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Technical Reports

Surgical Management of Pediatric Vesicoureteral Reflux: A Comparative Study Between Endoscopic, Laparoscopic, and Open Surgery

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Abstract

Aim: Our retrospective study compared the results of three surgical procedures for correction of pediatric vesicoureteral reflux (VUR): open Cohen, laparoscopic Lich-Gregoir reimplantation (LEVUR), and endoscopic subureteric injection (STING) procedure.
Methods: We analyzed 90 patients (50 girls, 40 boys, average age 4.86 years) operated in two centers of pediatric surgery for VUR. Exclusion criteria were Grade 1 VUR, Grade 5 VUR with megaureters requiring ureteral tapering, secondary VUR, and patients already operated for VUR. Thirty patients underwent Cohen, 30 LEVUR, and 30 STING procedure. Follow-up included renal ultrasonography and voiding cystourethrography 6 months postoperatively. The statistical analysis was performed using χ^2 Pearson and Fisher tests.
Results: Operative time was shorter using STING either for unilateral or bilateral correction ($P = .001$). Hospitalization was statistically shorter using STING and LEVUR compared to Cohen ($P = .001$). The pain scores were worse after Cohen ($P = .001$). Analgesic requirements were higher after Cohen ($P = .001$). Reflux persistence was higher after STING (10 cases versus 5 Cohen and 4 LEVUR). Cohen presented more complications compared to LEVUR and STING ($P = .001$). Intraoperative costs were higher for STING procedure ($P = .001$), while hospitalization costs were significantly higher for Cohen procedure ($P = .001$).
Conclusions: In children affected by VUR, open Cohen and LEVUR reported a higher success rate than STING procedure. However, Cohen procedure had a very long and painful hospital stay, more complications, more analgesic requirements compared to STING and LEVUR. Comparing the three techniques, it seems that LEVUR presents a high success rate similar to the Cohen procedure, but in addition, it presents the same advantages of STING procedure with no postoperative pain and a lower postoperative morbidity.

Introduction

Vesicoureteral reflux (VUR) represents one of the most significant risk factors for acute pyelonephritis in children.[1] The aim of any treatment in children with VUR is the prevention of renal injury, symptomatic pyelonephritis, or other complications of reflux that lead to renal scarring, with decreased renal function.[2–4] In recent years, the evolution of the surgical treatment recommendations permits to have several techniques and approaches available, starting from the classic open way using intravesical ureteral reimplantation according to Cohen or Politano, the endoscopic subureteric injection (STING) procedure, and recently, laparoscopic extravesical ureteral reimplantation according to Lich-Gregoir or LEVUR.[5–8]

In general, the choice of the therapy depends not only on the grade of reflux but also on ipsilateral renal function, bladder capacity and function, associated ureterorenal anomalies, age, compliance, parental preference, and surgeon's preference and experience.[9,10] Over the last decades, various surgical methods have been described to correct VUR in children. The Cohen, Politano-Leadbetter, and Lich-Gregoir procedures have gained the greatest popularity among the intra- and extravesical techniques used in daily practice.[11–14] Utilizing the same principle of lengthening the intramural ureter with a submucosal tunnel, all open surgical

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methods to correct VUR in children have been shown to be safe with few complications but may be associated with increased pain and length of hospital stay.[15–17] Minimally invasive procedures such as endoscopic injection of bulking agents and laparoscopic techniques have demonstrated equivalent good long-term results compared to open surgery.[18–20] With excellent success rates of greater than 90% reported with the current open techniques for antireflux surgery, many surgeons focus on the minimization of morbidity of the surgical procedure used for the treatment of VUR.[21] Proponents of the Lich-Gregoir technique embark on this surgical approach due to diminished postoperative pain and discomfort resulting from the elimination of postoperative catheter and drainage, as well as the avoidance of open cystotomy and trigonal dissection.[22,23]

The purpose of this article is to compare the results of the three different surgical techniques currently in use for the correction of VUR as follows: the open technique (Cohen), the endoscopic procedure (STING), and the laparoscopic extravesical ureteral reimplantation according to Lich-Gregoir (LEVUR).

Patients and Methods

We analyzed the records of 90 patients operated in two European centers of pediatric surgery in the period January 2012–June 2015 for primary VUR into a solitary collecting system.

