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Review Article

Endoscopic dilatation/incision of primary obstructive megaureter. A systematic review. On behalf of the EAU paediatric urology guidelines panel

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Summary

Introduction
Historically, ureteral reimplantation (UR) has been the gold standard for treatment of primary obstructive megaureter (POM) with declining renal function, worsening obstruction, or recurrent urinary tract infections. In infants, open surgery with reimplantation of a grossly dilated ureter into a small bladder, can be technically challenging with significant morbidity. Therefore, less invasive endoscopic management such as dilatation or incision of the ureter—vesical junction, has emerged as an alternative to reimplantation during the last decades.

Objective
To systematically evaluate the effectivity, safety, and potential benefits of endoscopic treatment (dilatation with or without balloon or incision) of POM in comparison to UR.

Study design
A systematic review was conducted. Randomized controlled trials (RCTs), nonrandomized comparative studies (NRSs), and single-arm case series including a minimum of 20 participants and a mean follow-up more than 12 months were eligible for inclusion.

Results
Of 504 articles identified, 8 articles including 338 patients were eligible for inclusion (0 RCTs, 1 NRSs, and 7 case series). Age at time of surgery was minimum 15 days to a maximum of 192 months. Indications for endoscopic treatment (ET) included patients with loss of split renal function (>10%) and worsening of hydroureteronephrosis. The studies analysed reported a success rate ranging from 35% to 97%. Success was defined as stabilization of differential renal function without further procedures. A post-operative complication rate of 23—60% was reported (mostly transient haematuria, urinary tract infections and stent migration or intolerance). In 14% of the cases salvage UR following initial ET, was performed due to relapse of symptomatic POM.

Conclusion
Endoscopic treatment for persistent or progressive POM in children is a minimally invasive alternative to UR with a long-term modest success rate. Additionally, it can be performed within a wide age span, with equal success rate and complication rates.

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Keywords
Primary obstructive megaureter; Endoscopic management; Pediatric urology; Systematic review

Abbreviations
POM, primary obstructive megaureter; RCT, randomized controlled trials; NRS, nonrandomized comparative studies; HUN, hydroureteronephrosis; DRF, differential renal function; UTI, urinary tract infection; PUV, posterior urethral valves; UVJ, ureterovesical junction; ET, endoscopic treatment; UR, ureteral reimplantation; SR, systematic review; UVJO, ureterovesical junction obstruction

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Introduction

Primary Obstructive Megaureter (POM) refers to a dilated retro-vesical ureter with a diameter >7 mm from 30 weeks gestational age onwards which warrants postnatal follow-up [1,2].

In the majority of cases POM spontaneously resolves during the first years of life without consequences for renal function [3]. Intervention may be necessary in case of symptomatic children (e.g., recurrent UTI, stone formation), renal function impairment during conservative follow-up and when hydroureteronephrosis (HUN) increases with parenchyma thinning [2].

The classic approach to management is UR performed as open or laparoscopic surgery with an intravesical, extravesical or combined technique. It can be technically demanding and associated with significant complications, especially in children younger than 6 months [4–7]. Hence, many surgeons prefer to postpone surgery until >1 year of age, and therefore less-invasive procedures, such as ET, have been proposed as an alternative.

During the last years, studies focusing on long-term effectiveness of ET of POM have been published.

In this systematic review (SR) we present the results of ET (dilatation with or without balloon or incision) of POM, regarding effectivity, safety, and potential benefits, also in comparison to UR.

Evidence acquisition

Types of participants

This study was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) statement [8]. A priori protocol was registered at the PROSPERO database (reference CRD42022326752).

Only paediatric patients (children and adolescents <18 years of age), with a uretero-vesical junction obstruction (UVJO) with a loss of differential renal function (DRF) defined as <45%, were included. Our exclusion criteria were: non-primary UVJO (e.g. resulting from a previous endoscopic or surgical procedures or in neurogenic bladder or in PUV-bladder), mean follow-up less than 12 months.

Types of study designs

Randomized controlled trials (RCTs), prospective and retrospective non-randomized comparative studies (NRS's), single-arm case series including a minimum of 20 participants were eligible for inclusion.

Types of interventions

Experimental intervention was ET of UVJO by dilatation with balloon or incision. These interventions could be compared to a control group that underwent open or laparoscopic UR. We did not include studies in which cystoscopy + JJ stent placement was performed as endoscopic management of POM [9]. Although, internal diversion with JJ stent alone for treatment of POM, has been reported with good outcomes and without the need for further intervention, it has been associated significant high rate of comorbidity [10–12].

