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Lich-Gregoir Reimplantation Causes Less Discomfort than Politano-Leadbetter Technique: Results of a Prospective, Randomized, Pain Scale-Oriented Study in a Pediatric Population

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Abstract

Objective: There is a consensus that transvesical reimplantation is more appropriate in cases of bilateral vesicoureteral reflex (VUR). In contrast to that it is not yet clear which approach should be used in unilateral VUR. This prospective, randomized trial compared the benefits and drawbacks of the intravesical and extravesical techniques in terms of operative comorbidity.

Methods: Forty-four children (29 girls, 15 boys, mean age, 67.23 mo) with unilateral VUR were assigned to two groups: 22 patients underwent Lich-Gregoir reimplantation and 22 underwent the intravesical Politano-Leadbetter technique. Follow-up evaluation included renal ultrasonography and voiding cystourethrography (VCUG) 6 mo postoperatively. The groups were compared for operative time, duration of hematuria, upper tract dilation, discomfort and pain, analgesic requirements, voiding dysfunction, and reflux persistency.

Results: No child had persistent VUR. Contralateral °II VUR was noted in five patients without significant difference regarding the treatment ($p = 0.345$). It was transient in all cases. Operative time was shorter using the extravesical technique (66.73 min versus 79.28 min; $p < 0.0001$). Gross hematuria occurred only after intravesical reimplantation lasting 4.19 d ($p < 0.00001$). The objective pain score was worse after intravesical surgery ($p = 0.002$). Analgesic requirements were higher after the Politano reimplantation ($p = 0.039$).

Conclusions: Both unilateral extravesical and intravesical reimplantation definitively correct VUR. The mean operative time was significantly

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shorter using the Lich-Gregoir technique, which underlines its simplicity; additionally, gross hematuria can be avoided. Postoperative pain and bladder spasms were reduced using the extravesical approach. Consequently, it represents an effective surgical technique to correct reflux while operative morbidity is low. Therefore it is the method of choice in cases of unilateral VUR requiring correction.

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1. Introduction

Nephropathy with renal scarring and subsequent hypertension leading to end-stage renal disease is still the most concerning issue in vesicoureteral reflux (VUR) [1]. The purpose of any treatment is the avoidance of kidney damage. Conservative management using antibiotic prophylaxis is widely accepted [2]. It has recently been supplemented by refined endoscopic therapies [3]. Nevertheless open surgical ureteral reimplantation is the primary option in cases of breakthrough infections, reflux nephropathy, or accompanying anomalies (e.g. diverticula, ureterocele) because open surgery is considered the gold standard for definitive treatment of primary VUR [2]. Politano and Leadbetter introduced their technique and reported data on a series of children being treated by ureteroneocystostomy [4]. Lich and Gregoir devised the extravesical approach [5,6]. Currently, success rates between 95% and 98% for open ureteral reimplantation are guaranteed [7]. Both approaches are used routinely with similar success rates [8]. Recently, operative comorbidities and cost effectiveness have become principal issues in treating VUR. Treatment is further influenced by the increasing popularity of minimally invasive endoscopic techniques [3]. There has been excellent research on ureteral reimplantation trying to point out the particular advantages and disadvantages of each technique, but no prospective randomized study has compared safety and efficacy among the different procedures yet [8]. In the United States, ureteroneocystostomy has been the standard in definitively treating VUR, whereas in Europe and Canada extravesical techniques are popular as well [9]. There is a consensus that transvesical techniques are more appropriate in bilateral VUR [8,9]. In contrast to that it is not clear which approach should be used in unilateral VUR [8]. In addition there is no information available prospectively evaluating comorbidity.

The objective of this prospective study was to investigate the particular advantages and complications of the Lich-Gregoir technique as compared to the Politano-Leadbetter ureteroneocystostomy in unilateral VUR requiring open surgery. Most impor-

tantly we focused on patients' pain perception using an objective pain scale (OPS) and on demanded analgesics in the postoperative period.

