OPEN AIMJ ORIGINAL ARTICLE

Laparoscopic Versus Open Transvesical Ureteric Reimplantation for Correction of Vesico-Ureteral Reflux in Children, A comparative Study

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Received *for publication December 20, 2021;* ***Accepted*** *April 16, 2022;* ***Published online*** *April 16,2022.*

doi: *10.21608/aimj.2022.112163.1738*

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ABSTRACT

Background: the retrograde flow of urine from the bladder into the upper urinary tract is known as vesicoureteral reflux (VUR).
Aim of The Work: to compare laparoscopic and open transvesical ureteral reimplantation for the VUR correction in children as regards the average surgery time in minutes (from the beginning of the skin incision to the finish of the wound closing), hospital stay in hours, complications, successful rate, recurrence rate, and follow-up by ultrasound every 1 month, Voiding cystourethrogram (VCUG) every 3 month and DMSA scan after 6 month.
Patients and Methods: This is a prospective comparative study between laparoscopic and open transvesical ureteric reimplantation for the correction of VUR in pediatric patients. It was done at Pediatric Surgical Department, Al-Azhar University Hospitals, and others Governmental and Private Hospitals over a period of 2 years. This study was done on (20) children.
Results: Urinary extravasation and growth hematuria varied significantly between the groups. Thus, they were significantly more common in Group B than in Group A.
Conclusion: : In unilateral and bilateral VUR, the minimally invasive laparoscopic method has a comparable rate of success to open surgery. The laparoscopic method decreases the need for pain medication after surgery and allows for a quicker return to normal activities. Keep in mind the neuroanatomy of the bladder, ureters, and VUJ for this approach. The limitation of our study, further comparative studies with larger sample sizes were needed to strength the present results

Keywords: *Laparoscopic; Versus Open Transvesical Ureteric Reimplantation; Vesico-Ureteral Reflux; Children, A comparative Study.*

Disclosure: *The authors have no financial interest to declare in relation to the content of this article. The Article Processing Charge was paid for by the authors.*
Authorship: *All authors have a substantial contribution to the article.*

INTRODUCTION

The retrograde flow of urine from the bladder into the upper urinary tract is known as vesicoureteral reflux (VUR). It is the outcome of a number of abnormalities relating to the ureter's functional integrity, bladder dynamics, and the anatomic structure of the ureterovesical junction (UVJ). The clinical manifestation varies, although the majority of patients are asymptomatic (hydronephrosis) or have pyelonephritis. Medical and surgical treatments are the two types of treatment options available. [1]

There are many methods for treating VUR today, including monitoring programmes with or without antibiotic prophylaxis, endoscopy, laparoscopy, and open methods. Surgical correction to eradicate VUR is a critical component of treatment.[2]

Intravesical or extravesical procedures for the VUR correction were documented with a high rate of success. In terms of the intravesical technique, the Ledbetter-Politano and Cohen procedures are the most prevalent ureteral reimplantation techniques, with a rate of success of 97–99%. [3]

In the open surgical treatment of VUR, the Cohen approach has historically been regarded as the "gold standard." This procedure has the natural outcome of putting the ureteric orifice across the midline of the trigon, potentially rendering future accessibility to the ureteric orifice more challenging than if it stayed lateralized.

Because the Glenn-Anderson procedure does not need the ureteric orifice to be placed contralaterally, future ureteric orifice accessibility is unlikely to be complicated.[4]

For a variety of pediatric urological disorders, laparoscopic surgery has largely supplanted open surgery. Minimally invasive surgical methods utilizing such approaches have been demonstrated to be beneficial in the treatment of VUR in children.[5]

In the realm of pediatric urology, transvesicoscopic ureteral reimplantation is rapidly substituting the open extravesical method. Reduced postsurgical bladder spasms, reduced incisional blood loss and pain, and better aesthetics are also significant

advantages. In 2005, laparoscopic techniques with CO2 bladder insufflation (pneumovesicum) were launched as minimally invasive treatments.[6]

This work aimed to compare laparoscopic and open transvesical ureteral reimplantation for the correction of VUR in children as regards the mean operative time, hospital stay, incidence of complications, successful rate, and recurrence rate.

