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ARTICLE

Endoureterotomy with the Lovaco technique for treatment of ureterointestinal strictures: outcomes in an experienced center and factors associated with procedural success or failure

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ABSTRACT

Introduction: The study aimed to present the outcomes of an endoureterotomy series using the Lovaco technique for the treatment of ureterointestinal strictures. Factors influencing the success or failure of this technique were also determined.

Materials and methods: Data were collected from all endoureterotomies for ureterointestinal strictures performed in a single-center between 2017 and 2020. Clinical variables and characteristics of the stricture were recorded in each case, and success was defined as the complete resolution of ureterohydronephrosis. Univariate analysis was used to correlate the variables recorded with procedural success or failure.

Results: A total of 25 patients were recruited: 16 with strictures on the left side, 5 on the right, and 4 bilateral. With the first endoureterotomy, 52% of the cases (13 patients) were resolved, and in patients undergoing a second intervention 64% success (16 patients) was achieved. Infectious complications occurred in 23.3% of surgeries. Stricture length, poor renal function, and left side involvement were associated with endoureterotomy failure.

Conclusions: Endoureterotomy with the Lovaco technique is a useful method in the setting of ureterointestinal strictures, achieving complete resolution of the obstruction in more than 60% of cases. Factors that can negatively affect the success of the procedure include stricture length, poor renal function, and left side involvement.

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Introduction

Ureterointestinal strictures are a frequent complication after radical cystectomy, occurring in 4–8% of cases with an ileal conduit, 13% with a neobladder, and up to 22% of ureterosigmoidostomies, the majority of cases being asymptomatic [1–3]. This common problem has been linked to over manipulation or excessive length of the ureter and devascularization due to loss of periureteral fatty tissue [4].

To avoid renal deterioration it is crucial to repair these structures [5], and open, laparoscopic, and robotic reconstructive techniques have proven the most effective surgeries, with around 90% success rates [6,7]. However, reconstructive procedures entail significant technical difficulty and high morbidity, occurring in up to 33% of cases [8], prompting urologists to attempt endoscopic repair before turning to reconstructive surgery in many cases.

Among the techniques used in this setting is retrograde endoureterotomy with intraluminal invagination, first described by Lovaco et al. [9,10]. In this technique, a balloon is inflated in the stenotic area and pulled back in a retrograde manner, so that the stenotic area is intraluminally invaginated, revealing the intestinal diversion. In this way, the exact area to be cut is observed from the intestinal segment, while keeping this area apart from external structures such as intestines or blood vessels, which improves the safety of the procedure [9]. Interestingly, no results reproducing this technique have been published since it was first reported.

The main aim of this study was to present the outcomes of this procedure carried out in a center specialized in this surgery type. The secondary objective was to determine which factors influence the success or failure of the technique.

Materials and methods

Study design

A prospective observational study was conducted, comprising all data from endoureterotomies using Lovaco's technique performed in our center for ureterointestinal strictures between 2017 and 2020. Data was compiled consecutively as surgeries were performed, recording all relevant variables. All procedures were performed by the same urologist. This study was approved by the research ethics committees of

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Supplemental data for this article can be accessed here.

our center and all patients provided informed consent for prospective data collection.

Study population and registered variables

Inclusion criteria for the study were patients with intestinal diversion, diagnosed with ureterointestinal stricture requiring surgical treatment. No specific exclusion criteria were applied. In consensus with patients, our center protocol was to perform at least one endourological procedure for attempted stricture repair (endoureterotomy in all cases) before considering reconstructive technique. A total of 25 patients were recruited.

The variables recorded were sex, age, type of intestinal diversion, number of endoureterotomy attempts, procedural success or failure, affected side, preoperative serum creatinine levels, differential renal function estimated by nuclear medicine tests (MAG 3 renogram), time to stricture formation, type of energy source used in endoureterotomy, number of ureteral stent indwelling days in the postoperative period, indwelling nephrostomy at time of surgery, stricture length, months of follow-up, and postoperative complications. Stricture length was measured intraoperatively and recorded in consensus between the main surgeon and assistants. Mean hospital stay and surgical time were also calculated.

