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ORIGINAL ARTICLE

Ipsilateral ureteroureterostomy. A safe alternative in complete duplicated collecting system with associated pathology

Uretero-ureteroanastomosis distal ipsilateral. Una alternativa segura en doble sistema renal completo con patología asociada

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What do we know about the subject matter of this study??

Uretero-ureteral anastomosis has been presented as a good alternative to heminephrectomy in patients with complete duplex kidney and pathology of one system with or without atrophy.

What does this study contribute to what is already known??

Our results using the uretero-ureteral anastomosis technique in patients with complete duplex kidney and single system pathology with or without atrophy show that it is an effective and safe technique for patient management.

Abstract

In patients with complete double renal system with the involvement of only one system, there are several surgical alternatives for its resolution. Uretero-ureteral anastomosis has been presented as a good alternative, even in cases with atrophy of the affected system. **Objective**: To report our experience in patients with complete double renal system with only one system affected, with the surgical technique of uretero-ureteral anastomosis. **Patients and Method**: Retrospective study of patients with double renal system with involvement of one of the systems, treated with uretero-ureteral anastomosis technique between January 2015 and May 2022. The variables of age, specific pathology of the affected system, preoperative study, days of hospitalization, postoperative complications (leakage, obstruction, infection), and follow-up time were evaluated. **Results**: We analyzed 26 procedures in 25 patients, mean age 36.8 months (range: 8-80); 53.8% had ectopic ureter, 23% ureterocele, 11.5% sphincteric ureterocele, and 11.5% VUR of the lower system. All were studied preoperatively with urethrocystography and 65% with scintigraphy. 50% of the operated systems showed signs of renal atrophy. The average hospital stay was 2.2 days (range: 1-7). In an average follow-up of 26.5

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months (range: 3-77), one patient presented leakage, no patient presented signs suggestive of obstruction, and one patient presented febrile urinary tract infection with persistent lower-grade reflux. **Conclusion**: In our experience, the uretero-ureteral anastomosis technique proved to be an easy and safe alternative to reproduce, with a success rate of 96%, 11% of grade I complications, and 4% of grade II complications according to the Clavien-Dindo classification.

Introduction

The duplex kidney is an anatomical variant present in up to 0.8% of the population according to autopsies[1]. Most of them do not present pathologies derived from this anomaly, however, there is a group of patients who are associated with a pathological system. The upper ureteral segment may be associated with obstructive phenomena such as ureterocele, ectopic ureter, and ureterovesical junction (UVJ) obstruction. The lower ureteral segment has a higher incidence of vesicoureteral reflux (VUR). These pathologies associated with the duplex kidney can lead to symptoms such as infections or urinary incontinence.

Ultrasound in patients with urinary tract symptoms is essential as an initial study. It is recommended to follow the study with a voiding cystourethrogram to rule out reflux from the lower system. The renal scintigraphy to define the function of the affected pole usually determines the type of surgical resolution to be performed[2].

There are several surgical options proposed for the resolution of duplex kidney with associated pathology. In general, this depends on the type of associated pathology, whether the affected system maintains or not its function, and whether the affection is of one or both systems. For those systems that maintain renal function, more conservative surgeries are proposed[3].

Regarding patients with single-system pathology, heminephrectomy together with uretero-ureteral anastomosis have been the most widely used surgical alternatives some years ago. While heminephrectomy is advocated for non-functioning systems, uretero-ureteral anastomosis can be performed in pathologic systems with or without renal function.

Among the advantages of uretero-ureteral anastomosis over heminephrectomy are the prevention of damage to the healthy renal system after the procedure, the technical ease, and the lower risk of bleeding since the renal parenchyma is not involved. The disadvantages are the potential arterial hypertension and acute pyelonephritis due to leaving a pathological system, possible stenosis of the anastomosis, and the "yo-yo" reflux between both ureters[2].

Our group used to perform open heminephrectomies and then laparoscopic heminephrectomies for patients with duplex kidney and an atrophic system. However, since the publication of good results with distal uretero-ureteral anastomosis in this group of patients[4-6], we have decided to change our surgical approach. The objective of this report is to analyze our experience in patients with a complete duplex kidney with only one system affected, treated with the uretero-ureteral anastomosis surgical technique.

Patients and Method

Retrospective descriptive review of uretero-ureteral anastomoses in patients with duplex kidney with pathology in one of the systems with or without atrophy of this one, performed by our team from January 2015 to date (May 2022) in our hospital. Patients with a follow-up of less than 3 months were excluded.