Thirty patients had bilateral reflux. For this reason, a total of 120 ureteral units have been treated. Exclusion criteria were as follows: Grade 1 VUR, Grade 5 VUR with megaureters requiring ureteral tapering, secondary VUR, and patients already operated for VUR. We excluded also patients with concomitant significant anatomical abnormalities (e.g., large paraureteral diverticula, ectopic ureters, duplex systems) that could have changed the decision of surgery and the success rates as well.

We included patients with Grade 2–5 VUR not requiring ureteral tapering.

Among the 90 patients, there were 50 girls and 40 boys with an average age of 4.86 years (range 11 months–12 years) and an average weight of 18.5 Kg (range 6–59 Kg). We enrolled with retrospective method 30 patients for each group as follows: 30 patients operated using the intravesical open Cohen technique, 30 using LEVUR, and 30 using endoscopic STING procedure.

In STING group, 50% of patients had Grade 2 VUR and only 6.7% had Grade 5 VUR, while in Cohen group, 60% of patients had Grade 5 VUR and 0% Grade 2 VUR, and in LEVUR group, the majority of patients had Grade 3–4 VUR.

The procedures were performed by three expert surgeons from two different institutions.

All the patients were operated under general anesthesia. Patients who underwent STING and unilateral LEVUR procedures had no bladder catheter, ureteral stents, or drainage during the postoperative period compared to patients operated with Cohen technique. We preferred to leave a bladder catheter for the first 24 hours after surgery in patients who underwent bilateral LEVUR repairs.

In laparoscopy, we adopted a 5-mm 30° optic and two 3-mm trocars and the bladder was suspended to the abdominal wall using a transparietal stitch to better expose the vesicoureteral junction (VUJ). The distal ureter was isolated and dissected toward the VUJ. The peritoneum was incised to expose the muscular wall of the bladder and create a lateral tunnel. The ureter was placed in the newly created tunnel and the detrusor muscle was reapproximated.

As for the endoscopic procedure, we adopted the subureteric injection (STING) method in all patients. We used a 9.5-mm operative cystoscope. Under direct vision, a needle was introduced under the bladder mucosa, 2–3 mm below the affected ureteral orifice at the 6 o'clock position. The needle was advanced into the lamina propria in the submucosal part of the ureter and the bulking agent was injected. We used dextranomer/hyaluronic acid copolymer (Dx/HA) as bulking agent. We preferred it since it is easy to inject, is biodegradable with stable implant volume, and is currently the first-choice injectable agent due to its safety and efficacy.

As for the open Cohen procedure, all the patients received a classic Pfannenstiel incision and an open cystotomy was performed. A cross-trigonal tunnel was created bringing the ureter to the contralateral side, and a bladder catheter, a drain in the prevesical space, ureteral stents, and a vesicostomy tube were left at the end of the operation. We preferred to leave both a bladder catheter and a vesicostomy in the open group because in our experience, the bladder catheters were often obstructed due to hematuria. To avoid the formation of blood clots, we performed also washing of bladder with saline through the vesicostomy, above all in the first postoperative period.

Statistical analysis was carried out by using the Statistical Package for Social Sciences (SPSS, Inc., Chicago, IL), version 13.0. Significance was defined as $P < .05$. The categorical variables were compared using χ^2 Pearson and Fisher tests. The ordinal variables were compared using the Student's two-tailed type 2 *t*-test and nonparametric test, Kruskal–Wallis. Data are presented as average ± standard deviation (SD).

Follow-up evaluation (average 2.6 years) included clinical examination, renal ultrasonography, and voiding cystourethrography 6 months postoperatively in all the operated children.

The groups were compared in regard to operative time, hospitalization, duration of hematuria, postoperative discomfort and pain, analgesic requirements, reflux persistence, complications, and intraoperative and postoperative hospitalization costs.

The study received the approval of the ethics committee.

Results

Sixty patients received unilateral treatment (18 patients underwent STING, 22 patients underwent LEVUR, and 20 patients underwent Cohen reimplantation) and 30 patients received bilateral treatment (12 patients underwent STING, 8 patients underwent LEVUR, and 10 patients underwent Cohen reimplantation).

