term percutaneous nephrostomy (PCN) is associated with a poor quality of life [2]. Therefore, many endoscopic techniques including ureteric stenting, balloon dilatation, endoureterotomy, cautery wire balloon incision have been studied in the past. Among these options, the success rate of balloon dilatation is mixed, ranging from 18–83% [3]. We would like to report the outcomes and complications of balloon dilatation of benign ureteric strictures in our observational series. In addition, we analyze the risk factors for stricture recurrence.

Material and methods

After excluding ureteroileal anastomotic strictures and malignant strictures, there are 109 strictures (100 patients) in in our single center retrospective cohort from August 2012 to July 2018. Non-incidental ureteric strictures are diagnosed by imaging such as CT intravenous pyelogram (CT IVP), intravenous urogram (IVU) and/or retrograde/antegrade pyelogram. An incidental stricture is defined as a stricture encountered during ureteroscopy and impassible by a semi-rigid ureteroscopy. A non-incidental stricture is defined as a stricture that can be diagnosed on preoperative imaging. The age of stricture is estimated by the first symptom (e.g. renal colic in a case of ureteric stone causing a stricture formation) or the first imaging (if asymptomatic) to the date of balloon dilatation is performed. Recurrence of stricture is defined as persistence/worsening on follow-up imaging or the need for long term PCN/DJ stent or need for reconstructive surgery.

Full informed consents are obtained from patients prior to the procedure. We ensure there is no active urinary tract infection and obtain a negative urine culture prior to procedure. There are 96 balloon dilatations of strictures performed via retrograde approach by 9 urologists and 13 strictures via antegrade approach by 4 interventional radiologists.

For the retrograde approach, patients are positioned in a lithotomy position. After placement of a safety 0.035″ guidewire, ureteroscopy and retrograde pyelography are

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performed to assess the stricture. The safety guide-wire is then exchanged to a stiff 0.018″ guide-wire to allow the introduction of the balloon dilator. The stricture is dilated with 0.035″ Reef HP high-pressure 4 or 5 mm (diameter) × 20 or 40 mm (length) balloon catheter (Invatec S.p.A., Roncadelle, Italy) under fluoroscopic guidance in all cases. The first dilatation is done for 1 min at a nominal pressure of 10 atm. Subsequent dilatations are performed at higher pressure, for 1 min each time, until stricture is successfully dilated. This is followed by a check ureteroscopy and retrograde pyelography to look for degree of dilatation and extravasation (Figures 1–3). At the end of procedure, a double-J (DJ) stent is inserted.

In the antegrade approach, a percutaneous nephrostomy tube is inserted prior to the procedure. This has usually been done in the setting of sepsis or obstructive uropathy. When the acute events have resolved, these patients will undergo antegrade dilatation by the interventional radiologists. This is done in a lateral or prone position under local anesthesia and/or sedation. The process of dilatation is similar to the retrograde approach. After dilatation, a check nephrostogram is done immediately. A DJ or nephroureteric stent is also inserted in every patient at the end of procedure.

The duration of stenting and follow-up imaging are at the discretion of the attending urologist after taking into consideration of the patients' clinical findings. All patients should also be covered with empirical antibiotics for 1 week perioperatively.

Statistical analysis

We compare the risk factors of stricture recurrence using the student *t*-test or Mann–Whitney *U* test for continuous variables and the Pearson chi-square test for categorical variables. Multivariate analysis is calculated by binary logistic regression analysis. Statistical analysis is conducted using IBM SPSS Statistics software version 21.0. $p < 0.05$ from use of two-side statistical tests is considered statistically significant.

Results

Table 1 shows the patients' baseline characteristics. There are a total of 109 benign ureteric strictures in 100 patients in our series. The mean duration of DJ stent placement was 5.5 weeks (SE ± 0.4) and the mean follow-up duration is 20.2 months (SE ± 1.8). 98/109 (89.0%) strictures are dilated in a single session, 12/109 (11.0%) require more than one dilatation.