The patients started the study due to prenatal diagnosis of hydronephrosis or urinary symptoms, mainly urinary tract infections and incontinence. Ultrasound was performed to confirm the diagnosis of duplicated pyelocaliceal system.

In the first surgical stage, those patients with a diagnosis of duplex kidney and hydroureteronephrosis due to obstructive ureterocele underwent a previous ureterocele puncture. If they presented a post-puncture ultrasound with hydroureteronephrosis or febrile urinary tract infection, we indicated a voiding cystourethrogram. Those cases that evolved with upper or lower system reflux were admitted for uretero-ureteral anastomosis.

Preoperative evaluation of the patients was performed with cystourethrogram to rule out reflux of the recipient ureter system. Those patients with reflux of the recipient system were not considered in this study. Since our hospital is a national referral center, scintigraphy was performed only on those patients who had the resource in their health center of origin. Since uretero-ureteral anastomosis is a procedure for patients with or without atrophy of the affected system, it was not an essential study.

As for the surgical technique, we ideally perform an intraoperative cystoscopy to place the recipient ureter fixed with a ureteral stent and thus be able to easily differentiate the donor ureter from the recipient. Once the cystoscopy is completed, we perform a mod-

ified Gibson incision ipsilateral to the affected kidney. In general, a 4 cm incision lateral to the edge of the rectus abdominis is sufficient. Once the oblique and transverse muscles are divulsed, we enter the retroperitoneum and look for the ureters, displacing the peritoneum medially. Once both are identified, we dissect one from the other ensuring their vascularization. We identify the ureter of the pathological system, section it obliquely and ligate it distally as caudal as possible. We make a longitudinal incision of the recipient ureter where the pathological ureter is most suitable for the anastomosis. We performed an end-to-side anastomosis with absorbable monofilament (PDS 6/0) with continuous suture (Figure 1). At first, we placed a double-J stent at the surgeon's preference to prevent stenosis of the anastomosis, but this is something that we do not perform currently. We placed a bedside drainage to rule out postoperative filtration and a urethral catheter in the bladder. 24 hours after surgery, if it has not leaked, we remove the urethral catheter. After 24 hours without the urethral catheter, we remove the drainage if it still does not leak, and the patient is discharged 48 hours after surgery without drainage or catheter.

Follow-up is performed with renal and bladder ultrasound (pre- and post-voiding in continent children) at 3 months after surgery. We did not routinely perform voiding cystourethrogram unless the patient had febrile urinary tract infections. The patient was discharged once sphincter control was achieved and at least 24 months of follow-up.

The following variables were analyzed: sex, form of presentation (antenatal diagnosis, febrile urinary tract infection, incontinence), associated pathology (ureterocele, ectopic ureter, VUR), previous surgeries (ureterostomy, ureterocele puncture), preoperative cystourethrogram, renal system function in preoperative scintigraphy, age at the time of surgery, use of intraoperative cystoscopy for ureteral stent placement, use of double-J stent in the postoperative period and associated complications, duration of bedside drainage, postoperative urinary filtration, days of hospitalization, months with antibiotic prophylaxis, ureteral obstruction or postoperative urinary tract infection, progression of hydronephrosis in the postoperative period, and follow-up time. The results were analyzed as percentages.

This study was approved by the Ethics Committee of the Faculty of Medicine of the University of Chile (project number 013-2021, file minutes number 16) and the Informed Consent of the parents of each patient.

Results

During the period studied, 28 procedures were performed in 27 patients. Two patients had less than 3 months of follow-up, so data from 25 patients were analyzed. One patient underwent uretero-ureteral anastomosis of both duplex kidneys at different surgical times, so the data were analyzed based on 26 renal units.

