Review Article

Minimally invasive ureteral reimplantation or endoscopic management for primary obstructive megaureter: a narrative review of technical modifications and clinical outcomes

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Background and Objective: Primary obstructive megaureter (POM) has various courses in different age populations. Although open ureteral reimplantation (OUR) remains the standard treatment for symptomatic POM, it is highly invasive with potential complications. In recent years, minimally invasive ureteral reimplantation (MIUR), including laparoscopic ureteral reimplantation (LUR) and robotic-assisted laparoscopic ureteral reimplantation (RALUR), and endoscopic management, such as double-J stent insertion, endoureterotomy and endoscopic balloon dilatation (EBD), have been utilized for POM in selected patients. However, few comparable studies between MIUR and endoscopic management have been published to date, and it remains unclear which surgical management is the optimal choice for POM in different age groups. This review provides a comprehensive perspective on technical development and clinical outcomes of MIUR and endoscopic management for POM in pediatric and adult populations.

Methods: The PubMed and Web of Science databases were used to comprehensively search English language articles related to MIUR and endoscopic management for POM in pediatric and adult populations up to March 2022. The technical modifications and the relevant clinical outcomes were reviewed.

Key Content and Findings: MIUR with various technical modifications related to intracorporeal suturing and ureteroneocystostomy with anti-reflux techniques appears to be as safe and effective for POM in different age groups as the open procedure. Double-J stent insertion should be regarded as a temporary option for infants by achieving internal urinary drainage, as it may present limited success rates and various complications. Endoureterotomy using pure cutting current or laser appears to be a safer, easier, and less invasive alternative to open surgical management. While EBD has emerged as a definite treatment for POM in the pediatric population, it is debatable whether EBD can substitute for MIUR in adult patients.

Conclusions: The safety and feasibility of MIUR and endoscopic management in patients from all age groups still need further investigation.

Keywords: Primary obstructive megaureter (POM); minimally invasive; endoscopic management; ureteral reimplantation; balloon dilatation

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Introduction

Primary obstructive megaureter (POM) is a congenital ureteral disease that results from an aperistaltic juxtavesical segment 0.5 to 4 cm long, which causes a functional obstruction, urine flow accumulation, and subsequent tortuosity and dilatation of the upper ureter (1-3). It occurs more commonly among neonates and young children asymptomatically (1). Adult POM commonly occurs in the third or fourth decades of life, and many years of silent subclinical damage may result in a higher incidence of complications and present more symptoms, such as flank pain, recurrent urinary tract infection (UTI), hematuria, urolithiasis, and even loss of renal function (4).

Open ureteral reimplantation (OUR) has shown an excellent success rate of nearly 90% and remained the gold standard treatment for symptomatic obstructive megaureter (3,5,6). Ureteral reimplantation is to excise the narrow ureteral segment with or without tailoring the ureter to the appropriate size by tapering or plication and to anastomose the distal ureter to the bladder with an anti-reflux submucosal tunnel or ureteral nipple (5,7). It can be performed intravesically or extravesically. However, the open approach is associated with painful invasiveness, postoperative complications, and prolonged convalescence. Recently, an increasing number of urologists have performed minimally invasive ureteral reimplantation (MIUR) for POM, including laparoscopic ureteral reimplantation (LUR) and robotic-assisted laparoscopic ureteral reimplantation (RALUR). MIUR has usually been performed for POM in adults and children aged more than 1 year old. For infant cases, other surgical methods such as refluxing ureteral reimplantation, cutaneous ureterostomy, and endoscopic management can be chosen instead considering that the reimplantation of a grossly dilated ureter into a small bladder could be challenging (5).

In addition to MIUR, endoscopic management has also played significant roles in treating POM, especially in infants and children (5). Double-J stent insertion, endoureterotomy, and endoscopic balloon dilatation (EBD) are performed through the urinary tract without skin incisions, providing an admissible option for relieving obstruction and promoting urinary drainage without excising the distal ureteral segment. Endoscopic management also appears to possess simpler operation, lower costs, less invasiveness, and quicker recovery of patients, whereas MIUR demands experienced surgeons and sophisticated technical details.