Types of outcome measures

The primary outcome for benefits was stabilization of DRF on MAG 3 scan or DMSA without further procedures (endoscopic or surgical). The primary outcome for harms was insufficient result of intervention (progressive loss of function, pain, progressive HUN) with a further need for procedures (endoscopic or surgical). Primary time point was 1 year of follow-up.

The secondary outcomes for benefits were: improvement of out–flow curve on MAG 3 scan, improvement of HUN (distal ureteric diameter, SFU-grade of hydronephrosis, or A-P diameter), resolution of clinical symptoms (such as flank pain), prevention of UTI (long term), prevention of stone formation (long term), length of hospital stay. The secondary outcome for harms were: subsequent secondary procedures requiring anaesthesia (redo-ET, removal of JJ catheter etc.), UTI subsequent to treatment, secondary VUR (de novo VUR and other complications (ureteric perforation, abscess, secondary stenosis of the UVJ).

Search strategy

The literature search was performed using the following databases: EBM Reviews - Cochrane Central Register of Controlled Trials < December2022>, Embase <1974 to 2022 December>, OVID Medline Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily and Ovid MEDLINE(R) 1946 to 2022 December. We used the string terms obstructive megaureter AND endoscopic treatment OR ureteric reimplantation in paediatrics age or synonyms of this. Only English publications were eligible for inclusion. Comprehensive search strategies for each database are provided in Supplement 1.

All abstracts were independently evaluated, using Endnote; by two (double screening) of the four independent reviewers (A.v.U., A.Z., U.K., M.S., M.G.). The disagreements were resolved by interactive discussion and consultation of an independent panel member (L.t.H.). All relevant full texts were evaluated by two (double screening) of the four independent reviewers (A.v.U., A.Z., U.K., M.S., M.G.). The disagreements were resolved by interactive discussion and consultation of an independent panel member (L.t.H.). Outcome data extraction was independently performed by two authors (M.S. and M.G.) using a Data Extraction Form developed a priori with clinical content experts (EAU Paediatric Urology guidelines panel). Any disagreements will be resolved by discussion or by consulting a third review author (L.t.H.).

Assessment of risk of bias

The risk of bias was assessed for each included study by two review authors independently (M.S. and M.G.). Any disagreements were resolved by interactive discussion and consultation of an independent panel member (L.t.H.).

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For the comparative studies and case series three issues were considered: the presence of an a priori protocol if the total eligible population was included and recruited consecutively if the primary harm and benefit outcomes were appropriately measured.

A list of the most important potential confounders for efficacy and safety outcomes was developed with clinical content experts (EAU Paediatric Urology guidelines panel) including: age, asymptomatic vs symptomatic, hydroureteronephrosis grade of severity, differential renal function, duration of follow-up, it was assessed whether the confounder was considered, balanced and controlled for in analysis.

The risk of bias was considered to be high if the confounder had not been considered and was imbalanced between patients or not corrected during analysis [13].

Data analysis

As valid and sufficiently homogeneous data were not available, we were not able to perform a meta-analysis. We performed a narrative synthesis.

Study characteristics and outcomes from the eligible studies are shown in Table 1 and Table 2, respectively. Regarding the binary/dichotomous/categorical benefit or harm outcomes, odds ratios (OR) were used where available. Mean difference (MD) with 95% confidence intervals (CIs) were used to report the continuous outcomes.

Evidence synthesis

Quantity of evidence identified

The search and selection process of the articles are demonstrated in the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) flow diagram (Fig. 1). A total of 504 abstracts and titles were screened and 22 were retrieved for full text screening. Finally, 8 studies were found eligible, recruiting a total of 338 patients (RCTs: 0, NRSs: 25, Case series: 313). Three hundred nine patients were analysed with 330 renal units included.

Characteristics of the included studies

The baseline characteristics of all included studies are presented in Table 1.

Characteristics of NRS

One NRS, including 25 patients met the inclusion criteria. This retrospective study compares outcomes between high-pressure balloon dilatation of the UVJ and UR with ureteral tapering to treat POM. Ureteral reimplantation was a Cohen's or Leadbetter-Politano neo-ureterocystostomy associated with a Hendren's tapering. Surgery was performed on a combination of clinical, ultrasonographic and functional scan [14].