In regard to indications for surgery, 71 patients (78.8%) showed recurrent febrile urinary tract infections (UTIs) before surgery (1 episode minimum, 11 episodes maximum, 3.11 median ± SD 2.601), 58 patients (81.7%) presented with breakthrough UTIs despite the administration of continuous antibiotic prophylaxis (CAP), while 13 patients (18.3%) presented with UTIs soon after the interruption of CAP. The remaining 19 patients showed new renal scarring and/or a marked decrease in renal function (>20% compared to the

Table 1. Patients' Baseline Demographics

Average age at surgery (years)			4.86
Average weight (Kgs)			18.5
Male			40
Female			50
M/F ratio			0.8
	STING (n = 30)	*LEVUR* (n = 30)	*COHEN* (n = 30)
Grade 2 VUR	15 (50%)	5 (16.6%)	0
Grade 3 VUR	7 (23.3%)	8 (26.6%)	2 (6.7%)
Grade 4 VUR	6 (20%)	13 (43.4%)	10 (33.3%)
Grade 5 VUR	2 (6.7%)	4 (13.4%)	18 (60%)
Unilateral repair	18	22	20
Bilateral repair	12	8	10
Bladder dysfunction	4	1	2
Average follow-up (years)	2.7	2.9	3.1
Indications for surgery			
Breakthrough UTIs despite CAP	22	17	19
Breakthrough UTIs without CAP	4	5	4
Renal scarring at DMSA scan	4	8	7

CAP, continuous antibiotic prophylaxis; DMSA, dimercaptosuccinic acid; LEVUR, laparoscopic Lich-Gregoir reimplantation; STING, subureteric injection; UTI, urinary tract infection; VUR, vesicoureteral reflux.

function of contralateral kidney) at dimercaptosuccinic acid (DMSA) renal scan routine evaluation, and they were candidates for surgical correction of VUR. Dysfunctional voiding was diagnosed in 7 patients (4 underwent STING, 1 underwent LEVUR, and 2 underwent Cohen). These patients were typical ''infrequent voiders'' with an average number of three micturitions per day, and after surgery, they were instructed to practice frequent bladder emptying by voiding every 2 hours.

All patients' baseline demographics are reported in Table 1.

All the procedures were completed without intraoperative complications and no conversion to another type of procedure was performed. The follow-up varied between 1 and 5 years (average 2.7 years in STING group, 2.9 years in LEVUR group, and 3.1 years in Cohen group).

Operative time was statistically significantly shorter using STING compared to the other techniques either for unilateral (16.50 ± SD 2.013 minutes [STING] versus 95.50 ± SD 33.59 minutes [LEVUR] versus 109.35 ± SD 17.73 minutes [Cohen]; $P = .001$) or bilateral corrections (26.39 ± SD 5.013 minutes [STING] versus 128.60 ± SD 36.58 minutes [LEVUR] versus 149.15 ± SD 28.75 minutes [Cohen]; $P = .001$).

Hospitalization was statistically shorter using STING and LEVUR compared to Cohen (1.11 days ± SD 0.567 [STING] versus 2.41 days ± SD 0.867 [LEVUR] versus 12.58 days ± SD 4.263 [Cohen]; $P = .001$; Table 2).

None of the patients who underwent STING and unilateral LEVUR procedures had a bladder catheter during the postoperative period, while only 8 patients who underwent bilateral LEVUR repair had a bladder catheter for the first 24 hours after surgery compared to 27 patients operated with Cohen technique ($P = .001$). Analgesic requirements (paracetamol 15 mg/kg; tramadol 2 mg/kg) were higher after Cohen reimplantation compared to STING and LEVUR (4.83 days ± SD 2.87 versus 1.00 day ± SD 0.29 versus 1.30 days ± SD 0.59; $P = .001$; Table 2).

In Cohen group, we removed the drains on the sixth or seventh postoperative day beginning from the ureteral drains, and then the bladder catheter, the vesicostomy tube, and finally, the drain in the prevesical space were removed. Before removing the ureteral drains, we injected methylene blue dye in the ureteral drain, and then we closed it to verify the absence of ureteral edema if we observed the passage of the blue dye into the bladder. Sometimes, we repeated these tests with blue dye two to three times before removing the drains due to the edema of the reimplanted ureter, and this could explain the long hospitalization of the patients who underwent open Cohen procedure, although the average analgesic requirement was only 4.83 days.

We evaluated the postoperative comfort and pain in all patients of each group during the first postoperative day through the vascular analog scale (VAS) Numeric Pain Distress Scale[24], and we created three categories of comfort as follows: very good (0–3 VAS score), good (3–7 VAS score), and bad (7–10 VAS score). The objective pain and discomfort scores were worse after Cohen procedure ($P = .001$; Table 3).