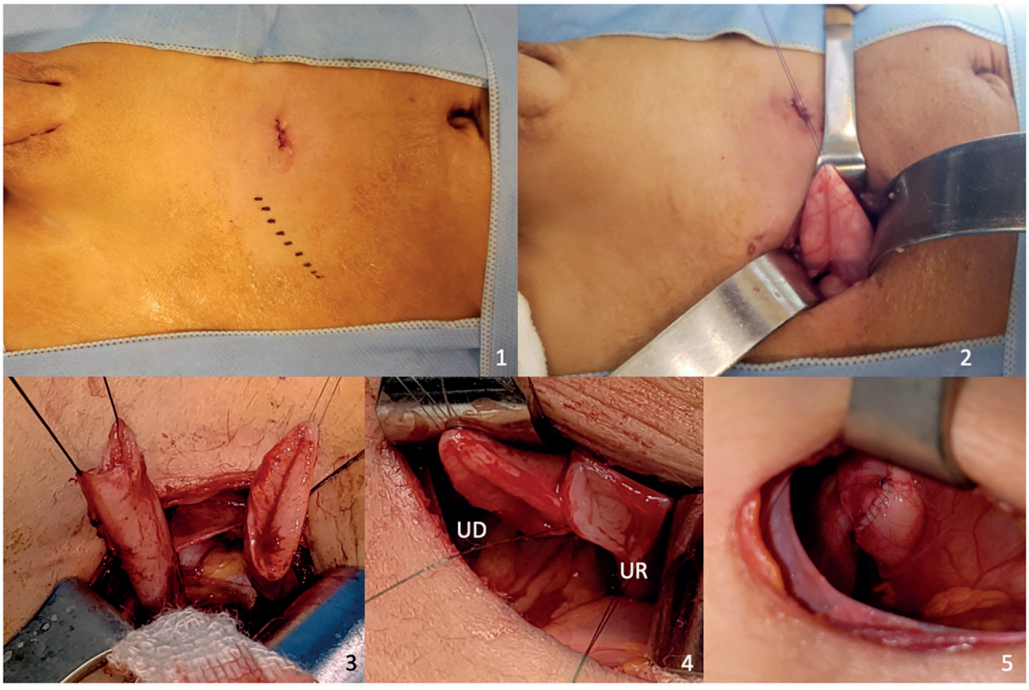

Figure 1. Intraoperative images. 1: Incision in the inguinal fold ipsilateral to the affected system. 2: Dissection of the ureters and identification of the donor or affected ureter. 3: Sectioning of the donor ureter. 4: Longitudinal section of the recipient or healthy ureter (UD: donor ureter, UR: recipient ureter). 5: Uretero-ureteral lateral-to-end anastomosis.

Most of the procedures were performed in female patients (84.6%). The most frequent form of presentation in this series was antenatal hydronephrosis (57.6%), followed by febrile urinary tract infection (30.7%), and urinary incontinence (7.6%). Only one patient presented postnatal hydroureteronephrosis within the study of a malformation syndrome (Figure 2).

A total of 96.1% of the renal units had preoperative hydroureteronephrosis on ultrasound, with a mean distal ureter of 10mm (range 5-15mm in 17 renal units that reported this measurement). Table 1 describes the pathologies associated with the duplex kidney.

Regarding procedures before uretero-ureteral anastomosis, all renal units with ureterocele (34.6%) were previously punctured, 5 patients underwent ureterostomy on average at 12.4 months of life (range 1-52 months, mean 3 months) for severe hydroureteronephrosis (ureters described on ultrasound from 10 to 14 mm).

All patients were studied with cystourethrogram before surgical planning. Of the 14 patients with ectopic ureter, one had grade III VUR of the affected system. Of the 9 patients with ureterocele, all showed VUR from grade I to grade V of the affected system. In those patients with VUR of the lower system, upper system reflux was ruled out (Table 1).

Only 17 renal units (65%) were studied with scintigraphy before surgery. Of these, 10 renal units presented atrophy of the affected system, defined as differential renal function less than 30% compared with the other ipsilateral system. Of the remaining 9 renal units (35%) that were not studied with scintigraphy, ultrasound showed signs of atrophy in 3 of them. Considering this, at least 50% of the renal units had some degree of atrophy of the affected system.

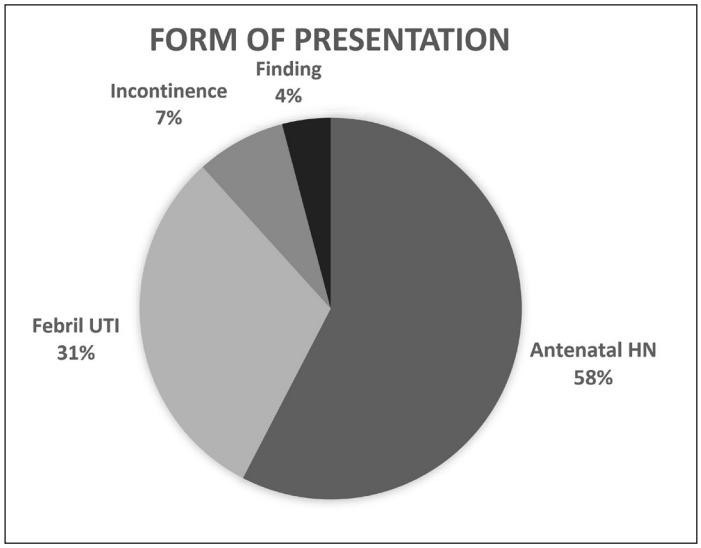

Figure 2. Graphic representing the form of presentation. HN: hydronephrosis. UTI: urinary tract infection.