Characteristics of case series

A total of 7 case series, including 313 patients, were included. All the studies were retrospective paediatric single centre case series from 2007 to 2022 with a recruitment period from 1999 to 2020 [15–21].

Indication for surgery were presence of: worsening of the HUN [18], symptoms [14–17,20,21], loss of DRE [14–17,20,21] described as more than 10% for preoperative DFR less than 40% in four studies [14,16–18], obstructive curve on MAG3 [15,20].

Endoscopic high-pressure balloon dilatation was performed in six studies under general anaesthesia with appropriate antibiotic prophylaxis [14,16–20]. A paediatric cystoscope (7Fr–9.5F) was introduced to the bladder and a hydrophilic guidewire was negotiated through the UVJ, followed by the dilating balloon. The balloons used were usually semi-compliant dilation catheters with various sizes (2.7–3.1 Fr, 2.5 Fr, 3.1F, 3.4–5.8 Fr etc) from various manufactures, inflated to 12–20 atm for 3–5 min. All dilatations were performed under fluoroscopic guidance. A JJ stent was positioned after the balloon dilatation and left in place for 4–12 weeks [14,16,18,20]. In one study [19], the authors did not use the JJ stent at the end of the procedure and compared the results with a control group that had a stent positioned after dilatation. One author only positioned JJ stent in very few selective cases following dilatation [17].

Kajbafzadeh et al. treated 47 children with an endoscopic endo-ureterotomy, with an incision made at the 6 o'clock using pure cutting current followed by JJ stent left indwelling for one week [21]. Teklali et al. [15]dilated the narrow UVJ under fluoroscopic guidance, with ureteral dilators (6-8Fr) advanced over a guidewire positioned in the ureter. Following removal of the dilator, a JJ stent adapted to the child's age was inserted for 4–6 weeks.

Risk of bias summary for the included studies

Fig. 2 demonstrates the risk of bias (RoB) summary and confounding assessments for the 8 articles. Low risk of attrition bias was present in more than half of the studies, whereas high risk was present for two study [16,20]. None of the studies had an a priori protocol, and the majority were not clear about the criteria of the included eligible population.

There was either a high or an unclear risk for confounders overall, with only one study [15] reporting general low risk of bias for confounder severity. All the studies had a general low or unclear risk for described confounders but high or unclear control for confounders (Fig. 2).

Primary outcomes of included studies

Data from NRS and case series

The primary outcome results of 1 NRS and 7 case series are summarized below and in Table 2.

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Table 1 Characteristic of the included studies.

General					N. of patients analysed			N. of patients excluded			N. of Renal Units			Age mean/median Months			
First Author Journal Year	Study design	Recruitment period Years	Inclusion criteria	Indications for surgery	ES	IN	CO	ES	IN	CO	ES	IN	CO	ES	IN	CO	FU mean/ median Months
Kajbafzadeh J. Endourol 2007	Retrospective Single center Single arms	1999–2005	POM	Symptoms; Worsening HUN; Loss of renal function; No VUR.	47	47	_	0	0	_	52	52	_	44,4 (1.5–132)	44,4 (1.5–132)	_	39 (14–62)
Garcia-Aparicio J Ped Urol 2013	Retrospective Single center Comparative	2005–2010	POM; Ureter >10 mm; Obstructice curve on MAG3; No VUR.	NR	25	13	12	0	0	0	25	13	12	_	7 (4–24)	14 (7–84)	36 (24–48) 72 (48–84)
Romero J. Endourol 2014	Retrospective Single center Single arms	2003–2010	POM; Worsering HUN (retrovesical ureter >10 mm); Impaired renal spilt function with obstructive curve.	Symptoms (febrile UTI, pyeonephrosis); Worsering HUN; Loss of renal function; Obstructive curve.	22	22	_	7	7	_	25	25	_	4.04 (1.6–39)	4.04 (1.6–39)	_	47 (IQR 39,07)
Teklali J Ped Urol 2018	Retrospective Single center Single arms	2006–2016	POM; Symptoms despite AP and release of preputial adhesions; Retrovescial ureter >10 mm, DRE <35%; No VUR.	Symptoms; Worsering HUN; Loss of renal function; Obstructive curve.	35	35	_	0	0	_	37	37	_	30.6 (2–192)	30.6 (2–192)	_	38 (8–120)
Ortiz Front. Pediatr. 2018	Retrospective Single center Single arms	2004–2016	POM; Distal ureter >10 mm Worsering HUN Obstructive curve on MAG-3 No VUR	"Febrile UTI despite AP; Worsening in HUN: DRE <40% or DRF reduction >10%."	73	73	_	19	19	_	79	79	_	4 (15°-43,2)°days	4 (15°-43,2)°days	_	67,2 (18–162)
Chiarenza Ped Med Chir 2019	Retrospective Single center Single arms	2005–2018	POM; Distal ureter >7 mm Worsering HUN Obstructive curve on MAG-3 No VUR.	Sympthoms; Worsering HUN; Loss of renal function.	35	35	_	3	3	_	35	35	_	23 (3–66)	23 (3–66)	_	78 (12–168)
Destro Ped Med Chir 2020	Retrospective Single center Single arms	2012–2018	POM; Retrovsecial ureter >10 mm; Drop in DRE; No VUR.	Febrile UTI despite AP; Worsening in HUN: DRE <40% or DRF reduction >10%.	30	30	_	0	0	_	31	31	_	3.6 (0,4–12,2)	3.6 (0,4–12,2)	_	39,6
Faraj J Ped Urol 2022	Retrospective Single center Single arms	2012–2020	POM; Worsering HUN: Drop in DRE; Symptoms; No VUR.	Sympthoms	42	42 E	_	0	0	_	46	46	_	12,5 (2–128)	12,5 (2–128)	_	35.5 (12–101)