PATIENTS AND METHODS

This was a prospective comparative study between laparoscopic and open transvesical ureteric reimplantation for the correction of VUR in pediatric patients. It was done at the Pediatric Surgical Department, Al-Azhar University Hospitals and other government and private hospitals over a duration of two years from December 2019 to December 2021. This research was done on (20) children. All patients had a thorough medical history and physical examination, as well as an ultrasonography, a Voiding cystourethrogram (VCUG), and a nuclear renal DMSA scan.

Inclusion criteria: Primary VUR Grade III, IV or V, both sexes and age from 1 to 18 years.

Exclusion criteria: Grade I & II VUR, secondary VUR and recurrent cases.

Patients divided into two groups (A&B) randomizedly selected by closed enveloped method. Ten patients submitted to Laparoscopic Transvesical Modified Glenn-Anderson Ureteric Reimplantation **Group (A)** and remaining 10 patients submitted to Modified Open Transvesical Glenn-Anderson Ureteric Reimplantation **Group (B)**.

Patient data:

Ten patients (3 male, 7 female) with mean age 5.10 ± 1.37 years were included in group (A), other 10 patients (6 male, 4 female) with mean age 4.30 ± 1.62 years were included in group (B), as **(table 1).** Clinical presentation was fever and recurrent UTI in all cases involved in group (A), 8 patients were presented with fever, UTI and 2 patients were diagnosed antenatally by hydroureteronephrosis in group (B). Five cases were bilateral, 3 cases were unilateral right sided, and 2 cases were unilateral left sided in group (A), 2 cases were bilateral, 3 cases were unilateral right sided, and 5 cases were unilateral left sided in group (B**),** as **(table 2).** Three cases were grade III, 4 cases were grade IV, and 3 cases were grade V in group (A), 2 cases were grade III, 4 cases were grade IV and 4 cases were grade V in group (B), as **(table 3).** The mean diameter of the ureter was 18.51 ± 4.32 mm in group (A), and 18.16 ± 4.54 mm in group (B), as **(table 4).**

Surgical technique:

Group (A): Following general anaesthetic and endotracheal intubation, the patient was positioned in a low lithotomy posture, allowing the surgery to begin with cystoscopy. The camera was positioned near the foot end, while the surgeon stood at the head end for young children as well as on the left side for bigger children. Under cystoscopic supervision, the bladder was filled with saline as well as a suture was introduced percutaneously at the bladder dome above the site of the proposed camera port installation. With saline bladder distension, the first port (for the camera) was put under cystoscopic view. A urethral catheter was placed, and CO2 bladder insufflation (pneumovesicum) was initiated at a pressure of 8 to 10 mm Hg. Under CO2 pneumovesicum, endoscopic visualisation of the bladder's interior has been established. Endoscopically, two 3-to 5-mm functioning ports are subsequently placed at the bladder's lateral walls. A percutaneously passed staying suture was used to attach every port to the bladder as well as the wall of the abdomen and was used to seal the port site when the operative procedure was completed. To aid with ureteral mobilisation and dissection, ureteric orifices have been cannulated with a 4- or 6-Fr feeding tube (Figure 1B). Laparoscopic tools with a diameter of 3 mm are generally employed **(Figure 1A).** The diathermy hook and laparoscopy scissors were used to mobilize the ureter with sharp and blunt dissection. The ureter was mobilized into the intravesical space for a length of 2 to 3 cm, with extra care made to prevent damaging the ureter's vascularity **(Figure 1C).** The ureteral hiatus then closed using interrupted 4-0 or 5-0 polydioxanone sutures. Using hook electro cautery, a muscular groove from the hiatus to near the neck of the bladder was prepared **(Figure 1D).** The site of ureteroneocystostomy is usually chosen to extend to a point above the bladder neck. A mobilised ureter is dragged into the muscular groove, and a ureteroneocystostomy is conducted with a ureteral stent for 4 to 6 weeks (Figure 1E). The stay sutures at the port entrance sites have been knotted to prevent urine extravasation following the ports have been removed, and absorbable skin sutures have been applied. Drainage of the urethra with a catheter has been needed for 24 to 48 hours, **(Figure 1F).**