2. Materials and methods

Forty-four children (29 girls and 15 boys; mean age, 5.5 yr; range, 8–110 mo) underwent ureteral reimplantation in this prospective, randomized trial. Informed consent and ethical approval was given in all cases. Reflux grades were II ($n = 18$), III ($n = 19$), and IV ($n = 7$) according to the International Reflux Study (Table 1) [1]. Conventional voiding cystourethrography (VCUG) including two fillings was used for evaluation; cycled fillings were done if ureteral ectopia was suspected. Mean age at initial diagnosis was 29.64 mo (6–75 mo). Six children had bilateral reflux (grade I in 2 and grade II in 4), which resolved during follow-up. Reflux persistency, breakthrough infections, complications due to antibiotics, progressive renal scarring, reflux nephropathy, and parental preference were considered as indications. Renal scans were performed in all patients of whom 19 revealed scarring. In cases of low-grade VUR (grade II) progressive scarring, breakthrough infections, and a deterioration of split renal function were decision criteria for open surgery to preserve kidney function. For study purposes preoperative and postoperative bladder function was evaluated by history and uroflowmetry with surface electromyography (EMG) in children with bladder control. Neurogenic bladder dysfunction, previous ureteral surgery (including endoscopic treatment), ureteroceles, double systems, posterior urethral valves, ectopic ureters, ipsilateral pyeloureteral junction-obstruction, and anatomic variations were exclusion criteria. Patients were randomized to extravesical ($n = 22$; mean age, 69.77 mo; range, 18–110 mo) or

Table 1 – Patient characteristics

	Politano-Leadbetter	Lich-Gregoir
Male ($p = 0.526$)	8	6
Female ($p = 0.526$)	14	16
Mean age (range)	62.14 months (8–110)	69.77 months (18–110)
Reflux grading ($p = 0.397$)		
I	0	0
II	8	10
III	9	10
IV	5	2
V	0	0
Dysfunctional voiding	5	7

intravesical reimplantation ($n = 22$; mean age, 62.14 mo; range, 8–110 mo; Table 1). The groups were comparable regarding reflux grade, gender, and age.

Surgery was done by two full-time pediatric urologists (J.O., C.R.) who equally performed both techniques. Caudal blocks were applied in children weighing <25 kg. The effectiveness of the block was tested intraoperatively, monitoring heart rate and blood pressure at the time of incision.

2.1. Extravesical technique [5,6,8]

A muscle-splitting inguinal incision is made and the perivesical space opened. The obliterated umbilical vessel is identified and suture ligated. The ureter is identified in the retrovesical space, bluntly dissected, and secured. Once the ureter is mobilized a detrusor incision is made in a cephalad direction in a 45° angle for a distance of 2–3 cm. The ureter is then laid in and the muscle is closed loosely over the ureter with interrupted, absorbable sutures. A urethral catheter remains in place for 48 h.

2.2. Intravesical technique [4]

Using a Pfannenstiel incision the bladder is opened. A retractor flattens the trigone. Ureteral dissection is performed. The ureter is inserted into the neohiatus and a submucosal tunnel is created. Then the distal ureter is sutured with absorbable sutures. Finally, the bladder is closed in two layers of absorbable running sutures. A suprapubic catheter was left for 48 h for urinary drainage. No ureteral stents or perivesical drains were used in either technique.

2.3. Postoperative management

To evaluate the painfulness of each procedure an objective pain scale (OPS) assessment was done postoperatively using a validated score system that is independent of subjective pain reporting by parents, the child, or medical staff [10,11]. Pain was assessed by monitoring blood pressure, crying, movement, agitation, verbal complaints, or body language of pain. Each variable contributed 0–2 points for a cumulative score between 0 and 10. A score of 4 normally indicates analgesic requirement [12]. OPS assessment was done in the afternoon of the day of surgery when the child had fully regained consciousness. The OPS score has been proven to be effective evaluating pain associated with pediatric urologic procedures [11]. Additionally, the relative demand for analgesics (opioids and diclofenac) was documented. Furthermore, the frequency of bladder spasms was documented. Bladder spasm was defined as a sudden onset of pain in the region of the bladder lasting for short periods of time when the child had been previously comfortable on the regular postoperative analgesia. For nonverbal children, bladder spasm was defined as a sudden onset of pain recognized by the parents and nursing staff when the child had been previously comfortable [13]. The duration of gross hematuria was observed in both groups. Evaluation of the voiding function after surgery was done by flow EMG. Residual urine was measured by automated three-dimensional ultrasound (Bladder Scan®).