A successful procedure was defined as resolution of ureterohydronephrosis (total or minimal hydronephrosis) in imaging tests after endoureterotomy, maintained throughout follow-up. In bilateral cases, resolution of both strictures was required to define success.

Surgical technique

Patients received general anesthesia and were placed in a supine position, with 30° elevation of the affected side (Valdivia position). The patient with a Studer-type neobladder ($n = 1$) was placed in a modified lithotomy position with the elevation of the affected side (Galdakao-modified supine Valdivia position). In cases with previous urine culture, antibiotic prophylaxis was administered based on an antibiogram, whereas in its absence prophylaxis with cefuroxime and tobramycin was administered. Antibiotic treatment was maintained during admission and for up to five days after hospital discharge.

The first step of the procedure was to pass a guidewire through the stenotic area (Figure 1), which can be performed antegrade or retrograde (locating the neomeatus with a rigid cystoscope under direct visualization). Antegrade passage decreased endoscopy time. In antegrade access, once the guidewire was located in the intestinal segment under fluoroscopic control, it was extracted through the stoma (ileal conduit) or the urethra (neobladder), optimizing safety during the procedure.

Subsequently, a dilatation balloon was passed retrogradely along the guidewire and inflated in the stenotic area. Dilation under direct observation reduced fluoroscopy time. Once dilated, the balloon was pulled outwards, invaginating the stenotic area towards the intestinal segment, delineating the area to be incised (Figure 2). Besides marking the area to be treated, this maneuver also served to separate the area to be cut from intestines or blood vessels near the ureterointestinal junction.

Next, a cut was made in the 12 o'clock position of the stenotic area with either holmium laser or electrocautery (using a Collins knife) (Figure 3), ensuring that the incision reached healthy tissue for regeneration of the area from healthy tissue to fibrotic tissue (Figures 4 and 5). The cut was extended until healthy ureteral mucosa was visible, and until the balloon could be mobilized with ease, indicating that it had bypassed the stenotic area. Finally, the ureteral stent was placed and kept in place for between 4 and 6 weeks. Patients were discharged after 24 h if not presenting with fever, pain, or intense hematuria.

Statistical analysis

In line with the first study aim, we performed a descriptive analysis of all patient characteristics. Univariate analysis was used to determine the association of clinical and stricture variables with procedural success or failure. Given the small sample size, a non-parametric test, the Mann-Whitney U test, was used to compare means, while Fisher's exact test was used to compare percentages. In univariate analysis, one