However, previous studies rarely made comparisons between MIUR and endoscopic management. Moreover, as there have been several technical modifications of these procedures with various clinical outcomes, it is unknown which surgical technique is the best option for POM cases in different age groups. Herein, we provide a comprehensive review of technical modifications and outcomes of MIUR and endoscopic management for POM in both pediatric and adult populations, which may be helpful to manage POM in different situations in current opinions. We present the following article in accordance with the Narrative Review reporting checklist (available at https://tau.amegroups.com/article/view/10.21037/tau-22-448/rc).

Methods

The search strategy was summarized in *Table 1*. The PubMed and Web of Science databases were used to perform a comprehensive search of POM up to March 2022. The inclusion criteria were articles related to MIUR and endoscopic management for POM in both pediatric and adult populations, regardless of study types. The search terms included megaureter, primary obstructive megaureter, ureteral reimplantation, endoscopic management, stent, endoureterotomy and balloon dilatation. Only studies that were published in English language were taken into consideration. The reference lists of the related articles were also searched for any additional included studies. Repeated articles and studies about animal models or gene analysis were excluded. Articles were initially screened for inclusion by two reviewers. Further discussion was necessary when there were discrepancies. The technical modifications of MIUR and endoscopic management for POM were reviewed and the relevant clinical outcomes were also analyzed.

Results

In our research, a total of 1,242 articles and their reference lists were primarily screened. Finally, 72 articles met the inclusion criteria and were included for reviewing technical modifications and clinical outcomes of MIUR and endoscopic management for POM in different populations.

Surgical indications for POM

It has been reported that 53% to 96% of megaureters get spontaneous regression with time as seen on follow-up in

Table 1 The search strategy summary

Items	Specification
Date of search	March 29, 2022
Databases and other sources searched	PubMed, Web of Science
Search terms used	Megaureter, primary obstructive megaureter, ureteral reimplantation, endoscopic management, stent, endoureterotomy, balloon dilatation
Timeframe	January 1, 1959–March 29, 2022
Inclusion and exclusion criteria	Inclusion criteria:
	- Articles related to minimally invasive ureteral reimplantation and endoscopic management for primary obstructive megaureter in both pediatric and adult populations
	- Articles of any study type
	- Articles in English language
	Exclusion criteria:
	- Repeated articles
	- Articles about animal models or gene analysis
Selection process	Articles were initially screened for inclusion by two reviewers and further discussion was necessary when there were discrepancies
Any additional considerations, if applicable	The reference lists of the related articles were also searched for any additional included studies

children (8-15). It may contribute to morphological and functional maturation of the terminal ureter. It has been widely believed that if renal function is not significantly affected and UTI is not a major issue, observation and antibiotic prophylaxis should be required (3). The British Association of Pediatric Urologists recommended that the key indicators for the operative intervention of POM involve an initial differential renal function of less than 40%, especially when it is associated with massive hydroureteronephrosis, and failure of conservative management (breakthrough febrile UTI, pain, worsening dilatation, or deteriorating differential renal function) (5).

In adult cases, the growth and maturation of the vesicoureteral junction (VUJ) and the kidney are complete. Accordingly, adults with POM rarely present spontaneous improvement and are usually symptomatic. Active management is more strongly recommended, especially when renal function or hydroureteronephrosis is worsening (4,16).

Minimally invasive ureteral reimplantation (MIUR)

LUR

Laparoscopic access has been appraised for superior cosmesis, morbidity and convalescence profiles, and been increasingly utilized for the reconstruction of various urologic pathologies (17). Since LUR for POM was first reported by Kutikov *et al.* in 2006 (18), much work on the modifications of ureteral reimplantation has been carried out to resolve the technical challenges in laparoscopic approaches. The modifications mainly correlate with two technical aspects of ureteral reimplantation.