Group (B) The patient was positioned in a low lithotomy posture following general anesthesia and endotracheal intubation, allowing cystoscopy to begin. A Pfannenstiel incision was made, and then the bladder was opened to expose the vesicoureteral junction. The opening of the ureter was found and a stent was implanted (Figure 2A). A circumferential incision was made around the opening of the ureter, the distal ureter was dissected proximally, and ureteral mobilization was performed (Figure 2B), and a muscular groove emerged from the original mucosal hiatus and prolonged to a point marked superior to the bladder neck. The muscular groove should be 4 or 5 times as long as the ureter width. Through the groove, the ureter is transferred. The muscular groove then sutured circumferentially with running absorbable sutures, **(Figure 2C).** Then bladder was closed, **(Figure 2D).**

Modification of Glenn-Anderson include: One or two interrupted 5/0 absorbable sutures were used to seal the detrusor defect in the ureteral hiatus and the ureter's seromuscular layer. Hook electrocautery was used to create a muscular groove from the hiatus to near the bladder neck. Where necessary, the terminal part of the ureter is resected to a sufficient length. For better fixation, the neoureteral opening's tip was sutured to the groove's end. A 5/0 absorbable running

suture was used to seal the mucosal layer above the muscular groove.

Post-operative: The main outcome comparative measurements of this study included the average operating duration in minutes (from the beginning of the skin incision to the conclusion of wound closing), hospital stay in hours, complications, rate of success, recurring rate, and follow-up by ultrasound every 1 month, Voiding cystourethrogram (VCUG) every 3 months, and DMSA scan after 6 months. In both groups, the rate of success was defined as the lack of recorded febrile UTI or the lack of VUR recurrence as objectivized by VCUG.

Ethical Consideration: Al-Azhar University's Ethical Research Committee considered and accepted the protocol for clinical study. The patient and his family have been given a thorough explanation of the study's procedures and goals. Before being enrolled in the study, written consent was sought. The patient is not denied medical care because his or her family refuses to grant consent.

Statistical Analysis:

SPSS 24.0 for Windows was used to collect, tabulate, and statistically analyze all of the data (SPSS Inc., Chicago, IL, USA). The Shapiro-Walk test was performed to determine if the data had a normal distribution. Frequencies and relative percentages were used to represent qualitative data. To calculate the difference between qualitative variables, the chi-square test ($\chi 2$) and Fisher exact were employed. For parametric data, mean ± SD was employed, and for non-parametric data, median and range were used. For parametric and non-parametric variables, the independent T test and Mann-Whitney test were employed to calculate the difference between quantitative variables in two groups. All statistical comparisons have been two-tailed, with a P-value of ≤ 0.05 indicating a significant difference, $p < 0.001$ indicating a highly significant difference, and $P > 0.05$ indicating a non-significant difference.

RESULTS

All procedures have been successfully completed. One patient (unilateral left sided) was converted to open surgery because of small bladder capacity. For comparison of Group A and Group B during and after operation (Table 5&6), Operative time of group A was longer than group B (P< .002) on unilateral cases (104.8 ± 3.96 versus 74.38 ± 4.14), and on bilateral cases (170.4 ± 7.96 versus 139 ± 1.41). Intraoperative blood loss was less in group A about (10.57 ± 2.61versus 21.48 ± 5.33), postoperative gross haematuria developed only in one case in group A while the gross haematuria developed in 6 cases in group B (1/10 versus 6/10), regarding the incidence of wound infection, there was no wound infections in group A and one case developed wound infection in group B (0 versus 1/10). Urinary extravasation developed in 2 cases in group B and no cases developed urinary extravasation in group A (0 versus 2/10), regarding the incidence of urinary tract infection there was one case in group B, while there have been no cases in group A (0 versus 1/10), the length of hospital stay after surgery was significantly lower in group A versus group B (3.3 ± 1.06 versus 4.7 ± 1.16). drainage tubes were needed in both groups.