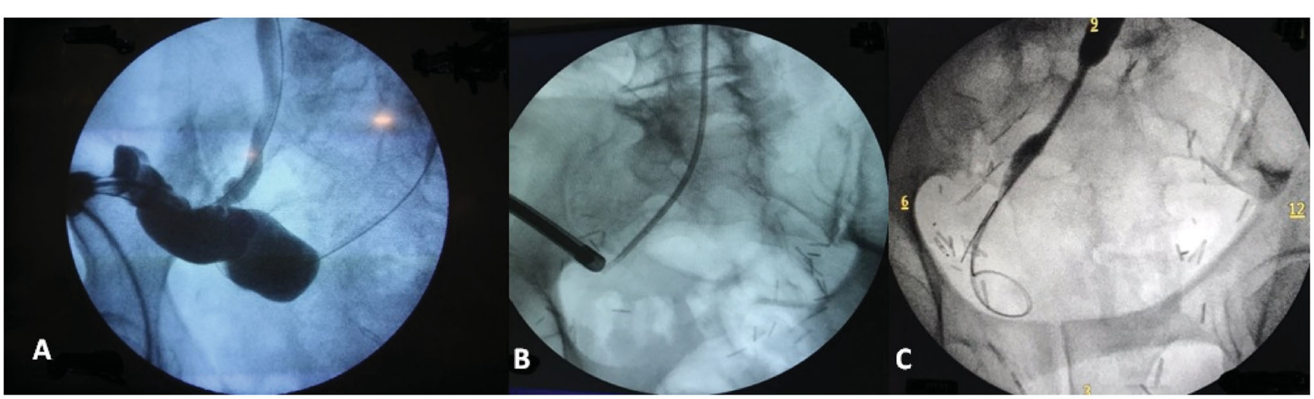

Figure 1. Fluoroscopic intraoperative images in three different cases. (A) Retrograde pyelography in a patient with an ileal conduit. Correct passage of contrast was verified to the right ureter, but not to the left where the stricture was located. (B) Patient with an ileal conduit. Union in the left neomeatus of the catheter introduced percutaneously and cystoscope. (C) Patient with Studer neobladder. Two-wire technique passed antegrade from the ureter to the neobladder.

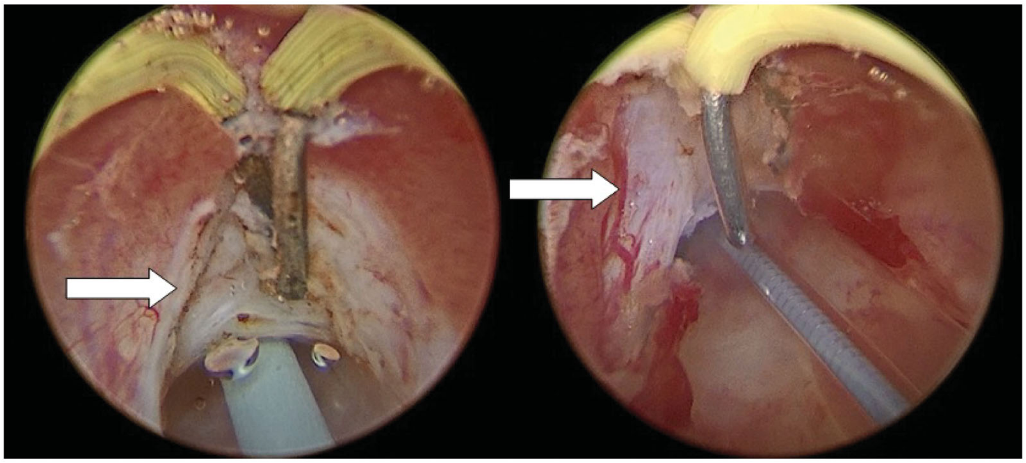

Figure 2. Balloon intraluminal invagination images. White arrows indicate the stenotic fibrotic area to be incised, mobilized with invagination.

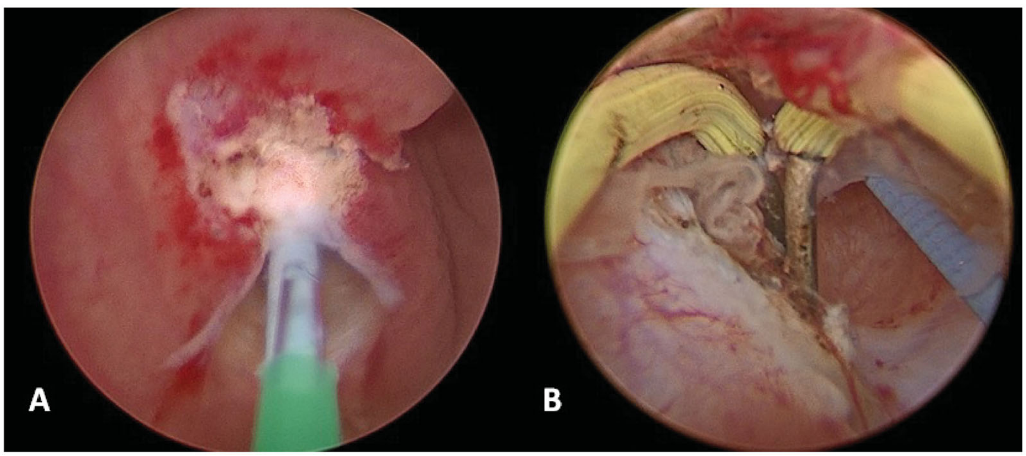

Figure 3. Examples of the two energy sources used in the study: holmium laser (A) and electrocautery (B).