Firstly, intracorporeal tailoring and suturing are technically demanding during LUR. Agarwal *et al.* utilized a vessel loop to put the ureter on traction and did not disconnect the ureter from the hiatus until tailoring was completed in 3 young adult patients (20 to 22 years old), leading to an anatomic orientation and a firm platform of the ureter, which greatly facilitated intracorporeal excisional tailoring and suturing (19). Khan *et al.* tapered the ureter intracorporeally over a preplaced ureteral dilator for 8 cases aged 14 to 22 years. The dilator acted as a tool for identifying the ureter, knowing the tapered ureteral diameter, and keeping the ureteral anatomy intact without disrupting the blood supply (20). In addition to intracorporeal tailoring, Ansari *et al.* advocated delivering out the ureter through the trocar and completing the tailoring extracorporeally for 3 patients aged 5 to

30 years (21). Extracorporeal ureteral tailoring followed by ureteroneocystostomy has yielded favorable outcomes for symptomatic POM in both adults and children (22-24).

Secondly, ureteroneocystostomy with ureteral anti-reflux management is also challenging in the laparoscopic approach (17). The classic anti-reflux technique is the submucosal tunnel. The 5:1 ratio of the tunnel length to the ureteral diameter may be used as a guide for effective reimplantation (25). The psoas hitch and Boari flap techniques can achieve a tension-free ureteroneocystostomy for inadequate ureteral length (26-30). In the pediatric population, Bondarenko performed laparoscopic extravesical transverse ureteral reimplantation for POM aged 6 months to 5 years, where the submucosal tunnel was oriented transversely on the lower part of the posterior bladder wall. It is easier than intravesical Cohen techniques and provides a longer tunnel length than anterolateral orientation (31,32). For adult cases, inspired by the anti-reflux nipple technique openly for the treatment of megaureters, our institute modified the LUR with extracorporeal tailoring and direct nipple ureteroneocystostomy, where the distal end was tailored and formed into an anti-reflux nipple extracorporeally and the ureteral nipple was intracorporeally reimplanted into the posterolateral wall of the bladder (33). In comparison with the open group, this technique resulted in less estimated blood loss, less narcotic analgesic, and shorter hospital stay, with no significantly different long-term outcomes including rates of recurrent ureteral stricture, rates of vesicoureteral reflux (VUR), and success rates (6).

Furthermore, in the field of pediatric urology, laparoscopic pneumovesical ureteral reimplantation for megaureters has been increasingly illustrated (34-36). Although with potential benefits compared with the open extravesical approach, including a reduction in postoperative bladder spasms, decreased incisional blood loss and pain, improved cosmetics, and prevention from VUR or anastomotic stricture, this procedure has not achieved widespread acceptance.

RALUR

With the advent of minimally invasive surgery, robotic-assisted laparoscopic platforms have provided better three-dimensional vision, increased operating dexterity and improved camera control, enabling complicated and narrow space urinary tract reconstruction. RALUR, psoas hitch and Boari flap have been reported for distal ureteral reconstruction (37,38).

According to our search, several case series of RALUR have described high success rates for managing POM in adults and children (*Table 2*) (39-45). In 2009, Hemal *et al.* first reported RALUR for 7 symptomatic POMs aged 6 to 60 years (39). A follow-up of 16 months has offered a 100% success rate. One patient had a urinary infection that was settled with appropriate antibiotics and stent removal. There was no appreciable difference in outcomes between intracorporeal and extracorporeal tailoring, but intracorporeal suturing does not need to undock and later redock the robot, and it is easier to assess the exact length of the ureter that needs to be excised and tailored, perhaps resulting in less longitudinal mobilization and less ischemic injury (39).