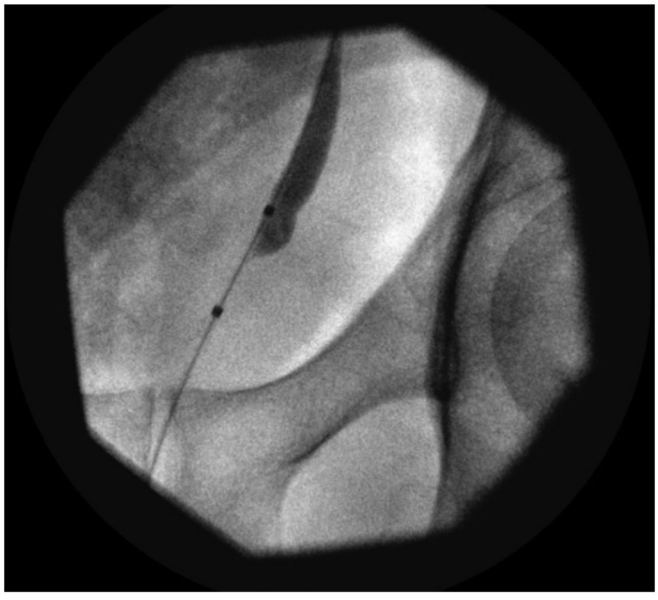

Figure 1. Balloon dilator positioned across left ureteric stricture.

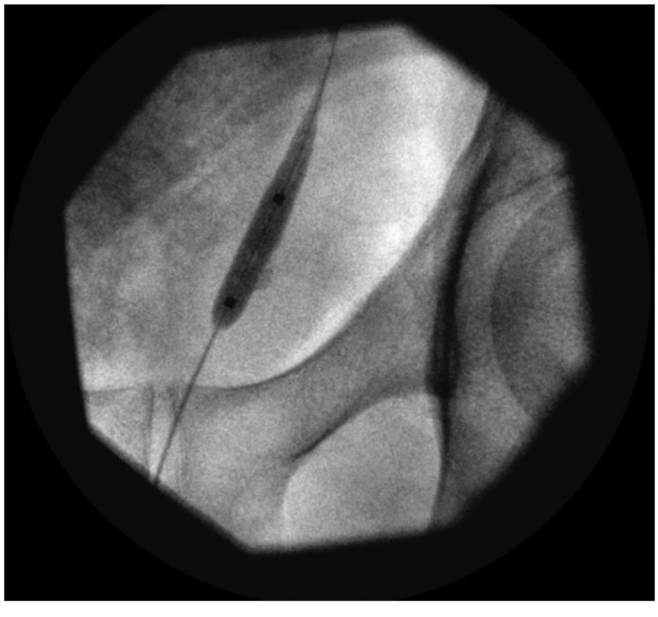

Figure 2. Balloon dilator inflated.

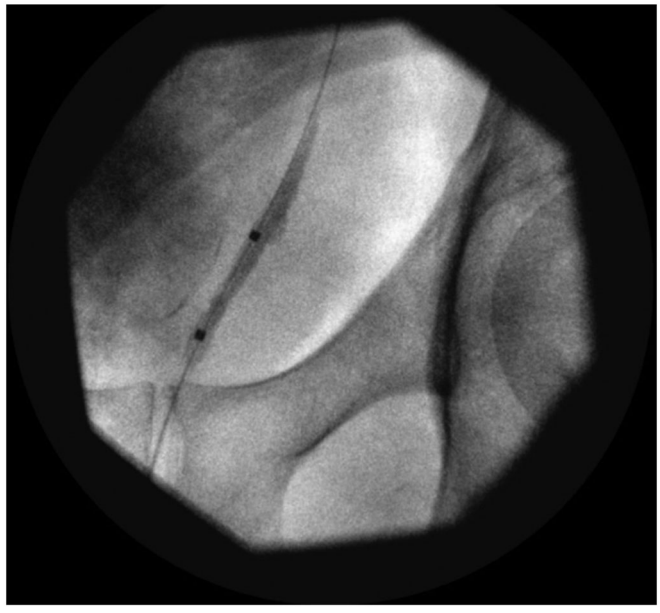

Figure 3. Balloon dilator deflated immediately after dilatation showing passage of contrast past the stricture.