Postoperative follow-up included ultrasound at 3 and 6 mo as well as repeat urinary cultures along with the individual patient's history. Control VCUG for study purposes was scheduled 6 mo after reimplantation. In older children we performed suprapubic VCUG, which is considered to be less traumatic [11]. Mean follow-up was 32 mo (range, 15–42 mo).

2.4. Statistical evaluation

Differences between the groups were analyzed using the Mann-Whitney U test and the χ^2 test for categorical data. Data are expressed as mean \pm SD with statistical significance considered at $p < 0.05$. A trend toward statistical significance was assumed if $p < 0.07$. SPSS for Windows 11.5 software (SPSS, Chicago, IL) was used for all analyses.

3. Results

Both groups were comparable regarding reflux grade ($p = 0.397$) and gender distribution ($p = 0.526$).

3.1. Reflux

Postoperative VCUG at 6 mo revealed no ipsilateral VUR in all cases, but contralateral reflux was apparent in five children, four of whom were operated extravesically (grade I, $n = 2$; grade, II $n = 2$) and only one case in the intravesical group (grade II) with no statistical significant difference ($p = 0.345$). Those children had follow-up VCUG 12 mo later. Contralateral VUR was always temporary and managed conservatively. Antibiotic prophylaxis was continued until a negative voiding cystogram was obtained. No reflux was seen 1 yr after reimplantation (Table 2). All patients with contralateral VUR originally had unilateral disease. No child with initially bilateral VUR experienced contralateral VUR.

3.2. Operative time and hospital stay

The Lich-Gregoir technique required a mean operative time of 66.73 min (± 6.9 min; range, 55–75 min), whereas ureteroneocystostomy took 79.24 min (± 9.68 min; range, 65–90 min), a statistically significant difference ($p = 0.0001$; Fig. 1). No intraoperative complications were encountered in any child. Postoperative retrovesical hematoma (3 \times 5 cm) was found in one girl after intravesical reimplantation but required no further surgical intervention. Transient hydronephrosis ($n = 4$) resolved in every child by 4 wk after surgery. No child required rehospitalization. Catheters were removed routinely 48 h after surgery.

Postoperative gross hematuria was observed subsequent to intravesical surgery at a mean of 4.19 d (± 1.17 d; range, 2–7 d), whereas no patient had

Table 2 – Summary of statistical data in both groups

	Politano-Leadbetter	Lich-Gregoir	p-Value
Operative time (min)	79.24 ± 6.9 (55–75)	66.73 ± 9.68 (65–90)	0.0001
VUR-recurrence (n)	0	0	1
Contralateral VUR (n)	1	4	0.345
Objective pain scale	5.6 ± 1.4 (2–8)	4.2 ± 1.2 (3–7)	0.002
Bladder spasm (n)	10 (45.5%)	3 (13.6%)	0.021
Diclofenac dose (mg)	88.7 ± 51.1 (12.5–200)	57 ± 29.8 (25–100)	0.039
Opioid dose (mg)	3.9 ± 5.4 (0–20)	1.4 ± 1.7 (0–20)	0.168
Gross hematuria (days)	4.19 ± 1.17 (2–7)	0	0.00001
Residual urine (ml)	15.71 ± 32.99 (0–100)	11.36 ± 19.95 (0–75)	0.7

Statistical significance considered, if $p < 0.05$. Mean ± SD (range).

gross hematuria after a Lich-Gregoir procedure ($p = 0.00001$; Fig. 2). This fact was directly linked to the duration of the hospital stay. Children returned home significantly ($p = 0.03$) earlier after extravascular surgery: Lich-Gregoir 89.45 h (± 10.94 h; range,

72–96 h) versus Politano-Leadbetter, 96 h (± 7.59 h; 72–120 h; Table 2).