It is worthwhile to pay attention to anti-reflux techniques in RALUR for POM. All previous studies of RALUR for children with POM have performed the traditional submucosal tunnel technique. For adult cases, Fu *et al.* performed submucosal tunnel reimplantation for slightly dilated megaureters and performed ureteral nipple implantation for seriously dilated megaureters. There were no major complications that occurred during or after the operations (40). However, due to the disadvantages including the small sample size, retrospective design, and short follow-up time in previous studies, it is still debatable which anti-reflux method is more suitable for children or adults. We prefer the anti-reflux nipple technique as it appears to be easier and less time-consuming, especially for complicated ureteral reconstruction in adults. Our institute has recently applied the RALUR with intracorporeal tailoring and ureteral nipple ureteroneocystostomy for adult POM and shown a low rate of postoperative VUR.

Furthermore, RALUR has shown promising success rates for children with megaureters which are similar to LUR (98% *vs.* 94%) (43) and OUR (91% *vs.* 92%) (45). There was also no significant difference in the incidence of complications between RALUR and LUR or OUR (43,45). Nonetheless, the high costs of robotic systems limit their widespread use. In addition, many surgeons lack experience in exerting emerging robotic systems. In the future, it is of great necessity to develop larger-size prospective studies or randomized controlled trials with long-term follow-up results for RALUR in both adult and pediatric populations.

Endoscopic management

Double-J stent insertion

For POM infants, ureteral reimplantation could be

Table 2 Clinical case series of RALUR for obstructive megaureter in adults and children

Study	Study type	Multi-center	Patients	Median age [IQR]	Ureteral tailoring	Ureteroneocystostomy	Median operation time [IQR] (min)	Median estimated blood loss [IQR] (mL)	Median hospital stay [IQR] (days)	Median follow-up [IQR] (months)	Success rate†	Complications
Hemal *et al.* (39) (2009)	Retrospective	No	7 POMs	6–60 years (range)	5 intracorporeal tapering; 2 extracorporeal tapering	Modified Lich-Gregoir technique	142.5 [115–230] (mean [range])	50 (mean)	3.2 [2–6] (mean [range])	16 [11–20] (mean [range])	100% (7/7)	1 UTI
Fu *et al.* (40) (2014)	Retrospective	No	4 POMs	29 [25–32] years	Intracorporeal tailoring	Submucosal tunnel reimplantation or ureteral nipple implantation	87 [170–205] (mean [range])	28.75 [15–20] (mean [range])	8 [7–10] (mean [range])	3–57 (range)	100% (4/4)	0
Neheman *et al.* (41) (2019)	Retrospective	NA	13 POMs	26 [16–60] months	Intracorporeal tapering	RADECUR	113 [90.5–140]	NA	2.5 [1.3–3]	20 [5.5–23]	NA	2 UTI; 1 fever
Neheman *et al.* (42) (2020)	Retrospective	Yes	24 POMs; 11 SOMs	28 [20–58] months	10 intracorporeal tapering; 25 no tapering	RADECUR	100 [90–125]	NA	1.5 [1–2.25]	10 [5–22]	97% (34/35)	3 UTI; 2 urinary retention; 1 port site herniation of omentum
Rappaport *et al.* (43) (2021)	Retrospective	Yes	27 POMs; 21 SOMs	24 [12–48] months††	11 intracorporeal tapering; 37 no tapering	RADECUR	93 [90–120]	10 [10–10]	1 [1–2]	8 [4–16]	98% (47/48)	5 UTI; 2 urinary retention; 1 port site herniation of omentum
Mittal *et al.* (44) (2021)	Retrospective	No	18 POMs	32 [19–108] months	7 intracorporeal tapering; 11 no tapering	Modified Lich-Gregoir technique	269.55	NA	2 [1.75–2]	27.5 [11–50]	100% (18/18)	1 omentum tracking along the drain site; 1 UTI; 1 suspected wound infection; 1 urine leak
Sforza *et al.* (45) (2021)	Retrospective	No	11 POMs	38 months	Intracorporeal tapering	Modified Lich-Gregoir technique	150	NA	6	29	91% (10/11)	1 port site herniation of small bowel