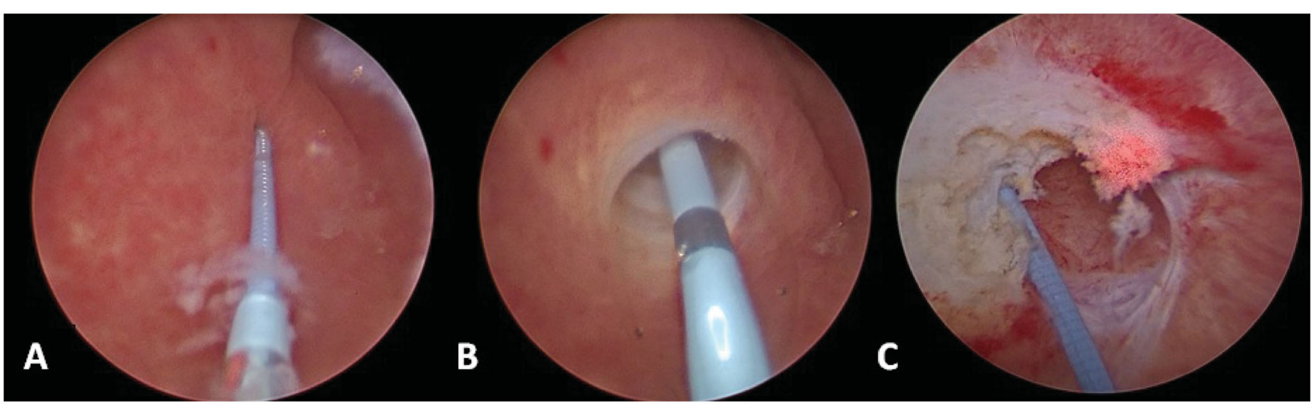

Figure 4. Endoscopic images of the procedure, both corresponding to the same patient. (A) The stenotic area was bypassed with the guidewire. (B) Endoluminal invagination with a balloon, pulling back the area to be cut. (C) Image taken after completed incision, showing the fibrous area incised with laser, and healthy ureteral mucosa at the back.

case was included for each stricture treated, making two records in bilateral cases or retreatments in the same neomeatus, each one with the characteristics of each ureter treated. Statistical significance was set at $p < 0.05$. SPSS version 20.0 software (IBM Corp., Armonk, NY, Released 2011) was used to carry out statistical analysis.

Results

A total of 25 patients were recruited. Patient distribution by stricture location and success rate in each group are shown in Figure 6. Mean hospital stay was two days and mean surgical time 50 min. In total, 48% of cases (12 patients) were