3.3. Analgesics and OPS

Preoperative caudal anesthesia was achievable in 25 of 36 children (Politano, $n = 14$; Lich-Gregoir, $n = 11$; 69.4%). Another eight patients weighing >25 kg did not have caudal anesthesia. Both groups received comparable amounts of carbostesin: Lich-Gregoir, 7.86 ml (± 8.39 ml; range, 0–25 ml) versus Politano-Leadbetter 6.05 ml (± 5.34 ml; range, 0–15 ml), $p = 0.586$. Postoperatively, both nalbuphine (only in the recovery room) and diclofenac (ketorolac is not approved in our country) were used as analgesics. No adverse reaction was recorded. No anticholinergics were given. Following transvesical ureteroneocystostomy a mean of 3.9 mg (± 5.4 mg; range, 0–20 mg) of nalbuphine was administered, whereas after the extravascular approach only 1.4 mg (± 1.7 mg; range, 0–20 mg) was needed ($p = 0.168$). Diclofenac was applied in both groups. A mean of 57 mg (± 29.8 mg; range, 25–100 mg) was required subsequent to extravascular reimplantation being significantly ($p = 0.039$) less than after intravesical reimplantation (88.7 ± 51.1 mg; range, 12.5–200 mg; Fig. 3) Analgesic requirements are reflected by the objective pain scale and the relative incidence of bladder spasms. Postoperative bladder spasms occurred in 13.6% (3 of 22) of the patients undergoing extravascular surgery as compared to 45.5% (10 of 22) after intravesical repair, a statistically significant difference ($p = 0.021$; Fig. 4). This difference is corroborated by the objective pain scale measurements. Those children who had extravascular surgery displayed a significantly ($p = 0.002$) lower mean OPS score of 4.2 (± 1.2 ; range, 3–7), whereas a score of 5.6 (± 1.4 ; range, 2–8) was noted after intravesical procedures, reflecting more subjective pain perception (Fig. 5). Nevertheless both techniques exceeded the OPS threshold of 4 normally indicating analgesic requirements (Table 2).

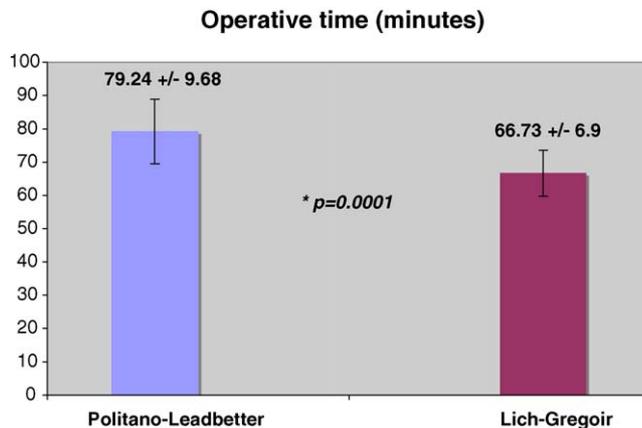


Fig. 1 – Statistical analysis of the mean operative time in minutes ± SD (* denotes statistical significance; Mann Whitney-U-test).

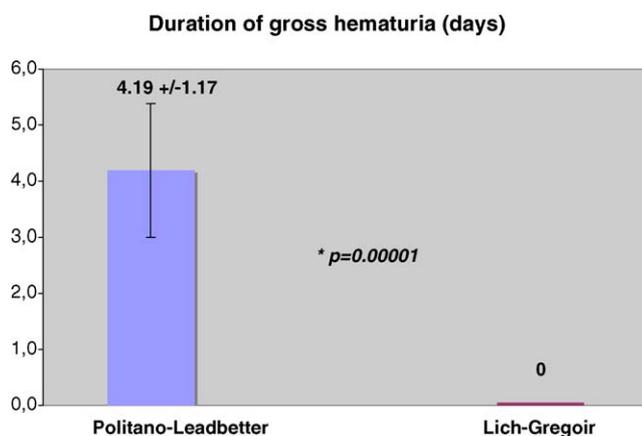


Fig. 2 – Relative duration of gross hematuria in days ± SD (* denotes statistical significance; Mann Whitney-U-test).