In regard to postoperative complications, Cohen presented more complications compared with LEVUR and STING [11 (36.6%) versus 2 (6.7%); $P = .001$].

All complications except one were classified as II grade according to the Clavien–Dindo grading system[25]; in fact,

Table 2. Postoperative Management for Each Group

	STING	*LEVUR*	*Cohen*	*STING vs. LEVUR* (P)	*STING vs. Cohen* (P)	*LEVUR vs. Cohen* (P)
Bladder catheter	0	8 (26.6%)	27 (90%)	.001	.001	.001
Vesicostomy tube	0	0	23 (76.6%)	.001	.001	.001
Anticholinergic drugs	0	0	2 (6.66%)	ns	ns	ns
Analgesic requirements (days)	1.00 ± 0.29	1.30 ± 0.59	4.83 ± 2.87	ns	.001	.001
Operating time unilateral VUR (minutes)	16.50 ± 2.013	95.50 ± 33.59	109.35 ± 17.73	.001	.001	.049
Operating time bilateral VUR (minutes)	26.39 ± 5.013	128.60 ± 36.58	149.15 ± 28.75	.001	.001	.049
Hospitalization (days)	1.11 ± 0.567	2.41 ± 0.867	12.58 ± 4.263	.001	.001	.030

LEVUR, laparoscopic Lich-Gregoir reimplantation; STING, subureteric injection; VUR, vesicoureteral reflux.

Table 3. Postoperative Pain and Comfort Scores for Each Group Using VAS Scale

	STING (%)	*LEVUR (%)*	*Cohen (%)*
Very good (VAS score 0–3)	28 (93.3)	30 (100)	0
Good (VAS score 3–7)	1 (1.11)	0	6 (20)
Bad (VAS score 7–10)	1 (1.11)	0	24 (80)

LEVUR, laparoscopic Lich-Gregoir reimplantation; STING, subureteric injection; VAS, visual analog scale.

they resolved spontaneously or after medical therapy, without the need of a new surgical procedure. Only one patient who underwent Cohen was reoperated because of an acute ureteral obstruction in the postoperative period (3 days after initial surgery) [III-b grade].

As for postoperative UTIs, only four patients (4.4%) showed long-term recurrent UTIs, and they were treated with CAP, without significant difference from each group. Hematuria and stranguria occurred only after intravesical reimplantation ($P = .001$). Reflux persistence was higher after STING compared with LEVUR and Cohen (10 cases versus 5 Cohen and 4 LEVUR, $P = .001$; Table 4).

In addition, we analyzed both intraoperative costs (materials, labor, time) and postoperative hospitalization costs for all procedures, and we found that the intraoperative costs were significantly higher using STING compared to the other techniques ($P = .001$), and this difference was mainly related to the costs of the bulking agent used. The hospitalization costs were significantly higher after Cohen procedure ($P = .001$; Table 4).

Discussion

In the past 30 years, the therapeutic approach to children with vesicoureteral reflux (VUR) has undergone a dramatic evolution from mainly surgery, as soon as VUR was detected, toward a conservative approach with CAP, to a minimally invasive approach using endoscopic or laparoscopic approach, or to an active surveillance without prophylaxis in asymptomatic patients without infections.[3,9]

Analyzing the international literature, it is evident that the treatment selection and decision for treating VUR in a child is an individualized process.[3] As for currently available surgical approaches, there are the classic open approach using Cohen or Politano-Lead better ureteral reimplantation,[7] the endoscopic approach using bulking agents,[18] and the laparoscopic approach using extravesical reimplantation according to Lich-Gregoir[23,26] or laparoscopic intravesical reimplantation described by Yeung and Valla.[20]

Considering that there are scanty comparative reports in the international literature and considering that in our centers, we perform the three different approaches of open surgery, endoscopy, and laparoscopy, we decided to plan this study to compare the results of the three different techniques and to give more objective criteria when a surgical correction is indicated. As for the criteria of exclusion of this study, they are as follows: Grade 1 VUR for which there is no indication for surgery and Grade 5 VUR with megaureters in which ureteral tapering is necessary, and it is challenging and time-consuming to perform it laparoscopically. In addition, we also excluded patients already operated for VUR and patients with concomitant significant anatomical abnormalities (e.g., large paraureteral diverticula, ectopic ureters, and duplex systems) that could have changed the decision of surgery and the success rates as well. We decided to analyze several parameters in this study. Not only the success rate but also postoperative course, hospitalization, complications, and costs because we noted in our experience that there is a dramatic difference in postoperative period in regard to pain, discomfort, and need for drugs among the different techniques adopted. The first and more impressive result of our study is the difference in the postoperative period; in fact, patients who underwent endoscopy and LEVUR had a faster postoperative course, less pain, and shorter period of analgesic requirement compared with patients who underwent classic open surgery.