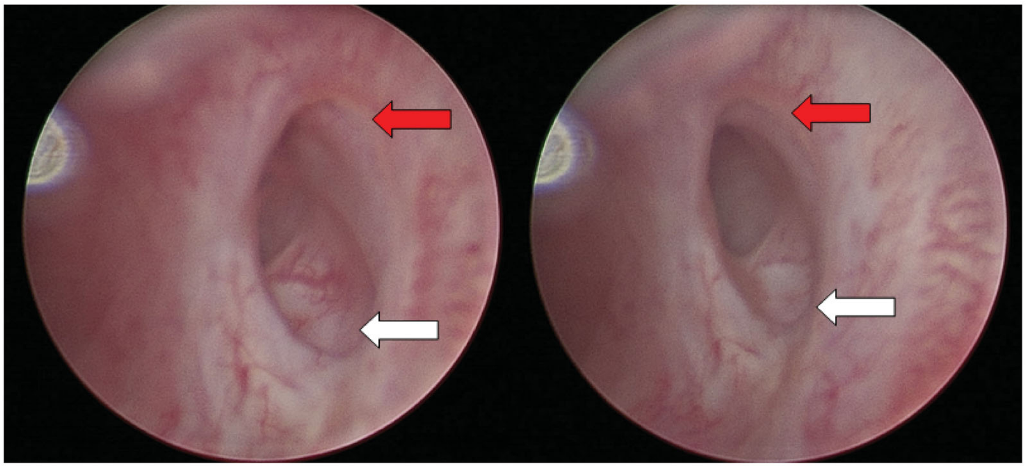

Figure 5. Two examples of previously incised neomeatus with successful endoureterotomy. Whitish areas of fibrosis can be seen to persist in the lower part of the neomeatus (incisions were made at the 12 o'clock position of the neomeatus), compared with complete re-epithelialization in the upper sides (red arrows).

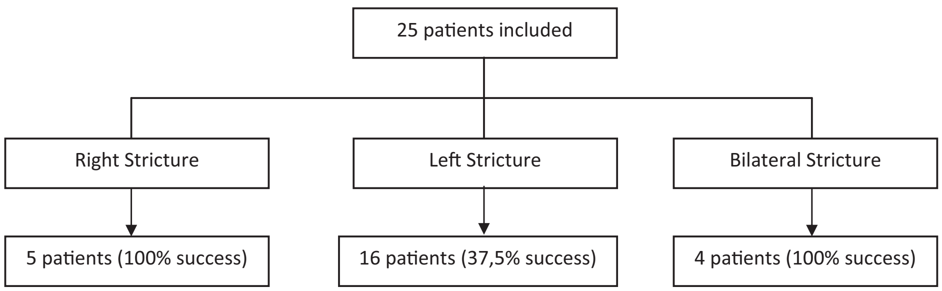

Figure 6. Flow chart of patient inclusion and endoureterotomy success rate according to stricture location.

resolved with a first endoureterotomy. If second endoureterotomies were also included, the success rate was 60% (15 patients). The obstruction was removed in three of the five cases with the second surgery. Accepting other criteria of treatment success, such as improvement in hydronephrosis, absence of pain or infection, or no need for a urinary catheter, the success rate would rise to 88%. Table 1 details the characteristics of the entire sample collected, and data for each individual case is detailed in Supplementary Table 1. Patient 3 had an indwelling left nephrostomy at the time of surgery. Following the patient's rejection of the second nephrostomy placement option, the alternative option of permanent ureteral catheter indwelling after surgery was jointly decided and maintained until the patient's death 10 months after endoureterotomy.

The type of intestinal diversion was the ileal conduit in all cases except for Patient 11 who had a Studer-type neobladder. Regarding energy sources, holmium laser was used in 17 cases and electrocautery in 13 cases. Turning to complications, all were infectious; of the 30 surgeries carried out, seven (23.3%) resulted in postoperative infection (all managed with hospital admission), three of which met the criteria for sepsis.

Follow-up was for a median of 20 months (range, 6–50). Across the entire sample, there was only one case of stricture recurrence (Patient 16), occurring after 12 months without hydronephrosis after endoureterotomy. The remaining outcomes remained stable (success or failure) throughout follow-up from the first imaging test to the last.

Table 1. Characteristics of the sample of patients undergoing endoureterotomy for ureterointestinal stenosis between the years 2017–2020.

Variable	Median (range)
Age (years)	68 (43–80)
Time to diagnosis (months)	5 (1–60)
Stricture length (cm)	1 (1–4)
	N (Percentage)
Gender	
Male	23 (92%)
Female	2 (8%)
Side	
Right	5 (20%)
Left	16 (64%)
Bilateral	4 (16%)
Number of endoureterotomies	
One	20 (80%)
Two	5 (20%)
Energy type	
Laser	17 (56.6%)
Electrocautery	13 (43.4%)
Complicactions	
None	23 (76.6%)
UTI	4 (13.4%)
Sepsis	3 (10%)
Result of surgery	
Success	15 (60%)
Failure	9 (36%)
Undefined	1 (4%)

cm: centimeters, UTI: Urinary tract infection.