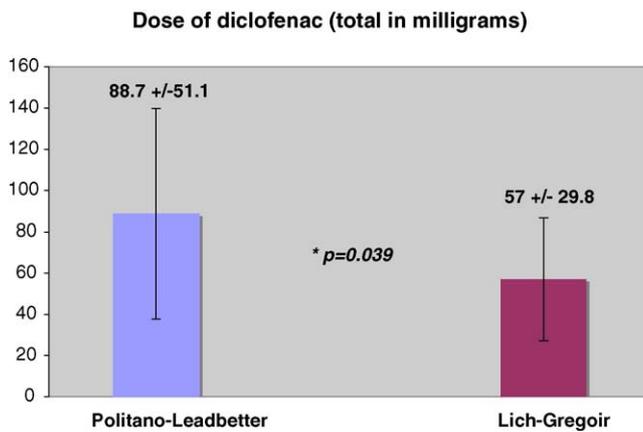


Fig. 3 – Mean dose of diclofenac in milligrams \pm SD (* denotes statistical significance; Mann Whitney-U-test).

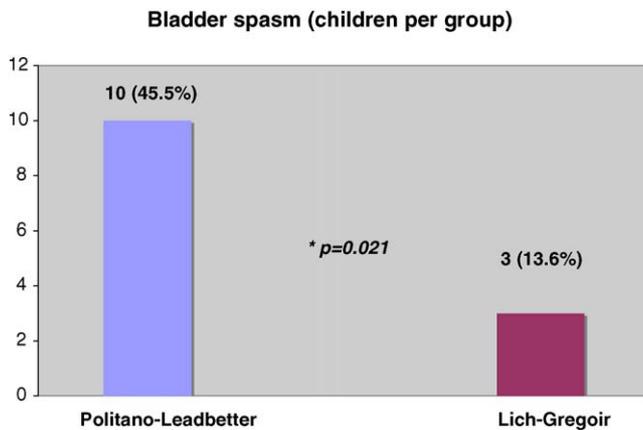


Fig. 4 – Absolute (relative) number of children per group with postoperative bladder spasms (* denotes statistical significance; Chi-Square-test).

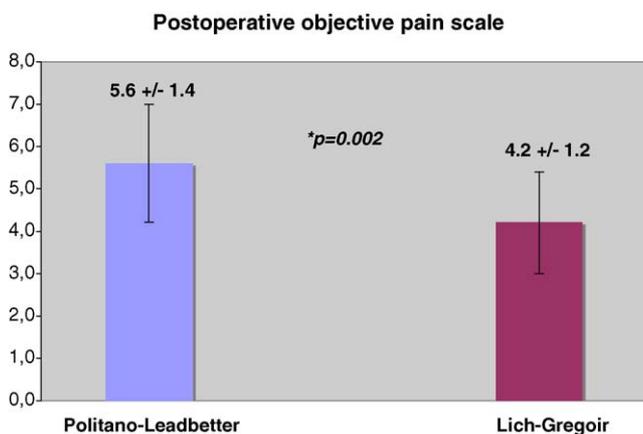


Fig. 5 – Statistical analysis of the mean objective pain scale \pm SD (* denotes statistical significance; Mann Whitney-U-test).

3.4. Bladder function

Postoperative residual urine after catheter removal was comparable between both groups ($p = 0.7$): Lich-Gregoir 11.36 (± 19.95 ; range, 0–75) versus Politano-Leadbetter 15.71 (± 32.99 ; range, 0–150). Preoperative flow EMG revealed voiding dysfunction in seven patients but in only five children postoperatively. Consequently, normal voiding efficiency is preserved using both techniques. Afebrile cystitis with positive urine culture was noted in a total of three patients within 1 yr postoperatively; all those children had transvesical surgery. No patient suffered febrile urinary tract infections or pyelonephritis.