Regarding the intraoperative variables observed (Table 2), the mean age at the time of surgery was 36.8 months (range 8-80 months, median 34.5 months). In 46.1% of the procedures, intraoperative cystoscopy with catheterization of the affected ureter was performed. In 8 (30.7%) procedures, a double-J stent was placed. In 92% of the intervened renal units, bedside drainage was placed in the anastomosis. The average duration of drainage was 40.6 hours (range 24-168 hours, median 48 hours). In one case, prolonged use of the drainage was required (more than 72 hours) due to urine leakage in the immediate postoperative period, which subsided spontaneously with a urethral catheter; in this patient, a double-J stent had been placed during surgery. The mean number of days of hospitalization was 2.2 days (range 1-7 days), up to 7 days in the patient who presented urine leakage.

The double-J stent had to be removed earlier than scheduled in 2 cases, one due to urinary tract infection and the other due to displacement. In the remaining 6 patients, removal was after 10 weeks (6-12 weeks) on average. Prophylaxis was discontinued at 3.8 months on average postoperatively. The mean follow-up of the patients was 26.5 months (3-77 months). No patient has presented major postoperative hydroureteronephrosis suspicious of obstruction, instead, hydroureteronephrosis resolved in all renal units, observing distal ureters up to 5 mm postoperatively. 26.9% of patients presented afebrile urinary tract infection in the context of lower urinary tract dysfunction, with normal ultrasound study. One patient presented a febrile urinary tract infection postoperatively. The cystourethrogram study of the latter patient revealed a worsening of a known VUR on the right side (not operated, duplex kidney with grade I reflux preoperatively and grade III postoperatively) and a persistence of reflux on the left side to a lesser degree (operated, grade IV preoperatively and II postoperatively). The patient is being monitored and treated for lower urinary tract dysfunction prior to any possible need for reintervention. Table 3 summarizes the postoperative complications.

Discussion

The duplex kidney is an anatomical variant present in up to 0.8% of the population according to autopsies[1]. It consists of a kidney with drainage of 2 independent renal systems (upper and lower), both ureters can reach the bladder, or both can converge in a single ureter. The duplex kidney is formed by the induction of two ureteral buds from the mesonephric duct, which are directed toward the metanephric blastema.

Table 1. Pathologies of the intervened duplex kidney

Associated Pathology	n (%)	Anatomical features	VUR characteris-tics in UCG
Ectopic ureter	14/26 (53.8%)	4 bladder neck 2 distal urethra 3 vaginal 5 undetermined	1 grade III (ectopic ureter to the bladder neck)
Punctured ureterocele with secundary VUR	6/26 (23%)	5 intravesical 1 cecoureterocele	1 grade I 3 grade III 4 grade IV 1 grade V
Sphincteric type urterocele	3/26 (11.5%)	All previously endoscopically punctured	
Inferior VUR	3/26 (11.5%)		1 grade I 1 grade IV 1 grade V

VUR: vesicoureteral reflux. UCG: urethrocystography

During apoptosis of the mesonephric duct, the ureter of the lower system remains normally inserted, while the ureter of the upper system moves caudally, leading into the lower part of the bladder, urethra, vagina, or epididymis. Most patients do not present pathologies derived from this anomaly, however, there is a group of patients that are associated with a pathological system. The upper ureteral segment enters in a more caudal and medial position and may be associated with obstructive phenomena such as ureterocele, ectopic ureter, and UVJ obstruction. The ureter of the lower segment ends more cephalic and lateral, which may result in a shorter intramural trajectory and consequently a higher incidence of VUR. Some patients may present with involvement of only one renal system while another group may present with involvement of both systems. These pathologies associated with the duplex kidney may lead to symptoms such as infections or urinary incontinence.

Ultrasound in patients with urinary symptoms is essential as an initial study, finding in many cases patients with duplex kidney and hydroureteronephrosis either by obstruction or reflux. In these cases, it is recommended to continue the study with voiding cystourethrogram to rule out reflux of the lower system. In addition, the renal scintigraphy to define the function of the affected pole usually determines the type of surgical resolution to be performed[2].