N. = Number; N.R. = Not reported; O = open; E = Endoscopic; ES = Entire Study; IN= Intervention; CO= Control; FU= Follow-up; POM = ; DRE = Differential renal function; VUR= Vesical-Ureteral reflux; HUN= Hydronephrosis; AP = antibiotic prophylaxis; UTI= Urinary tract infection.

Table 2 Primary and secondary outcomes of the included studies.

		Primary Outcomes > 12 months													Secondary outcomes																				
		N. (%) of successful procedures			DRF median/mean			N. (%) of pts with complications			N. (%) Re-do procedures			N. (%) Failure of POM Uretral reimplat	N. (%) Intervention intended not feasible			N. (%) of pts with post operative pain			N. (%) of pts with UTI			N. (%) of pts with stone formation			Lenght of hospital stay (days)	HUN Pelvis diamter (mm) median/mean			Ureteral diameter (mm) median/mean			Lenght JJ stent placement (post dilatation (weeks)	Improvement of outflow curve on Renogram
First Author Journal Year	Definition for cure or success	ES	IN	CO	ES	IN	CO	ES	IN	CO	ES	IN	CO	IN	ES	IN	CO	ES	IN	CO	ES	IN	CO	ES	IN	CO	ES	ES	IN	CO	ES	IN	CO	ES	ES
Kajbafzadeh J. Endourol 2007	Improvement of HUN and drainage at MAG-3.	47/52 (90)	47/52 (90)	–	NR	NR	–	NR	NR	–	6/47 (13)	6/47 (13)	–	5/47 (11)	2/47 (4)	2/47 (4)	–	NR	NR	–	0	0	–	0	0	–	1,3 (1-3)	NR	NR	–	NR	NR	–	1	NR
Garcia-Aparicio J Ped Urol 2013	Improvement of HUN and drainage at MAG-3.	–	11/13 (85)	11/12 (92)	NR	Pre op: 45 (36-60) Post op: 42 (35-55)	Pre op.: 41,5 (18-53) Post op.: 48 (18-52)	15/25 (60)	12/13 (92)	3/12 (25)	7/25 (28)	7/13 (28)	2/12 (17)	3/25 (12)	NR	NR	NR	NR	NR	NR	3/25 (12)	3/13 (23)	0	0	0	0	NR	–	Pre op.: 27 (10-47) Post op.: 0 (0-10)	Pre op.: 19 (10-58) Post op.: 9,5 (0-24)	–	Pre op.: 14 (10-26) Post op.: 5 (0-12)	Pre op. 16 (9-45) Post op.: 5 (0-14)	8	Renograms became non-obstructed in pts in whom HUN improved
Romero J. Endourol 2014	Improvement of HUN and drainage at MAG-3.	20/27 (74)	20/27 (74)	–	Pre op.: 36 (24-43)	Pre op.: 36 (24-43)	–	9/29 (31)	9/29 (31)	–	0	0	–	7/29 (24)	2/29 (7)	2/29 (7)	–	NR	NR	–	5/29 (17)	5/29 (17)	–	0	0	–	NR	Pre op.: 18 (12-26) Post op.: 8 (0-20) at 18 m.	Pre op.: 18 (12-26) Post op.: 8 (0-20) at 18 m.	–	Pre op.: 14,2 (11-21) Post op.: 8,5 (3-11) (in 5 pts)	Pre op.: 14,2 (11-21) Post op.: 8,5 (3-11) (in 5 pts)	–	4-6	20/29 (69%) Renal units