In univariate analysis, shown in Table 2, we analyzed data from the 35 endoureterotomies performed across 30 procedures (including retreatments and bilateral cases). Cases with left-sided stricture were more frequent in the failure group, with reduced differential function in nuclear medicine tests

Table 2. Univariate analysis.

Variables	Surgery outcome: Success	Surgery outcome: Failure	*P*
Age, years (average ± SD)	64.2 ± 8.5	68.4 ± 7.1	0.18*
Side (*n* (%))			
Left	11 (52.4%)	12 (92.3%)	0.02**
Right	10 (47.6%)	1 (7.7%)	
Preoperative creatinine, mg/dL (average ± SD)	1.6 ± 0.8	1.3 ± 0.7	0.29*
Percentage of differential kidney function (average ± SD)	52 ± 21	31 ± 9	0.01*
Time to diagnosis of stricture, months (average ± SD)	13.6 ± 16.1	12.5 ± 20.6	0.10*
Type of energy			
Laser	13 (61.9%)	7 (50%)	0.36**
Electrocautery	8 (38.1%)	7 (50%)	
Ureteral stent time, days (average ± SD)	35.2 ± 16.2	30.9 ± 12.5	0.53*
Length of stricture, cm (average ± SD)	1.1 ± 0.3	2 ± 0.9	0.001*
Cystectomy approach			
Open	17 (81%)	13 (92.9%)	0.32**
Laparoscopic	4 (19%)	1 (7.1%)	
Nephrostomy indwelling at time of surgery			
Yes	15 (71.4%)	6 (42.9%)	0.09**
No	6 (28.6%)	8 (57.1%)	

Relationship between clinical variables and success or failure after endoureterotomy.
SD: standard deviation.
*Mann-Whitney's *U* Test **Fisher's Exact Test.

and greater stricture length: 2 (SD 0.9) cm in the failure vs. 1.1 (SD 0.3) cm in the success group.

Discussion

To our knowledge, the present study is the first since the 2005 Lovaco study of endoureterotomy with intraluminal invagination to reproduce the procedure and present outcomes with the same sample size as the original publication [9]. In our view, this surgery demonstrates significant advantages, such as performability without using flexible endoscopic material, additional safety provided by intraluminal invagination of the stricture, and the convenience of approaching the stricture from the wide space afforded by the intestinal diversion compared to antegrade access from the ureter. After 30 procedures and 35 endoureterotomies, the main weakness found in this technique is that in some cases (especially longer strictures) invagination towards the lumen is very limited as the perianastomotic area is well-adhered and firm. Despite not complicating the endoureterotomy itself, this reduces safety and visibility compared to cases in which optimal invagination is achieved.

With respect to procedural success, rates in our series are lower than the 80% reported by Lovaco. One explanation for this is that our study followed a stricter definition of success, only including cases in which hydronephrosis was resolved. In the Lovaco series, improvement in hydronephrosis, recovered normal daily life activities, absence of pain or infection, and no need for urinary catheter for renal diversion was accepted as indicators of success [9]. Applying these criteria to our series, the success rate would have been much higher, at 88%. Many of our cases undergoing nephrostomy surgery were catheter-free after endoureterotomy and remained asymptomatic, although without resolution of hydronephrosis. In these cases, and indeed generally in cases with asymptomatic ureterointestinal stricture and without repercussions, reintervention is not a widely accepted approach in many groups [11]. In our series, after each failed intervention all options (including repeat endoscopic treatment, reconstructive surgery, and continuing with conservative management) were evaluated with each patient to reach a joint consensus.