Table 2. Observed intraoperative variables

Intraoperatorive variables (N = 26)	
Age	36,8 (8-80) months
Intraoperative cystoscopy	12 renal units (46,1%)
Doublé-J stent use	8 renal units (30,7%)
Drainage use	24 renal units (92%)

There are several surgical options proposed for the resolution of duplex kidney with associated pathology. In general, this depends on the type of associated pathology, whether the affected system preserves function or not, and whether the condition affects one or both systems. Certainly, those systems that preserve renal function will be proposed more conservative surgeries. Those patients with ureterocele can be managed by ureterocele puncture, this being the definitive treatment in up to 50% of cases[3]. For those patients with hydroureteronephrosis not associated with ureterocele, VUR of the upper system post ureterocele punc-

Table 3. Postoperative complications in the average follow-up of 26.5 (3 to 77) months

Postoperative compli-cation	Complication degree	Renal units (n = 26)
Leakage	I	1
Doublé-J stent complication	I	2/8
Ureteral obstruction	IIIb	0
Post operative urinary tract in-fection	Depends on the cause	7 afebrile (due to lower urinary tract dysfunction) 1 febrile (due to worsening of contralateral grade I VUR)

ture, or system with pathology without renal function, heminephrectomy (with or without ureterectomy) of the affected system without function, pyelo-pyelic anastomosis, or uretero-ureteral anastomosis are proposed. For patients with pathology of both systems, with or without renal function, it is both systems that must be intervened, generally requiring double ureteral reimplantation.

Although Buchtel published his experience using uretero-ureteral anastomosis in children with pathological duplex kidney in a series of 6 cases as early as 1965[7], it was not until 20 years ago that the first series of cases with a greater number of patients began to be reported.

Arguments against uretero-ureteral anastomosis have influenced its massification as the technique of choice as opposed to heminephrectomy. The main one has been the possible development of arterial hypertension due to leaving a non-functioning renal pole. However, several reports have not found greater development of hypertension in this group of patients; in turn, it has developed in patients with renal scarring due to previous urinary tract infections[8,9]. In a comparative study, hypertension was observed to develop at similar rates in patients with heminephrectomy (9%) versus patients with uretero-ureteral anastomosis (8%) at 15 years of follow-up[10].

The "yo-yo" effect as a cause of reflux in the healthy system has been another reason for concern against uretero-ureteral anastomosis. Although it is generally believed that this may exist, it would not have clinical relevance since no postoperative hydroureteronephrosis has been observed in both healthy and pathological systems, nor an increased incidence of febrile urinary tract infections[11].

Just as the idea of leaving a non-functioning renal system has been accepted, concerns about heminephroureterectomy have arisen. Loss of function of the healthy renal system has been reported to be around 5% in 5-17% of patients[2]. In addition, the greater technical difficulty of heminephroureterectomy compared with uretero-ureteral anastomosis is a point on which all groups agree.

All this evidence in the literature made us rethink the surgical approach in patients with complete duplex kidney and pathology of one system, with or without atrophy of this one. Since we started performing uretero-ureteral anastomosis to date, we have operated 28 renal units. Two patients with single system involvement had less than 3 months of follow-up, so the results of 26 renal units were analyzed. Nine renal units had previously ureterocele puncture that, on subsequent study with cystourethrogram, presented VUR of the upper system. All patients underwent preoperative cystourethrogram to rule out healthy system VUR. 17 renal units were studied with scintigraphy due to the limited availability of the test in the regions of some of the referred patients. 13 renal units presented atrophy by scintigraphy (10/13) and ultrasound (3/13).

Cystoscopy was performed preoperatively in 12 (46.1%) of the procedures. In 8 (30.7%) procedures, a double-J stent was placed, with complications requiring early removal in 2 cases.

In a follow-up of 26.5 (3-77) months, one patient presented leakage of the anastomosis in the immediate postoperative period, which subsided with the use of a urethral catheter. Resolution of hydroureteronephrosis was observed in all patients. Seven patients presented afebrile urinary tract infection at follow-up in the context of lower urinary tract dysfunction. One patient presented febrile urinary tract infection, with a workup showing worsening of a known right-sided VUR (preoperative I and postoperative III) and persistent reflux in the operated system (preoperative IV and postoperative II). The patient is currently under management of lower urinary tract dysfunction.