Teklali J Ped Urol 2018	Improvement of HUN and drainage at MAG-3.	32/33 (97)	32/33 (97)	–	Data in table 1: Pre op. (29 pts) 44,3 (17-57). Data in the text: Pre op. (29 pts) 45 (17-57). Data in table 1: Post op. (23 pts) 44,8 (28-53) Data in the text: NR	Data in table 1: Pre op. (29 pts) 44,3 (17-57). Data in the text: Pre op. (29 pts) 45 (17-57). Data in table 1: Post op. (23 pts) 44,8 (28-53) Data in the text: NR	–	15/35 (43)	15/35 (43)	–	0	0	–	1/35 (3)	2/35 (6)	2/35 (6)	–	2/35 (6)	2/35 (6)	–	7/35 (20)	7/35 (20)	–	1/35 (3)	1/35 (3)	–	NR	NR	NR	–	Pre op.: 16 (10-30) Post op.: 6 (2-20)	Pre op.: 16 (10-30) Post op.: 6 (2-20)	–	7 (3-16)	20 (57)
Ortiz Front. Pediatr. 2018	NR	48/79 (61)	48/79 (61)	–	Pre op. 44.4 ±6.3 Post op. 46.2 ±5.9	Pre op. 44.4 ±6.3 Post op. 46.2 ±5.9	–	23/79 (29)	23/79 (29)	–	8/79 (10)	8/79 (10)	–	10/79 (13)	4/79 (5)	4/79 (5)	–	NR	NR	–	5/79 (6)	5/79 (6)	–	NR	NR	–	1 (1-7)	Pre op.: 19,2 ±4,9 Post op.: 5,2 ±3,5 at 18 m.	Pre op.: 19,2 +-4,9 Post op.: 5,2 +-3,5 at 18 m.	–	"Pre op.: 14,9 ±2,9 Post op.: 6,6 ±6,5 at 18 m."	"Pre op.: 14,9 ±2,9 Post op.: 6,6 ±6,5 at 18 m."	–	4-6	NR
Chiarenza Ped Med Chir 2019	Improvement of HUN and drainage at MAG-3; No UTI.	8/23 (35)	–	–	NR	NR	–	NR	NR	–	9/35 (26)	9/35 (26)	–	6/35 (17)	11/35 (31)	11/35 (31)	–	0	0	–	0	0	–	0	0	–	1 (1-2)	NR	NR	–	NR	NR	–	4	NR
Destro Ped Med Chir 2020	NR	25/30 (83)	25/30 (83)	–	NR	NR	–	7/30 (23)	7/30 (23)	–	0	0	–	5/30 (17)	3/30 (10)	3/30 (10)	–	1/30 (1)	1/30 (1)	–	1/30 (1)	1/30 (1)		0*	0*	–	24 h after cathter remuval*	NR	NR	–	Pre op. 16 (10-25) Post op. 7,9 (2-15)	Pre op. 16 (10-25) Post op. 7,9 (2-15)	–	13	NR
Faraj J Ped Urol 2022	Absecne of further ureteral reimplantatio n	33/42 (79)	33/42 (79)	–	Pre op. 49,5 (17-100) Post op. 50,5 (16-100)	Pre op. 49,5 (17-100) Post op. 50,5 (16-100)	–	13/42 (31)	13/42 (31)	–	0	0	–	9/42 (21)	NR	NR	–	2/42 (5)	2/42 (5)	–	4/42 (9)	4/42 (9)	–	3/42 (7)	3/42 (7)	–	NR	Pre op.: 15 (0-46) Post op.: 9 (0-36)	Pre op.: 15 (0-46) Post op.: 9 (0-36)	–	Pre op.: 15 (6-27) Post op.: 9 (0-30)	Pre op.: 15 (6-27) Post op.: 9 (0-30)	–	3-6	NR

N.= Number; PTS= Patients; NR= Not reported; ES= Entire Study; IN= Intervention; CO= Control; DRE= Differential renal function; HUN= Hydronephrosis; UTI= Urinary tract infection.
*Reported by authors

Treatment success

The definition of success was highly variable in the included publications: decrease or resolution of the HUN [14–17,20,21], improved or stable drainage on MAG-3 [17,20,21], no obstructive curve on MAG-3 [14], absence of VUR [14], UTI [14,17], symptoms [15], no further surgery required (reimplantation) [19] or not reported in Refs. [16,18].