Table 1. Patients' baseline characteristics.

Baseline characteristics	*n* (%)
Age (mean, years)	57.7 (SE ± 1.2)
Gender	
Male	71 (71.0%)
Female	29 (29.0%)
Location of strictures	
Upper ureter	30 (27.5%)
Mid ureter	15 (13.8%)
Lower ureter	64 (58.7%)
Mean length of strictures (mean, mm)	11.0 (SE ± 0.8)
Upper ureter	9.8 (SE ± 1.2)
Mid ureter	13.0 (SE ± 2.6)
Lower ureter	10.8 (SE ± 1.1)
Previous ureteric intervention	
Yes	31/109 (28.4%)
No	78/109 (71.6%)
Causes of strictures	
Stone/inflammation	93/109 (85.3%)
Iatrogenic	11/109 (10.1%)
Radiotherapy	5/109 (4.6%)
Number of dilatations	
1	97 (89.0%)
2	5 (4.6%)
3	4 (3.7%)
4	1 (0.9%)
5	2 (1.8%)

Outcomes

All strictures are successfully dilated and stented. 61.8% (55/89), 63.6% (35/55), 63.2% (24/38), 52.0% (13/25) and 38.5% (5/13) strictures remain patent at 3, 12, 24, 36 and 48 months, respectively. 2 out of 3 patients who are followed up for 60 months do not have any recurrence. Overall, mean patency rate is 63.7% at mean follow-up of 20.2 months (SE ± 1.8).

105/109 (96.3%) strictures do not have extravasation. The 6 patients who have mild extravasation after balloon dilatation are treated with a placement of a ureteric stent. None of these 6 patients require immediate or delayed repair of ureteric injury.

Risk factors of recurrence

Strictures caused by stone/inflammation are at 28.0% (21/75) risk of recurrence compared to iatrogenic causes, 63.6% (7/11), and radiotherapy, 100.0% (5/5) ($p = 0.001$). Non-incidental strictures also have significantly higher risk of recurrence at 57.4% (27/47) vs. incidental strictures at 13.6% (6/44) ($p = 0.000$).

The mean length of strictures is 12.5 mm (SE ± 1.7) in the recurrence group vs. 9.6 mm (SE ± 0.7) in those without recurrence ($p = 0.001$). Stricture recurrences are 38.5% (10/26), 57.1% (4/7) and 34.0% (17/50) for upper, mid and lower ureteric strictures, respectively ($p = 0.588$).

The presence of ipsilateral atrophic kidney is associated with 72.2% (13/18) risk of recurrence vs. normal kidney 27.4% (20/73) ($p = 0.000$). Moderate to severe hydronephrosis (including ruptured system) has 55.6% (10/18) risk of recurrence compared to no or mild hydronephrosis 31.5% (23/73) ($p = 0.057$). The mean age of stricture is 14.5 months (SE ± 4.6) and 5.2 months (SE ± 2.1) in the recurrence and non-recurrence groups respectively ($p = 0.013$).

Non-incidental stricture, length of stricture and age of stricture are found to be statistically significant risk factors for recurrence on multivariate analysis.

Discussion

Balloon dilatation of ureter was initially introduced in the 1980s [4–6]. In our series, mean 63.7% of the strictures were successfully dilated. With mean follow-up of 20.2 months, our short term and intermediate term recurrence-free rate is encouraging. Table 2 shows the long-term outcomes reported by our series as compared with all published series [5,7–28].

From prior studies, the cause of ureteric strictures is known to be a main determining factor for recurrence. Lang et al. report 8/9 of radiotherapy strictures fail balloon dilatation in the long run [10]. Wolf et al. classify a stricture as ischemic when it follows surgery or radiotherapy, while non-ischemic when it is secondary to stone passage or a congenital anomaly [29]. On the contrary, Beckmann et al. report all 3 radiotherapy strictures with 100% success dilatation [14]. A population-based study by Welk et al. shows that ureteric repair was needed after surgery (3.4%) for cervical cancer [30]. Our results show that radiotherapy and iatrogenic strictures are at highest risk of recurrence. Radiotherapy and surgery tend to devascularise the ureter and subsequent healing will result in dense fibrotic scar tissue.