4. Discussion

Both extravesical and intravesical reimplantation are excellent surgical procedures to correct VUR definitively [8,9]. Current data suggest overall success rates for open surgical reimplantation between 95% and 98% covering all reflux grades and associated anomalies [8]. In the United States, intravesical ureteroneocystostomy has been more popular for unilateral VUR [8,9], whereas the extravesical approach is generally accepted in Europe and Canada [8,14,15]. Many studies have elaborated the particular advantages and pitfalls of these techniques retrospectively [8,14,15], but no prospective randomized trial has compared safety and comorbidity between these two procedures [8].

Generally, transvesical surgery is considered to be more invasive than the extravesical approach [8,14,15]. The bladder has to be opened and the ureterovesical junction is dissected dividing the ureter's trigonal attachment. Gross hematuria is a typical postoperative feature sometimes requiring extended monitoring and prolonged catheterization [8,15]. This is avoided using the Lich-Gregoir technique. We observed a mean duration of gross hematuria of >4 d, whereas no child had hematuria in the Lich-Gregoir group. Bladder incision is also thought to be responsible for the occurrence of postoperative pain and bladder spasms [13]. Others have previously pointed out that extravesical reimplantation creates fewer episodes of bladder spasm and is less painful than transvesical techniques [15]. Up to 62% of all children with transvesical surgery experience an average of three bladder spasms [13]. This recent prospective trial did not note a significant effect of any catheter variable or postoperative analgetic protocol on the number of spasms experienced [13]. It is supposed that the

type of surgery influences the incidence of spasm episodes [13]. Extravesical reimplantation yields a lower incidence of bladder spasms [15]. In our study bladder spasms occurred significantly less frequently after the Lich-Gregoir reimplantation (13.6% versus 45.5%). Others emphasized that suprapubic catheterization causes less pain and discomfort than urethral catheterization due to reduced bladder neck irritation. Those patients who experienced both preferred the suprapubic catheter, implying that the suprapubic route is to be preferred [16–18]. Hence, the group with suprapubic drainage even seems to be in favor.

Postoperative pain perception and analgesic demand are linked to the relative abundance and intensity of bladder spasms influencing the length of hospital stay [13,15,17]. Others have shown that extravesical procedures require less pain medication and anticholinergics postoperatively, which allows early hospital discharge. This study particularly focused on bladder spasms, subjective pain perception, and analgesic demands. The pediatric objective pain scale is efficient for evaluating pediatric urologic procedures [11]. It was demonstrated that the patients in the Politano group (OPS score, 5.6) experienced significantly more pain than those in the Lich-Gregoir group (OPS score, 4.2). Nevertheless both exceeded the OPS threshold of 4 that indicates pain medication requirements [12]. For this reason an optimal pain control regimen has to be provided after each type of reimplantation surgery. Modern pain control using caudal anesthesia has reduced the relative need of analgesic drugs in pediatric surgical procedures but still most children require additional medication for pain control [8,13,17]. According to the different OPS results also the relative analgesic demand was different in both groups. Those children who underwent intravesical surgery demanded significantly more pain medication than those who had extravesical reimplantation even though all patients had comparable amounts of local anesthetics for caudal block. Other authors have reported similar findings [8,15]. Extravesical surgery is less painful than transvesical approaches. Consequently, some authors advocate day surgery in unilateral cases [18]. Day surgery is difficult to achieve in our Alpine environment with remote regions and little medical infrastructure. Hence, most of the hospital data provided in the study indicate longer stays than reported in the literature [17]. We conclude that lengthy hospital stays in our population are more a consequence of insurance modalities and lack of cultural acceptance than of medical considerations. Most authors agree that transvesical reimplantation

is more appropriate for bilateral VUR [8,14,15]. Bilateral extravesical surgery is associated with transient voiding dysfunction and urinary retention in up to 15% sometimes requiring intermittent catheterization [8,19–21]. Others have advocated staged procedures, which are limited by additional anesthesia [8,14,15]. Unilateral Lich-Gregoir is equal to intravesical techniques that do not cause deterioration of bladder emptying [22]. In our study postoperative residual volume and flow EMG data representing voiding dysfunction were comparable in both groups. Unilateral extravesical reimplantation does not impair bladder function.