The treatment success rates were between 35% and 97% in the included case series. Garcia-Aparicio et al., who compared the outcomes between ET and UR present success rates of 85% and 92% respectively [14].

Median follow-up in case series was between 35.5 (12–101) to 78 (12–168) months [15–17,21], while mean follow-up reported by Romero et al. was 47 IQR 39,07 months [20]. Median follow-up in the NRS for the ET and UR groups was 36 months (24–48) and 72 months (48–84) respectively [14].

Differential renal function

Only three studies report clear data regarding pre- and post-operative median/mean DFR [14,15,21] whereas Romero et al. reports only pre-operative median DRF 36% (24–43%) [20].

Median DRF in Teklali's et al. case series was 44.3% (17–57%) in 29 cases pre-operatively and 44.8% (28–53%) in 23 patients post-operatively [15]. Mean DRF in Ortiz's et al. case series was 44.4% ± 6.3% pre-operatively and 46.2% ± 5.9% post-operatively [18]. Median DRF in Faraj's et al. case series was 49.5% (17–100%) pre-operatively and 50.5% (16–100%) post-operatively [19].

Pre-operative median DRF in the NRS for the ET and UR groups was 45% (36–60%) and 41.5% (18–53%) respectively whereas post-operative median DRF in the NRS for the ET and UR groups was 42% (35–55%) and 48% (18–52%) respectively [14]. Overall, a tendency towards a stable DRE pre-operatively compared to post-operatively, regardless of the choice of management, was observed in the studies mentioned above.

Redo procedures

Redo procedures were reported in only three case series [17,18,21] and in the NRS [14]. Kajbafzadeh et al. described 6/47 redo procedures (13%), Ortiz et al. 8/79 (10%) while Chiarenza et al. 9/35 (26%). Only Chiarenza et al. reported a case where it was necessary to repeat the procedure twice. Garcia-Aparicio et al. reported 5/13 (38%) for the ET and 2/12 (17%) for the UR groups.

Secondary outcomes of included studies

Data from NRS and case series

The secondary outcome results of 1 NRS and 7 case series are summarized below and in Table 2.

Complication of surgery/interventions

García-Aparicio et al. reported overall minor and major complications in 15 (60%), specifically 12 (92%) for the ET and 3 (25%) for the UR groups.

Minor and major complication in the case series from Teklali et al. Romero et al., Ortiz et al. Destro et al. and Faraj et al. were 15 (43%), 9 (31%), 23 (29%), 7 (23%), 13 (31%) respectively [15,16,18–20]. Two studies did not report the number of complications [17,21].

Overall post-operative complications reported by the included NRS and case series were: stent migration, stent intolerance, UTIs, transient haematuria, pain, persistent UVJO. The most reported complications were UTI's, haematuria and VUR. UTI was seen in 75% of the studies [17,21]. Urinary stone formation was described in only one patient in the Teklali's series and in three by Faraj et al. [15,19].

Faraj et al. [19] reported a significantly higher rate of post-operative complications (severe sepsis requiring urinary diversion, stent migration associated with pain etc) in the group of patients with JJ stent placement after endoscopic balloon dilatation compared to patients without JJ stent. No differences in success rate (defined by absence of further UR) where registered between the two groups.

The reported percentage of de novo VUR was 8% (26/330 renal units) in the current review [14–21]. Of these 26 renal units, 17 cases were managed by sub-ureteral endoscopic bulking therapy, 7 cases by UR and in 2 cases no details about secondary management were noted [14,19]. Three case series reported no incidence of de novo VUR [15,16,21]. Only one author routinely screened for de novo VUR postoperatively with VCUG [14]. Others performed VCUG during follow up only in case of febrile UTI to rule out VUR [17,18,20]. The remaining authors did not specify when, why and whether VCUG was performed during follow up [15,16,19,21].

Intervention not feasible

The most frequent reasons for a non-feasible procedure were the failure of the guidewire to pass through the UVJ reported in 13/24 [18,20,21] and anatomical anomalies (ectopic ureteral implantation, meatal stenosis etc.) in 4/24 patients [15,17] whereas in 7 patients it was not specified [16] and in two studies it was not reported [14,19].