Voegeli et al. attribute their high success rate to the early diagnosis of strictures in renal transplant patients who are closely followed [13]. Beckmann et al. find that strictures less than 3-months-old and more than 3-months-old are successfully dilated in 88 and 67%, respectively [14]. Punekar et al. also suggest best response to balloon dilatation occurs in strictures aged 3 to 6-months-old. Older strictures tend to be more dense and fibrotic and resistant to balloon dilatation [22]. In a series by Johnson et al., 14/22 (64%) strictures aged less than 7 months are of favorable outcomes. None of the five strictures older than 7 months are successful [9]. However, Ravery et al. find that recurrence of stricture occur in younger stricture (8.9 vs. 11.8 months; $p < 0.05$) [21]. In our series, the mean age of stricture was 14.5 months (SE ± 4.6) and 5.2 months (SE ± 2.1) in the recurrence and non-recurrence groups respectively ($p = 0.013$). Lang et al. also propose that chronicity, that is, a dense and fibrotic stricture will compress vessels and therefore decrease oxygenation. A vicious cycle will form that leads to worsening and denser stricture [10]. We postulate that chronicity of stricture formation will cause higher recurrence. In this aspect, we demonstrate that the presence of ipsilateral atrophic kidney is significantly associated with recurrence of stricture. We also show that severity of hydronephrosis may be significantly associated with recurrence. This is again because of denser fibrotic tissues at the stricture that is resistant to balloon dilatation. Longer strictures are more devascularised and fibrotic. Punekar et al. cite strictures longer than 2 cm as high risk of recurrence after balloon dilatation [22]. Mean lengths of stricture in those with recurrence are 1.23 cm (0.1–3 cm) vs. no

Table 2. Clinical outcomes in various balloon dilatation series.

Studies	*n*	Mean follow up, month	Success	Remarks	DJ stent duration
Glanz [5]	6	NA	50%	Multiple dilatations	
Banner [7]	44	NA	48%	5 ureterolithotomy 3 ureteroneocystostomy 20 ureteroileostomy 1 ureterolysis for retroperitoneal fibrosis 6 hysterectomy 5 benign gynecologic surgery 3 pyeloplasty 1 PCNL	1 week
Finnerty [8]	6	12	83%		
Johnson [9]	31	6–36	18 (58%)	21 secondary to surgery 4 stone 1 infection 5 unknown cause (all non incidental)	Variable
Lang [10]	127	15	50%		3–6 weeks
O'Brien [11]	24	13	50%		
Shapiro [12]	37	12	16%		
Voegeli [13]	14	29	79%	Renal transplant	NA
Beckmann [14]	33	1–40	76%		4–8 weeks
Kramolowsky [15]	7	16	71%		
Netto [16]	19	24	58%	ureterolithotripsy in 47.7% of the patients, open ureterolithotomy in 9.5%, other urological procedures in 23.8%, general surgical and gynecological procedures in 9.5% and miscellaneous factors in 9.5%.	
Meretyk [17]	13	20	62%	Ureterotomy incision	
McClinton [18]	49	18	80%		
Kwak [19]	28	6	54%	Multiple dilatations	4 weeks
Taille [20]	25	8.5	64%	14 ureteroileal anastomosis	8 weeks
Ravery [21]	25 (11 ureteric, 14 ureteroenteric)	16	52%		
Punekar [22]	16	15–53	11/69 (69%)	3 after pyelolithotomy 3 after failed pyeloplasty 8 GU TB 2 after ureteric reimplantation 62% puj , upper ureter 31% lower ureter 2 (7%) long over mid & lower ureter 5 > 2 cm 11 < 2 cm	
Richter [23]	81	6.3 years	33/37 (89.2%) – short & intact vascular supply 3/8 (37.5%) long 1/2(50%) PUJ overall 48/81 (59.3%)	2 congenital 65 prior surgery 9 traumatic injury 7 basketing attempts 16 ureteric stones, URS 3 flexible URS 12 infections	
Bhayani [24]	4	23.5	75%	Ureteroureterostomy stricture	4–6 weeks
Byun [25]	21	36	57%		3 weeks
Corcoran [26]	34	7.7	85%	Some with initial laser endoureterotomy	6–8 weeks
Markic [27]	24	?	50%	11 latrogenic 1 post TB 1 congenital 1 retroperitoneal fibrosis 10 unknown	
Reus [28]	32/43	36	72%	32 balloon dilations 10 catheter dilations 1 laser ureterotomy	
Yam (This study)	109	20.2	63.7%		5.5 weeks