†, success was defined as improvement of hydronephrosis without reintervention during follow-up; ††, there is an overall median age of patients in both RADECUR and LDECUR (laparoscopic dismembered extravesical cross-trigonal ureteral reimplantation) arms. RALUR, robot-assisted laparoscopic ureteral reimplantation; IQR, interquartile range; POM, primary obstructive megaureter; SOM, secondary obstructive megaureter; RADECUR, robot assisted dismembered extravesical cross-trigonal ureteral reimplantation; NA, not available; UTI, urinary tract infections.

challenging as previously mentioned, and ureteral stent insertion is a potential alternative to achieve internal urinary drainage. The stent can stretch the stenotic VUJ, allow decompression of the dilated system and ensure unimpaired urine flow across the VUJ until spontaneous maturation of the VUJ (46). Initially, double-J stents were inserted openly in POM infants (47). Thereafter, endoscopic double-J stent insertion was also reported, but it was correlated with limited success rates (26% to 66%). It was most likely to bring on complications (stent migration, stent encrustation, UTI, stone formation, and recurrent hematuria) and require subsequent ureteral reimplantation (46,48-50). Therefore, stenting should be regarded as a temporary option in infants until the patient is appropriate for definitive procedures. In contrast, double-J stent insertion has been discounted as a treatment option for cases aged more than 1 year (50).

Endoureterotomy

In 2000, Bapat *et al.* first carried out endoureterotomy for 5 POM adults. After cystoscopic evaluation and ureteroscopic introduction, all the layers of the obstructive ureteral segment, ranging from 0.5 to 1.5 cm, were incised at the 6 o'clock position using pure cutting current, which allowed the detrusor muscle bulk to prevent VUR. If necessary, a similar cut was made at the 12 o'clock position. Utmost care was taken not to incise the bladder mucosa. The double-J stent was left indwelling for 3 weeks. Follow-up of 1 to 4 years achieved free drainage with a marked reduction in proximal stasis and freedom from recurrent infection and pain (51). Endoureterotomy using pure cutting current was also applied in the pediatric population, achieving satisfactory success rates of approximately 90% with a low incidence of complications (52,53).

Electrocautery incisions offer precise control of the incision width and length and immediate local hemostasis (52). In addition, yttrium-aluminum-garnet lasers have also been applied during endoureterotomy for POM (54,55). Despite the cutting modality, endoureterotomy appears to be safer, easier, and less invasive than open surgical management. It prevents damage to the vasculature near the distal ureter and decreases the rate of postoperative morbidity and costs compared with ureteral reimplantation, although its applicability needs to be validated (53).

EBD

Since EBD of obstructive megaureter was first reported by Angulo *et al.* in 1998 (56), many urologists have published their experiences and outcomes (*Table 3*) (55,57-69). EBD was traditionally performed under fluoroscopic monitoring. The dilating balloon was insufflated until the narrow ring disappeared, and a double-J stent was positioned and withdrawn 2 months after the procedure. Short-term follow-ups have yielded various success rates (46% to 100%) after the first dilatation and rates of hydronephrosis improvement (76% to 100%) (as shown in *Table 3*) (58-60,62,64,68,69). Moreover, long-term follow-ups of 6.9 and 10.3 years also present high overall success rates of 95% and 100% respectively (63,66). Ortiz *et al.* reported the largest series of EBD in 79 POMs (73 children) to date. A median follow-up of 5.6 years showed a success rate of 87.3% (67). Kassite *et al.* conducted the first multicenter study of high-pressure balloon dilatation for children with POM, with an overall success rate of 92% (65). Overall, these studies have considered EBD as a valid option as a definitive treatment for children with POM.

However, few articles have compared the outcomes of EBD with those of ureteral reimplantation, particularly MIUR. García-Aparicio *et al.* reported 13 POMs treated with EBD and 12 POMs treated with OUR in the pediatric population, showing no significant differences in the improvement of hydroureteronephrosis, postoperative VUR, and secondary ureteral reimplantation (70). A meta-analysis showed a similar pooled proportion of clinical efficacy (92% *vs.* 92%) and complication rates (6.1% *vs.* 12.0%) of EBD compared with ureteral reimplantation for POM, although there was significant heterogeneity (I^2=54.9%) between studies of ureteral reimplantation (71). However, a limitation of the study is the lack of consideration of patient age and follow-up time.