Failure of the treatment

The number of failed procedures that required a ureteral reimplant varied widely between the studies: Teklali et al. 1/35 (3%), Kajbafzadeh et al. 5/47 (11%), Garcia-Aparicio et al. 3/25 (12%), Destro et al. 5/30 (17%), Chiarenza et al. 6/35 (17%), Romero et al. 7/29 (24%), Ortiz et al. 10/79 (13%) and Faraj et al. 9/42 (21%) [14–21]. Chiarenza et al. performed Cohen's ureterocystostomy [17]. None of the other case series reported the method of salvage UR [15,16,18–21]. In the NRS a psoas-hitch-Leadbetter-Politano technique was used in two patients in the UR group as secondary UR [14].

Pre- and post-operative hydronephrosis

Three case series report data about the diameter of the renal pelvis [18–20]. In Romero et al. study population pre-operative median diameter was 18 (12–26) mm and 8 (0–20) mm 18 months after surgery, Ortiz et al. report a pre-operative mean pelvis diameter of 19.2 ± 4.9 mm and 5.2 ± 3.5 mm post-operative 18 months after surgery and Faraj et al. report a median pre-operative diameter of 15 (0–46) mm and post-operative of 9 (0–36) mm.

In the study by García-Aparicio et al., pre-operative major diameter of the renal pelvis was 27 (10–47) mm and post-treatment 0 (0–10) mm in the ET group whereas it was 19 (10–58) mm pre-operative and 9.5 (0–24) post-operatively in the UR group.

All studies reporting data about renal pelvis showed an improvement after surgery [14,18–20].

Also, all the studies reporting ureteral diameter showed an improvement after surgery. Pre- and post-operative ureteral diameter was reported by Teklali et al. 16 (10–30) mm and 6 (2–20) mm respectively, by Destro et al. 16 (10–25) mm and 7.9 (2–15) mm respectively, Ortiz et al. report a pre-operative mean diameter of 14.9 ± 2.9 mm and 6.6 ± 6.5 mm post-operative 18 months after surgery and Faraj et al. report a median pre-operative diameter of 15 (6–27) mm and post-operative of 9 (0–30) mm. Romero et al. reported pre-operative diameter 14.2 (11–21) mm and post-operative data from only five patients 8.5 (3–11).

Improvement of the outflow curve on renal scan

Improvement of the out–flow curve on renal scan was found in 57% patients by Teklali et al. and in 69% of renal units in Romero's et al.

Discussion

Principal findings

Treatment success rates were between 35% and 97% in the included case series, whereas the only NRS [14] that compared the outcomes between ET with high-pressure balloon dilatation of the UVJ and UR, presented a success rate of 85% and 92% respectively.

Age at intervention was not uniformely reported, some as mean ± SD in months [15,16,21] others a median and range in months [14,17–20]. Therefore, no overall average age in months was reported in this SR. A tendency towards a younger age at intervention in the ET group compared to the UR group in the NRS [14] was noted, although not statistically significant.

Some studies evaluated age at intervention [16,17] and/or cystoscopic appearance of the ureteral orifice [16] as predictors for success of treatment. No significant differences in success of ET of POM were found in these subgroups.

Drainage (JJ stent) of the upper urinary tract following dilatation/incision of a narrow UVJ, is suggested for a short period to prevent possible obstruction due to oedema,