Table 4. Postoperative Complications and Outcome for Each Group

	STING	*LEVUR*	*Cohen*	*STING vs. LEVUR (P)*	*STING vs. Cohen (P)*	*LEVUR vs. Cohen (P)*
All complications	2 (6.66%)	2 (6.66%)	11 (36.6%)	ns	.001	.001
Fever	0	0	0	ns	ns	ns
UTIs	1 (3.33%)	1 (3.33%)	2 (6.66%)	ns	ns	ns
Bleeding	0	0	0	ns	ns	ns
Urinoma	0	0	1 (3.33%)	ns	ns	ns
Wound dehiscence	0	0	1 (3.33%)	ns	ns	ns
Recurrent abdominal pain	0	0	1 (3.33%)	ns	ns	ns
Urinary retention	0	0	1 (3.33%)	ns	ns	ns
Nausea/vomiting	1 (3.33%)	0	4 (13.3%)	ns	ns	.035
Reoperation	0	0	1 (3.33%)	ns	ns	ns
Acute ureteral obstruction	0	0	1 (3.33%)	ns	ns	ns
Stranguria	0	0	3 (10%)	ns	ns	ns
Hematuria	0	0	28 (93.3%)	ns	.001	.001
Reflux persistence	10 (33.3%)	4 (13.3%)	5 (16.6%)	.001	.001	ns
Intraoperative costs (Eur)	2.226	1.357	1.248	.001	.001	ns
Postoperative hospitalization costs (Eur)	1.057	1.854	6.953	ns	.001	.001

LEVUR, laparoscopic Lich-Gregoir reimplantation; STING, subureteric injection; UTI, urinary tract infection; ns, not significant.

Patients who underwent endoscopic injection and LEVUR had no bladder catheters, ureteral stents, or drains after surgery and no hematuria or bladder spasms, compared with the long and painful postoperative course of open surgery. We always preferred to leave a bladder catheter for the first 24 hours after surgery in patients who underwent laparoscopic bilateral reimplantation to avoid the risk of postoperative urinary retention reported in bilateral repairs. In fact, in our series, we had only one patient who underwent bilateral Cohen reimplantation who presented with postoperative bladder emptying difficulty, requiring temporary urethral catheterization postoperatively. LEVUR was not associated with bladder dysfunction as in open surgery, even in bilateral procedures.

Cohen procedure presented significantly more complications and higher morbidity compared to LEVUR and STING. In particular, patients who underwent open Cohen presented with hematuria, an important pain due to bladder spasms, urine leakages around the bladder, and needed a drain near the bladder. In addition, they sometimes presented with catheter or stent occlusion due to the hematuria. However, the majority of complications recorded in our series were classified as grade II according to the Clavien–Dindo grading system[25]; in fact, they resolved spontaneously or after medical therapy, without the need of a new surgical procedure. Only one patient who underwent Cohen was reoperated because of an acute ureteral obstruction [grade III-b].

Data concerning hospitalization and postoperative morbidity were all significantly better after endoscopy and LEVUR compared to open Cohen procedure. These data were also confirmed by the analysis of nurses' data; in fact, for patients operated with open technique, nurses were called for problems or pain more times per day compared to the assistance required by the patients who underwent LEVUR and endoscopy. In addition, the scores recorded using the VAS pain scale were worse after Cohen.

As for the length of surgery, endoscopy was statistically faster compared to open surgery and LEVUR either for unilateral or bilateral corrections.