After follow-up by clinical symptoms, ultrasonography and VCUG, there were marked improvement regarding the degrees of hydroureter obtained by US and absent of VUR in postoperative VCUG in group A, while one cases developed recurrence in group B (Table 7), There were no statistically significant differences in follow-up between these 2 groups such as fever, recurrent UTI, grade of VUR and improvement of ureteral diameter.

Variables		Group A (n=10)	Group B (n=10)	t / χ^2	P
Age(years) Mean± SD		5.10 ± 1.37	4.30 ± 1.62	.525	.606
Sex	Male	3 (30%)	6 (60%)	1.82	.178
	Female	7 (70%)	4 (40%)		

Table 1: Demographic characteristics between studied groups

We found no significant differences in age, sex, or BMI between the two groups studied.

Variables	Group A (n=10)		Group B (n=10)		χ^2	P
	N	%	N	%		
Clinical presentation distribution						
Antenatal diagnosis	0	--	2	20%	2.22	.136
Fever	10	100%	8	80%		
Recurrent UTI	10	100%	8	80%		
Laterality distribution						
Right	3	30	3	30	2.57	.276
Left	2	20	5	50		
Both	5	50	2	20		

Table 2: Clinical presentation distribution and Laterality distribution among the two studied groups

This table reveals that there was no statistically significant difference between the groups studied. This table showed that regarding group A, 50% of the patients were on both right and left and regarding group B, 50% of the patients were on left without statistical significance difference between the two groups.

Variables	Group A (n=10)		Group B (n=10)		χ^2	P
	N	%	N	%		
Grade III	3	30%	2	20%	2.39	.302
Grade IV	4	40%	4	40%		
Grade V	3	30%	4	40%		

Table 3: Grade of VUR distribution between the two studied groups

This table reveals that there was no statistically significant difference between the groups studied

Variables	Group A (n=10)	Group B (n=10)	t/χ^2	P
Ureteral diameter (mm) Mean± SD	18.51 ± 4.32	18.16 ± 4.54	.177	.862
10 – 15 mm	3 (30%)	1 (10%)	2.39	.302
15 – 20 mm	5 (50%)	4 (40%)		
> 20mm	2 (20%)	5 (50%)		

Table 4: Ureteral diameter distribution between the two studied groups

This table reveals that there was no statistically significant difference between the groups studied

Variables	Group A (n=10)	Group B (n=10)	T	P
Operative time (min) Mean± SD	137.6 ± 35.08	87.3 ± 27.49	**MU 10**	**.002**
Unilateral	(n=5)	(n=8)	**13.1**	**.000**
	104.8 ± 3.96	74.38 ± 4.14		
Bilateral	(n=5)	(n=2)	**11**	**.000**
	170.4 ± 7.96	139 ± 1.41		
Blood loss (ml) Mean± SD	10.57 ± 2.61	21.48 ± 5.33	**5.8**	**.001**
Unilateral	(n=5)	(n=8)	**3.16**	**.009**
	8.45 ± 1.75	14.82 ± 4.23		
Bilateral	(n=5)	(n=2)	**4.14**	**.002**
	9.88 ± 2.34	19.64 ± 4.87		
Drainage tube	10 (100%)	10 (100%)	--	1
Hospital stay (day) Mean± SD	3.3 ± 1.06	4.7 ± 1.16	**MU 19.5**	**.016**

Table 5: Operative data between the two studied groups

This table demonstrates that the operative time in group A was much longer than in group B. In comparison to group B, group A's hospital stay was much shorter. However, blood loss was significantly lower in group A compared to group B. All patients in both groups had drainage tube.

Variables	Group A (n=10)		Group B (n=10)		χ^2	P
	N	%	N	%		
Cosmetic outcome						
Good	10	100%	7	70%	3.53	.061
Poor	0	--	3	30%		
Postoperative complication						
Wound infection	0	--	1	10%	1.05	.307
Urinary extravasation	0	--	2	20%	**13**	**.001**
Urinary tract infection	0	--	1	10%	1.05	.307
Growth hematuria	1	10%	6	60%	**5.49**	**.019**

Table 6: Cosmetic outcome and Postoperative complication between the two studied groups

In terms of cosmetic outcome, there are no significant differences between the groups. However, 30% of cases in group B were poor, while none were in group A. There is a significant difference between the groups regarding urinary extravasation and growth hematuria. Thus, in comparison to group A, they were significantly more common in group B.