We try to obtain preoperative scintigraphy in all cases, however, if the patient comes from another region where this resource is not available, we do not necessarily perform it before the procedure. Likewise, it is not a test that we routinely indicate postoperatively, and the function of the affected renal system preoperatively does not influence our surgical decision.

Initially, cystoscopy before uretero-ureteral anastomosis was performed only if preoperative imaging did not show significant hydroureteronephrosis of the affected system (generally greater than 7mm). However, the intraoperative findings did not always correlate with the preoperative images, and it was not always easy to determine which is the donor and recipient ureter, so we decided to start all procedures with a preoperative cystoscopy and catheterization of the donor ureter.

Regarding the use of the double-J stent in the postoperative period, we initially positioned it transanastomotically for at least one month. In our series, we observed complications associated with its use, such as urinary tract infections and displacement. Nathan et al. in 2018 compared two groups of patients who underwent uretero-ureteral anastomosis, with and without the use of a double-J stent. The group in which it was used, presented minor postoperative complications associated with its use (febrile urinary tract infection, dysuria, displacement), while the group in which no stent was placed did not present any postoperative complications[12]. Based on our experience and the literature, we decided not to place double-J stents.

In 2001, Lashley et al[4] published their results after performing uretero-ureteral anastomosis in 96 renal units, reporting a 94% success rate. The failures were

in 3 renal units that presented obstruction of the anastomosis, reflux in 2 cases, and ureteral remnant that required resection in 1 case. This series included 23 renal units in which once both systems were anastomosed, the recipient was reimplanted due to reflux. In 2007, Chacko et al.[5] reported their results of 41 uretero-ureteral anastomosis. This group also included renal units where they also performed reimplantation of the recipient ureter (30/41). Two patients required urinoma drainage in the immediate postoperative period and no patient developed obstruction. In 2009, Prieto et al.[6] reported their experience with 26 renal units. They did not consider patients with lower system reflux. They did not use drainages or catheters in the postoperative period. They observed resolution of preoperative hydroureteronephrosis in all cases and no obstruction in the postoperative period.

In our series, we analyzed the results of 26 interventions, without reimplantation of the donor system. The success rate was 96% (25/26), with complete resolution of preoperative hydroureteronephrosis in almost all cases. One of the cases presented partial resolution of hydroureteronephrosis, which has not yet required reintervention. There were no patients with obstruction in the postoperative period.

The limitations of our study are mainly due to the small number of cases and because it is a retrospective review. However, we consider it important to report our experience based on the scarce published literature and the benefits of using this technique in the treatment of a complete duplex kidney, even in those with an atrophic system.

A larger donor ureter diameter has not been associated with a higher complication rate. In a retrospective review of patients undergoing uretero-ureteral anastomosis, the results with a donor ureter smaller than 1.2cm were compared with a donor ureter larger than 1.2cm, showing no significant differences in postoperative complications, specifically febrile urinary tract infections and need for reintervention[13]. Another retrospective review of 35 procedures also found no difference between the degree of ureteral dilatation and postoperative outcomes[14]. Unfortunately, the difference in caliber between donor and recipient ureter was not recorded in our study since it is data that we do not usually record in the operative protocol. It is likely that in our team we did not perform this procedure in severely dilated ureters, either because ureterocele decompression or ureterostomy was previously performed in newborns with severe hydroureteronephrosis.

Another data that was not recorded in our series was pre- and postoperative blood pressure. Although the literature found no relationship between the development of arterial hypertension and conservative surgery for atrophic poles, it would be interesting to analyze this variable in the long term in our series of patients.

In conclusion, our results allow us to recommend this surgical technique in selected patients with complete duplex kidney and single system pathology. It is an easy-to-reproduce and safe alternative, with a success rate of 96%, 11% grade I complications, and 4% grade II complications according to the Clavien-Dindo classification in our series.

Ethical Responsibilities

Human Beings and animals protection: Disclosure the authors state that the procedures were followed according to the Declaration of Helsinki and the World Medical Association regarding human experimentation developed for the medical community.

Data confidentiality: The authors state that they have followed the protocols of their Center and Local regulations on the publication of patient data.

Rights to privacy and informed consent: The authors have obtained the informed consent of the patients and/or subjects referred to in the article. This document is in the possession of the correspondence author.

Conflicts of Interest

Authors declare no conflict of interest regarding the present study.

Financial Disclosure

Authors state that no economic support has been associated with the present study.

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