As for the technical point of view, it seems that LEVUR is more technically challenging for the surgeons, it requires a skilled laparoscopic team and its learning curve is longer compared with the other two techniques. For this reason, it is necessary to start LEVUR experience with a mentorship period to well master all the details of the technique.[27] In our experience with LEVUR, our learning curve plateaued and our operative time decreased significantly after five to six cases. We still make a video recording of all of our procedures to allow the surgeons to be critical of their technique and permit further improvement. Moreover, these advanced laparoscopic procedures have very bad ergonomics for surgeons, and we recently published an article about this topic, in which it was demonstrated that surgeons, after this kind of procedure, take anti-inflammatory drugs to heal shoulder, back, and wrist pain.[28]

Analyzing the international literature, endoscopy seems to be more expensive compared to open surgery and LEVUR, and this aspect is linked to the high costs of the bulking agents.[29]

Responsible management of limited resources should be a factor in choosing among different acceptable choices. For this reason, we decided to analyze both intraoperative costs (materials, labor, and time) and postoperative hospitalization costs for all procedures, and we found that the intraoperative costs were statistically higher using STING compared to the other techniques and this difference was mainly related to the high cost of the bulking agents. The hospitalization costs were significantly higher after Cohen procedure and the difference was linked to the longer hospital stay.

Reflux persistence, as already reported in the international literature, was higher after STING compared to LEVUR and Cohen.[26] Analyzing the international literature, the success rate using open Cohen and LEVUR is higher than 95%, while the success rate of endoscopy after the first injection is about 75%–80%.[30] This is a key point because parents ask the surgeon mainly to heal their child and the other points of the technique are secondary aspects for them.[31]

We reported a 67% success rate with STING procedure. There are many factors that may affect the success of the procedure. Preoperative (patient selection), intraoperative (injection technique), and postoperative variables have been shown to correlate with treatment outcome such as the presence of a volcano, the injected volume of the bulking agent, the VUR grade, and the surgeon's experience. We believe that most failures are due to technical errors that can be avoided intraoperatively. The technique for injection (intraureteric, submucosal) and the means of determining the endpoint of injection (the creation of a mountain range rather than a mound) may be the most important of these factors. Postoperatively, failures may result from bulking agent displacement (most often caudal implant migration), disruption (bleb loss of material through a mucosal breach), or dissolution (decrease in implant volume). While technical failure can be avoided, the latter three mechanisms may be inescapable.

We reviewed the reports of patients with failure of STING procedure in our series, and we noted that all these patients had no identifiable Dx/HA implants by ultrasonography performed during follow-up.

Besides STING, many other methods of endoscopic injection have been described in the last few years as follows: the hydrodistention implantation technique (HIT) and then its modification, the double HIT, described by Kirsch in 2008, through which two tandem intraluminal ureteric tunnel injections are made.[32] This last method allows for relatively higher volumes of Dx/HA to be injected (1.5 cc/ureter, depending on ureteral hydrodistention grade) compared to STING, with a mean injected volume of 0.5 cc/ureter in our series. In 2012, Kalisvaart et al. reported that the double HIT leads to a 93% clinical and 93% radiographic intermediate/long-term success rate.[33] In our series, we have included only endoscopic treatments performed with STING procedure. In our mind, the high VUR persistence rate reported with STING is due to the technical limitations of this injection method in accordance with the other reports of the recent literature.[34]

Our results demonstrated that Grade reflux plays a key role in the choice of the surgical technique; in fact, in STING group, 50% of patients had Grade 2 VUR and only 6.7% had Grade 5 VUR, while in Cohen group, 60% of patients had Grade 5 VUR and 0% Grade 2 VUR. From this point of view, LEVUR seems to be handier since it was adopted in all grades of VUR.[35]

We have to also acknowledge that one limitation of our study is that the results may be skewed by the fact that the grade of VUR was four or five in 93% of the Cohen operation

group compared with the 27% in the STING and 57% in the LEVUR groups.

The results of our study demonstrated that in children affected by VUR, open Cohen and LEVUR reported a high success rate, better than STING procedure, in accordance with the current literature. Comparing the three techniques, it seems that LEVUR is superior to the other techniques in terms of success (versus endoscopic injection) and postoperative morbidity (versus Cohen reimplantation), with a painless postoperative period without hematuria. In addition, it offers a good choice in terms of intraoperative and postoperative costs, due to the short hospital stay and the use of reusable laparoscopic instrumentation and avoiding the high costs related to the use of the bulking agents.

In our opinion, it may be a good option for a surgical team to manage all three techniques and to adopt one or the other according to patient's condition with the possibility to associate, in case of bilateral VUR, an endoscopic procedure on the side, with the lower degree reflux, and a LEVUR procedure on the other side with the higher degree reflux.

Disclosure Statement

No competing financial interests exist.

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