recurrence 1.06 cm (0.1–3 cm) in the series by Ravery et al. All three patients whose strictures are more than 2 cm have recurrence [21]. In our series, the mean lengths of strictures are 12.5 mm (SE ± 1.7) in the recurrence group vs. 9.6 mm (SE ± 0.7) in those without recurrence ($p = 0.001$). This shows that there may be further subdivision of whom will benefit from balloon dilatation. 9/13 (69%) of upper or mid ureteric strictures are successfully dilated in a series by Johnson et al. Lower ureter or ureteroileal anastomotic dilatation is successful in 9/18 (50%) [9]. We do not find any statistically significant difference in stricture recurrence among upper, middle and lower ureteric strictures. This is reassuring that balloon dilatation can be utilized for strictures encountered in any location.

In general, the reports of the adverse outcome of balloon dilatation of ureteric strictures are minor. Banner et al. encounter one extravasation and one balloon rupture when the technique is in its infancy [7]. Johnson et al. report 5 extravasations among 31 procedures [9]. Meretyk et al. have one case of urinoma formation. However, it is an incision endoureterotomy followed by balloon dilatation technique [17]. We perform dilatation of the strictures with a balloon catheter over a 0.018″ stiff guidewire to allow us to perform retrograde pyelogram immediately after dilatation without further catheter or guidewire exchanges. It also offers guide-wire access across the stricture at all times. In the event of extravasation after ureteric dilatation, this will facilitate ease of ureteric stenting and increase overall safety of balloon dilatation.

Cases of stent migration are published by McClinton and colleagues [18]. Lastly, one case of urosepsis is found each in McClinton and Richter's series [18,23]. We do not have any complication of urosepsis by ensuring all active urinary tract infection has resolved and obtaining sterile culture before the procedure.

The main advantage of balloon dilatation of a ureteric stricture is the ability to treat only at the diseased segment of the ureter. This avoids manipulation of the non-diseased segment. In addition, balloon dilatation over a guidewire acts as a safety across the pelvicalyceal system at all time. In our opinion, the 4 mm balloon dilator is adequate for Asian patients. One patient with single dilatation underwent open ureteroureterostomy; another patient with long 3 cm stricture (initially declined reconstructive surgery) had five dilatations and she underwent open Boari flap reconstruction eventually. Both surgeries went uneventfully. This shows that repeated dilatation is safe and it does not complicate subsequent definitive surgery, if required.

Our study has several limitations in view of the retrospective/observational nature. The mean stricture length is 11.0 mm for all the patients. This could be due to selection bias where only short strictures are offered balloon dilatation. However, we further analyze that causes of strictures and incidental/non incidental stricture do add to prognosticate the outcome of balloon dilatation in this cohort of short strictures. Secondly, the procedures are performed by a heterogenous group of urologists and interventional radiologists. Furthermore, many of the strictures are encountered only during ureteroscopy and not found on preoperative imaging. Therefore, there is no functional scan performed to assess the severity of obstruction. We recognize that further standardization of technique, size of DJ stent, duration of DJ stent and post-operative follow-up imaging will also help address our limitations.

Conclusions

In summary, balloon dilatation of benign ureteric stricture is a safe and feasible option in current era. Its effect can be long lasting in carefully selected patients, that is, non-irradiated, incidental, short strictures with normal kidneys; These outcomes may benefit those who are not fit for reconstructive surgery to avoid long term nephrostomy tube. Future prospective studies can be conducted to compare the outcomes of balloon dilatation and other forms of ureterotomy.

Disclosure statement

The authors report no conflicts of interest.

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