During the inflation of the balloon catheter, the disappearance of the stenotic ring in some cases provides a pathophysiological hypothesis of anatomical obstruction at the VUJ instead of just simple functional obstruction. The ring is sometimes extremely tough. If simple balloon dilatation is insufficient to achieve its disappearance even using high filling pressure, cutting balloon ureterotomy or subsequent endoureterotomy can be attempted (55,61). It appears worthwhile to further investigate the safety and efficacy of EBD combined with endoureterotomy for POM.

Table 3 Clinical case series of EBD for primary obstructive megaureter in children

Study	Study type	Multi-center	Patients/ ureters	Age [range]	Duration of stenting	Follow-up [range]	Success rate after the first dilatation†	Hydronephrosis improvement rate	Complications	Postoperative VUR rate
Angerri *et al.* (57) (2007)	Retrospective	No	7/7	12 [5–34] months	2 months	31 [12–56] months	71% (5/7)	85% (6/7)	1 UTI	0 (0/7)
Christman *et al.* (55) (2011)	Prospective	No	17/17	7 [3–12] months	8 weeks	3.2 [2–6.5] years	71% (12/17)	71% (12/17)	2 recurrent urolithiasis	0 (0/17)
Garcia-Aparicio *et al.* (58) (2012)	Retrospective	No	13/13	7 [4–24] months	2 months	25 [12–36] months	46% (6/13)	85% (11/13)	2 UTI	15% (2/13)
Torino *et al.* (59) (2012)	Retrospective	No	5/5	8 [6–12] months	6–8 weeks	23.8 [16–30] months	100% (5/5)	100% (5/5)	0	0 (0/5)
Romero *et al.* (60) (2014)	Retrospective	No	29/32	4.03 []1.6–39] months	4–6 weeks	47 [18–104] months	69% (20/29)	76% (22/29)	5 UTI	17% (5/29)
Capozza *et al.* (61) (2015)	Retrospective	No	12/12	8 [6–12] months	6–8 weeks	21 [2–44] months	58% (7/12)	83% (10/12)	0	0 (0/12)
Garcia-Aparicio *et al.* (62) (2015)	Retrospective	No	20/22	14.18 [3–103] months	2 months	49 [14–80] months	55% (12/22)	86% (19/22)	4 UTI	27% (6/22)
Bujons *et al.* (63) (2015)	Retrospective	No	19/20	17 [1–44] months	2 months	6.9 [3.9–13.3] years	90% (18/20)	95% (19/20)	2 lithiasis; 2 UTI	5% (1/20)
Kassite *et al.* (64) (2017)	Retrospective	No	12/12	14 [9–84] months	3 months	12.5 [6–30] months	83% (10/12)	92% (11/12)	7 UTI	0 (0–12)
Kassite *et al.* (65) (2018)	Retrospective	Yes	33/42	14.7 [3–180] months	3 months	24 [2–60] months	86% (36/42)	90% (38/42)	13 UTI; 6 worsening of hydronephrosis; 2 stent encrustation	0 (0/42)
Casal Beloy *et al.* (66) (2018)	Retrospective	No	13/13	9 [2–24] months	4–6 weeks	10.3 [4.7–12.2] years	100% (13/13)	NA	4 UTI	NA
Ortiz *et al.* (67) (2018)	Retrospective	No	73/79	4 [0.5–44] months	4–6 weeks	5.6 [1.5–13.5] years	61% (48/79)	87.3% (69/79)	9 late restenosis; 5 UTI; 1 early restenosis with stent migration and pyonephrosis	22% (17/79)
Teklali *et al.* (68) (2018)	Retrospective	No	35/35	30.6 [2–192] months	4–6 weeks	38 [8–120] months	91% (32/35)	89% (31/35)	7 UTI; 5 hematuria; 3 stent migration; 2 pain; 1 stent node	3% (1/35)
Torino *et al.* (69) (2021)	Retrospective	No	12/12	14.5 [5–61] months	6–8 weeks	16.5 [15–30] months	100% (12/12)	100% (12/12)	0	0 (0/12)

†, success was defined as improvement of radiological or functional ureteral obstruction during follow-up after EBD only once without VUR or reimplantation. EBD, endoscopic balloon dilatation; VUR, vesicoureteral reflux; NA, not available; UTI, urinary tract infections.