There are multiple case series of endoureterotomy for treatment of ureterointestinal strictures, showing success rates of between 30 and 100% [12–20]. However, these studies cannot strictly be compared either between each other or with our series: firstly, due to the great variety of techniques used, with different approaches (antegrade, retrograde, combined), energies (cold scalpel, Acucise™, laser, etc.) and balloon dilation techniques, but predominantly because of patient selection bias, including cases with diverse types of intestinal diversion, and especially with different stricture characteristics.

Our secondary study aim was to determine which patient and stricture clinical factors influenced the technique under analysis. Taking into account the possible limitations inherent to the small sample size, the factors found to be associated with endoureterotomy failure were longer stricture length, left side location, and worse differential renal function. Variables of length and differential function are well known to influence success rates, not only in ureterointestinal strictures but in benign ureteral strictures in general. Some authors have set thresholds of a maximum 1 cm stricture length and at least 25% differential function to attempt endoscopic treatment with some guarantee of success [21–24], the latter cutoff based on the theory that a poorly functioning renal unit has a greater risk of stricture recurrence given that less urine passing through the treated area increases the risk of a drier area, which favors recurrence. The main issue encountered regarding stricture length is the challenge of objective preoperative measurement. Although a variety of imaging tests are used, retrograde pyelography by injecting contrast through the intestinal diversion seemingly provides the most information on stricture anatomy and length. This test frequently permitted preoperative measurement of the stricture, yielding results coinciding with intraoperatively measured length, and can also be used to verify other findings such as strictures at other levels of the ureter, or ureter displacement from the intestinal loop. Accordingly, we recommend retrograde pyelography before planning an endoureterotomy in this setting.

Worse outcomes in left side strictures is a frequently replicated finding in other similar studies reporting endourological treatment outcomes in this setting [12,14–18,20], and can be explained by etiological factors of ureterointestinal strictures such as distal ischemia of the ureter or the need to perform a tension anastomosis. Although left ureter involvement is not a contraindication for endoureterotomy, patients should be informed of the lower success rates before making a decision.

The last two variables analyzed in the study are energy type and complications. Regarding energy source, it is worth underlining that Collins knife electrocautery outperformed laser in our series: first, because the laser can easily break the balloon, frequently requiring the use of several balloons during the same procedure and thus increasing surgery costs, and secondly, since the Collins handle allows mechanical traction of the area to be incised, thus facilitating visualization of the area being treated [19]. With respect to complications, our results show that they were all infectious in nature. Intestinal reservoirs are likely a great source of microorganisms colonizing this part of the urinary tract, so strategies such as requesting urine cultures prior to endoureterotomy seem prudent, as does maintain antibiotic treatment during the first few days after the intervention.

The main limitation of the present study is the relatively reduced sample size; nonetheless, as the technique under study is very specific and performed in only a few centers, recruiting large samples is complicated in this setting. The fact that all cases were collected in a single center and operated on by a single surgeon could be considered another drawback, although it might also be viewed as a strength in that it ensured that the results precisely reflect the success or failure of the technique, without being influenced by potential variations in surgeon experience. The follow-up time span in our series seems adequate given the above explained minimal changes in ureterohydronephrosis after treatment during the post-operative course.

Despite certain drawbacks, this study achieved its primary aims of reproducing the endoureterotomy technique with intraluminal invagination, verifying its success rate, and establishing factors of success and failure. The data provided herein may be useful to further disseminate this technique, which may help towards avoiding complex reconstructive surgeries with their associated high morbidity. Although several authors indicate endourological treatment only in elderly or comorbid patients, our findings could facilitate shared decision-making between physicians and patients as to the best therapeutic option in the ureterointestinal stricture setting; indeed, this procedure could even become considered a first-line therapeutic option, regardless of comorbidities or patient age.

In conclusion, the results in our series demonstrate that endoureterotomy with the Lovaco technique is a useful method in the ureterointestinal stricture setting, achieving complete resolution of the obstruction in around 60% of cases. Factors such as stricture length, poor renal function, and left side involvement negatively affect the success of the procedure.

Disclosure statement

No potential conflict of interest was reported by the authors.

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