Extravesical techniques are considered to be surgically simple and less time consuming. As in our study most groups noted significantly shorter operating times using the Lich-Gregoir technique, which reflects its relative simplicity [8,14,15,18]. Extravesical reimplantation can also be used in duplex systems and associated bladder diverticula without compromising postoperative success [8]. Additionally, severe complications such as bowel injury occur very rarely and are more frequently encountered using the Politano method. Neohiatus formation is especially considered a hazardous maneuver [8].

Mild postoperative hydronephrosis occurs in 6–7% of all patients but is transient in almost all cases, with <1% requiring surgical revision for obstruction [7,8].

Contralateral VUR after unilateral reimplantation remains an unsolved problem. Up to 22% de novo contralateral reflux has been reported in the literature [23]. Different etiologies have been discussed, including a pop-off mechanism and trigonal distortion due to ureteral preparation [8]. Others postulate a failure to detect contralateral reflux preoperatively because of its intermittent nature [8]. The method of surgery does not influence the relative incidence of contralateral VUR [8,23]. In our study both techniques had a comparable incidence of contralateral VUR. Some surgeons have argued about exposure of the contralateral ureteral orifice in extravesical surgery because they routinely reimplant the contralateral ureter if the appearance of the orifice is reflexive [24]. Nevertheless this issue is a subject of intensive discussion because the appearance of the orifice does not correlate with the incidence of VUR [8]. Diamond et al. found that the contralateral orifice appeared normal in all patients; altogether they noted contralateral VUR in up to 22% [23]. Additionally, spontaneous resolution of new-onset contralateral VUR is as high as 100% until 14 mo postoperatively [25]. We found similar rates in our study; a total of five children had low-grade

contralateral VUR that spontaneously resolved at 12 mo. Burno et al. concluded that children should not be offered bilateral repair because VUR will most likely disappear [25]. They even included cases that had formerly had bilateral reflux. A significant percentage of children will undergo an unnecessary procedure. The risk to which the ureter is exposed needs to be weighed against the benefits in trying to prevent this relatively infrequent and often temporary complication, most importantly because there are no hard criteria to identify those at risk of developing contralateral VUR [8]. Initial conservative management of contralateral reflux is reasonable because resolution rates are up to 100% [8,25].

In the treatment of unilateral VUR Lich-Gregoir ureteral reimplantation is superior to the Politano-Leadbetter technique. It is effective, simple, and less painful and requires shorter hospital stays and significantly fewer analgesics.

5. Conclusion

Extravesical and intravesical ureteral reimplantation are good options to treat VUR, with success rates of up to 98% [8]. Nevertheless dismembered transvesical ureteroneocystostomy is more invasive and subjected to more comorbidities than extravesical reimplantation [15]. Those children who had transvesical surgery experienced more postoperative pain and required more analgesics. Particularly, bladder spasms that cause substantial discomfort occurred more frequently. Nonetheless, it is emphasized that a standardized pain management protocol is mandatory after any open ureteral surgery. Moreover, the extravesical repair is a rather simple technique that require less operative time, has a shorter hospital stay, and avoids gross hematuria. The extravesical approach is also an option for duplicated systems and associated diverticula [8]. Furthermore, bladder emptying is equally good when both surgical techniques are compared [22]. Extravesical reimplantation creates less pain and fewer comorbidities than transvesical surgery. It should be the method of choice in cases of unilateral VUR requiring open surgery. Transvesical reimplantation should be reserved for cases of bilateral VUR.

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