Variables	Group A (n=10)		Group B (n=10)		χ^2	P
	N	%	N	%		
Fever and recurrent UTI	1	10%	1	10%	--	1
Hydronephrosis Grade						

Resolved	2	(20%)	1	(10%)	.392	.531
Grade I	3	(30%)	3	(30%)	--	1
Grade II	5	(50%)	4	(40%)	.202	.653
Grade III	0	0	2	(20%)	2.22	1.36
Grade IV	0	0	0	0	--	--
Grade of ureteral diameter:						
Grade I (<5 mm)	8	(80%)	7	(70%)	.267	.606
Grade II (5–9 mm)	1	(10%)	2	(20%)	.392	.531
Grade III (10–15 mm)	1	(10%)	1	(10%)	--	1
Grade IV (>15 mm)	0	0	0	0	--	--
Ureteral diameter (mm) Mean± SD	4.62 ± 1.45		4.95 ± 1.43		.512	.615
Success rate	**9 (90%)**		**9 (90%)**		**--**	**1**

Table 7: Follow-Up and Success rate between the two studied groups

In terms of the rate of success, there is no significant difference between the two groups. There is only conversion of one case in group A and one recurrent case in group

B.

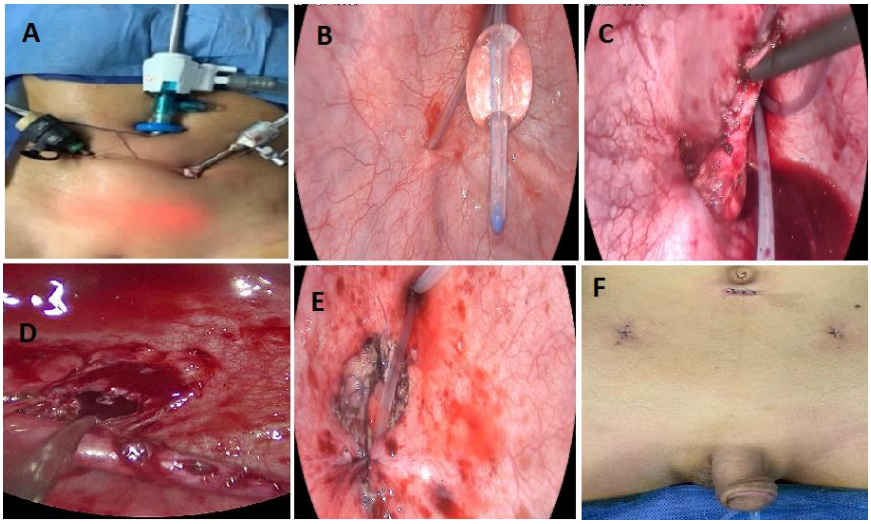

Fig.1: A- Locations of trocars, B&C- A feeding tube was implanted as a stent into the ureter to aid in later ureter mobilisation and dissection. D- Rather than a tunnel, a muscular groove is created from the ureteral hiatus to the trigone, E- Closure of muscular groove over the dissected ureter was done, F- Post operative view.