Dilation of the ureteral orifice is concerned for its possibility of resulting in iatrogenic VUR. In the published literature, the incidence of postoperative VUR after EBD is no more than 27% (*Table 3*). However, the actual incidence is unclear, because most of the authors did not systematically perform voiding cystourethrogram after EBD due to its invasiveness (58,59,66). Nevertheless, it was suggested that VUR might be a transient condition after EBD and could be treated endoscopically or conservatively with good outcomes (62). Voiding cystourethrogram appears ineffective if patients remain asymptomatic and continue to show normal renal function without hydronephrosis (64).

UTI is one of the most common complications after EBD (*Table 3*). In addition to VUR, bacterial colonization on the double-J stent is another underlying cause of UTI. Kassite *et al.* found that infectious stent-related complications occurred in 25% of POM after EBD despite antibiotic prophylaxis. The longer duration of stenting (3 months) may potentially account for the higher incidence than previously reported (64).

Another important issue to discuss is that balloon dilatation was almost performed under endoscopic and fluoroscopic guidance, except for a few studies (66,67). Ortiz *et al.* made a comparison between 43 POMs treated under the original technique with fluoroscopic control and 36 cases treated only under cystoscopic vision. Significant differences were not revealed between the two groups in initial technical failure, early postoperative complications, secondary VUR, restenosis, long-term ureteral reimplantation, or final outcome (67). It is appropriate to be concerned about the risk of side effects from the associated ionizing radiation in the pediatric age. These authors depicted that although the radiation administered in the EBD of POM was very low, fluoroscopic guidance was only reserved for those cases in which the upper urinary tract anatomy needs to be checked, dilatation is difficult or double-J stent insertion is troublesome (67). Our institute has performed X-ray-free EBD on patients with ureteral stenosis (72). It is rational to regard fluoroscopy-free EBD as a promising technique for treating POM with short and uncomplicated strictures.

To our astonishment, EBD for adult POM has been scarcely published in the literature. It deserves further investigation whether endoscopic management is an alternative to MIUR for adult POM. Our institute has performed EBD with or without endoureterotomy under no radiographic control for treating adult patients. The length of the narrow ureteral segment and the extent of ureteral dilatation and tortuousness may be essential factors to determine whether to perform endoscopic management (63,64).

Conclusions

The operative intervention of POM should be determined by comprehensively considering multiple factors of the patients, including age, the severity of symptoms and complications, the extent of ureteral dilatation, and the progressive condition of renal function. MIUR has experienced various technical modifications associated with intracorporeal suturing and ureteroneocystostomy using anti-reflux techniques. It appears to be as safe and effective for POM in different age groups as the open procedure. Double-J stent insertion achieves internal urinary drainage but presents limited success rates and various complications for infants with POM. Endoscopic stent insertion should be performed in infants temporarily waiting for definitive procedures. Endoureterotomy has been performed using pure cutting current or laser, offering a safer, easier, and less invasive alternative to open surgical management. EBD has emerged as a definite treatment for POM in the pediatric population with satisfactory success rates and low incidences of complications. EBD combined with endoureterotomy or without fluoroscopic control has also been attempted. However, it is debatable whether EBD can substitute for MIUR in adult patients.

Above all, larger-size, prospective, or randomized controlled studies with long-term follow-up are required to confirm the safety and feasibility of MIUR and endoscopic management in patients of all ages in the future.

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Footnote

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