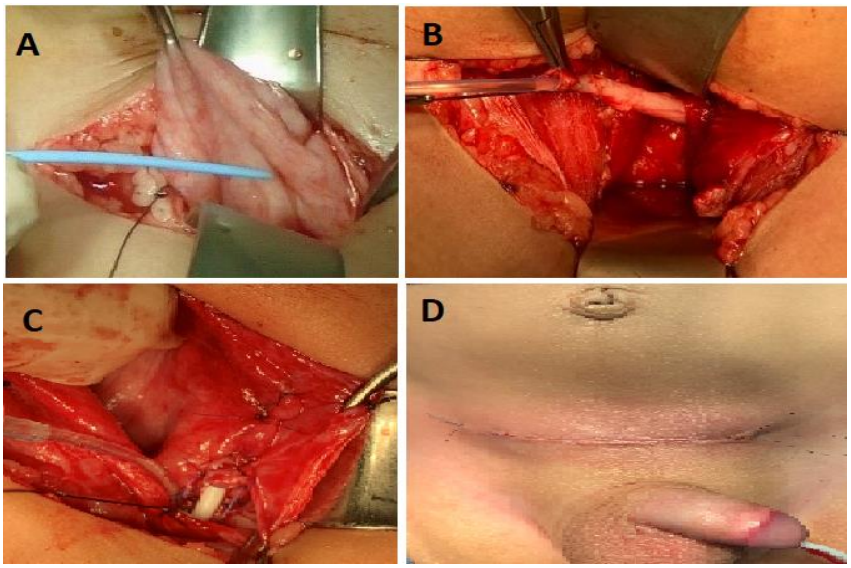

Fig.2: A&B- A ureteric catheter was placed as a stent into the ureter to aid in later ureter mobilization and dissection, C- Closure of muscular groove over the dissected ureter was done, D- Post operative view.

DISCUSSION

One of the most important risk factors for acute pyelonephritis (APN) in children is vesicoureteral reflux (VUR). The most serious issue in VUR remains nephropathy with renal scarring.[7] Early diagnosis and monitoring are the cornerstones of VUR treatment and renal protection. The assessment of VUR therapy results should take into account not only the resolution of VUR over time, but also the absence of urinary tract infections (UTI) and the progression of kidney scarring.

Our study was supported by the retrospective multicenter comparative study by Bustangi et al., [8] who compared the outcomes of open and laparoscopic Lich-Gregoir surgery in patients with VUR. They included 96 VUR patients in their study (27 males and 69 females). Fifty patients (34 females and 16 males) underwent open surgery (group A). The average age of the participants was 4.22 years (14–147 months). In 46 patients, the laparoscopic method (group B) was used (35 females and 11 males). The average age was 4.19 years (15–110 months). They reported a significant difference in age, sex, and weight between the two groups tested.

A systematic review and meta-analysis by Babu & Chandrasekharam, [9] they compared the results of laparoscopic extravesical ureteric reimplantation with those of trans vesicoscopic ureteric reimplantation, and 23 publications were included after reviewing a total of 45 studies (10 articles on LEVUR and 13 articles on TVUR). A total of TVUR (530 patients; 873 ureters) with mean age 5.5 (1.8) years and with mean age 5.6 (2.9). They reported a significant difference in age between the two groups studied.

As regard Clinical presentation distribution among the two studied groups, we found that both groups differed significantly. Fever and Recurrent UTI were the most common presentations in our patients.

While the study by Dubrov et al., [10]reported that the most common presentations were Prenatal ultrasound in 60 (79%), Febrile UTI in 33 (43.4%), Urinary incontinence in 12 (15.8%) and Back pain in 5 (6.6%) children.

Soulier et al., [11] also reported that these patients commonly exhibit the following signs and symptoms: mild to severe abdominal, flank, or back pain, vomiting, fever, haematuria, urine leakage, and leukocytosis.

Regarding indications for surgery, Esposito et al., [12] reported that 71 patients (78.8%) had recurrent febrile urinary tract infections (UTIs) prior to operation (1 episode min, 11 episodes max, 3.11 median – SD 2.601), 58 patients (81.7 %) had breakout UTIs in spite of continuous antibiotic prophylaxis (CAP), and 13 patients (18.3 %) had UTIs immediately following CAP was discontinued. At a routine dimercaptosuccinic acid (DMSA) kidney scan, the remainder of 19 patients revealed new kidney scarring and/or a significant loss in kidney function (> 20% relative to the contralateral kidney function), and they have been candidates for surgical VUR correction.

Regarding Laterality distribution between the two studied groups, we found that regarding group 1, 50% of the patients were on both right and left and regarding group 2, 50% of the patients were on left without statistical significance difference between the two groups.

In line with our study the study by Bustangi et al., [8] reported that in both groups there was 34% of the patients were on both right and left, regarding open group, 64.9% of the patients were on left and regarding lab group, 77.1% of the patients were on left without statistical significance difference between the two groups.

Esposito et al., [12] found no statistically significant differences in laterality between the three groups studied.

While Babu and Chandrasekharam's systematic review and meta-analysis [9] revealed that in the TVUR group 67.9% of patients were bilateral and in the LEVUR group only 31.1% of patients were bilateral, there was a statistically significant difference between the two studied groups (P-value = 0.001).

As regards the grade of VUR distribution between the two studied groups, we discovered that there were no significant differences between the groups studied.

In agreement with our results, the study reported by Bustangi et al., 8 found no significant differences between the examined groups in terms of all grades of VUR, with the majority of open and laparoscopic groups being grade III (45.8% and 59.1% respectively).

While Babu and Chandrasekharam's 9 systematic review and meta-analysis found a statistically significant difference between the examined groups in terms of grade 5 VUR (among articles which gave grade), (P-value = 0.001).

Furthermore, the study by Aydin et al., [13] reported that there was no significant difference between the studied groups as regard the mean grade of VUR with mean of 3,7±0,8 and 3,9±0,8 for groups A &B respectively.

Dubrov et al., (14) reported that the majority (87%) were grade III according to Pfister–Hendren grade hydronephrosis.

In the present study, the ureteral diameter distribution between the two studied groups showed that there were no significant differences between the examined groups (p = 0.302).

While the study Liu et al., [14] revealed that the mean Ureteral diameter was 1.29 ± 0.30 cm as regard Ureteral diameter improvement in the modified pneumovesical GlenneAnderson procedure there were significant decrease in the Ureteral diameter for the studied groups at 1 month, 6 months and one year following up.

Furthermore, the study by Dubrov et al., [10] reported that the average distal diameter of the ureter was 18.4

mm. They performed univariate logistic regression of factors related to radiographic failure and found that the diameter of the ureter at surgery ≥15 was not significantly associated with radiographic failure (p-value = 0.087).

As regards operational data between the two studied groups in the present study, we found that operative time in group I was significantly greater than in group II. While the stay in the hospital was significantly lower in group I compared to group II. However, compared to group II, the loss of blood in group I was significantly lower. All patients in both groups had drainage tube.

In agreement with our results, Babu and Chandrasekharam's [9] systematic review and meta-analysis revealed that the mean operative time for both unilateral and bilateral surgery was significantly greater in the TVUR group than in the LEVUR group, as did the mean hospital stay period ($p<0.05$).

In this research, we found that laboratory parameters did not differ significantly between the two groups. Also, there was no significant difference in the cosmetic outcome across the groups. In group II, however, 30% of the patients were poor, while none of the patients in group I were. We also found a significant difference between groups in terms of urine extravasation and growth hematuria. Thus, they were significantly more common in group II than in group I. There is only one recurrent case in group II.

While the study by Bustangi et al., [8] reported no significant differences in complications between the two groups.

Also, Babu and Chandrasekharam 9 found no significant difference in the rate of complications between the two groups.

Cohen had more complications than LEVUR and STING (P =.001), according to Esposito et al., [16]. In addition, they reported that the STING operation had higher intraoperative expenses (P =.001), whereas the Cohen technique had significantly higher hospitalization expenses (P = .001).

Finally, we found that the rate of success of the two groups was not significantly different.

In line with our results, Bustangi et al., [8] found that group A had a rate of success of 98% and group B had a rate of success of 97.8%. There was no significant difference in success rates between the two groups.

While the study by Babu & Chandrasekharam, [9] revealed that the rate of success was significantly greater in the LEVUR group (96.7%) in comparison to the TVUR group (93.7%) (p=0.007).

Furthermore, Esposito et al., [12] revealed that Open Cohen and laparoscopic therapy employing the LG method were more successful than the STING method. They reported that the STING technique had a 67% success rate. There are numerous aspects that could influence the procedure's success. Preoperative (patient choice), intraoperative (injection method), and postsurgical factors like the existence of a volcano, the administered quantity of the bulking agent, the VUR grades, and the surgeon's expertise have all been demonstrated to correlate with therapy success.

CONCLUSION

We demonstrate that a minimally invasive laparoscopic technique is as successful as open surgery in unilateral and bilateral VUR. The laparoscopic method decreases the need for pain medication after surgery and allows for a quicker return to normal activities. Further comparative studies with larger sample sizes were needed to strength the present results

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