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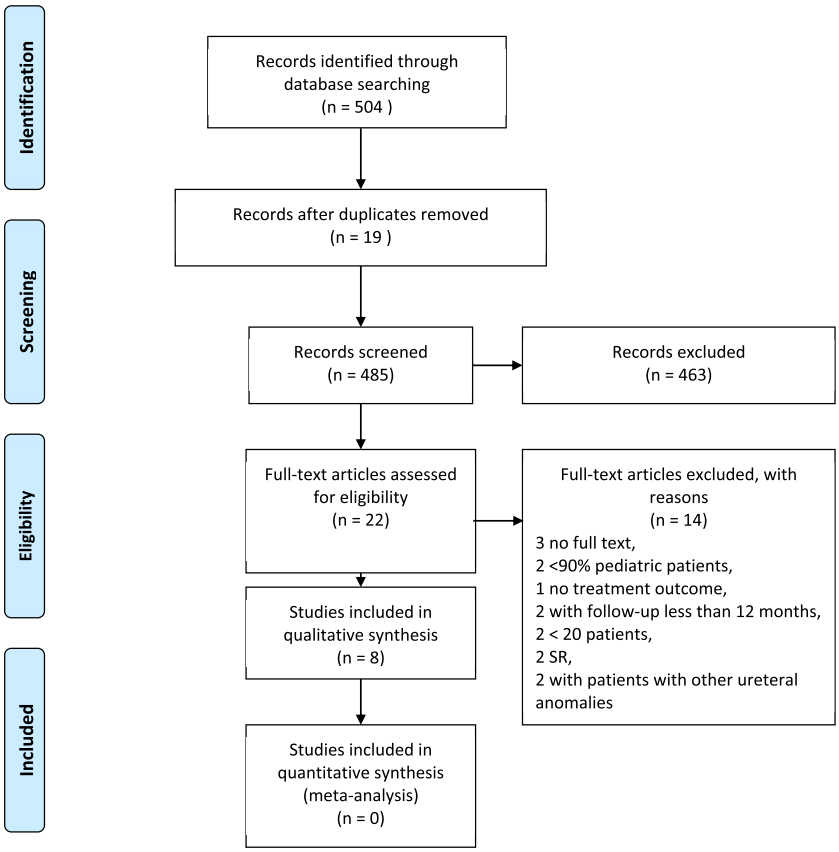

Fig. 1 PRISMA flow diagram. PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-analysis.

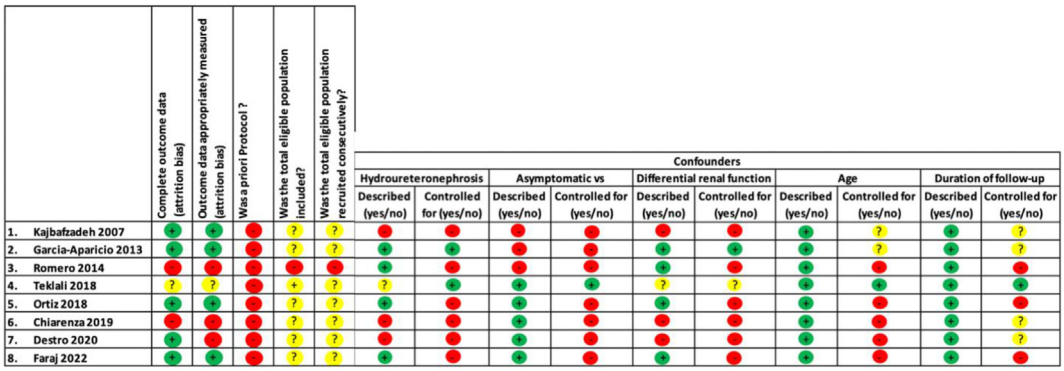

Fig. 2 Risk of Bias and Confounders for the 8 studies.

epithelia hyperplasia, or inflammatory cell reaction. However, JJ stent placement has been reported to be associated with morbidity [10]: abdominal pain, haematuria, stent migration or incrustation, urinary tract infections etc. Faraj et al. noted at significantly higher post-operative complication rate in the group of patients with a JJ stent positioned after endoscopic balloon dilatation compared to the group without JJ stents. The two groups being comparable with a demonstrated equal success rate following treatment.

In 2018 by Doudt et al. [9] published a SR, investigating ET of POM and its outcome. They included 12 case series describing 222 patients with 237 obstructed renal units.

Mean age at time of surgery was 24.6 months (range 3–84). All study subjects were either examined by an ultrasound scan of the urinary tract or MAG 3/magnetic resonance urography; some received both. After a single intervention (cystoscopy + balloon dilatation + JJ stent, cystoscopy + ureterotomy + JJ stent or cystoscopy + JJ stent), there was a 69.6% improvement in HUN and a 68.0%

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either stable or improved DRF. Success rates were highest in children ≥12 months of age (overall 71.8% after a single intervention) compared to infants (overall 61.9% after a single intervention).

Another SR was published by Aiello et al. [22] who included 13 retrospective studies with a total of 324 patients with a median age ranging from 4 months to 7 years. Indications for treatment varied in the different studies, however most studies included patients with increasing dilatation, obstructive patterns on MAG-3 scan, decreased renal function or symptoms. Endoscopic management included endoscopic balloon dilatation or incision of the UVJ usually followed by temporary JJ-stent placement. The overall median follow-up was between 21 months and 10.3 years. Overall success rate reported ranged from 69 to 100%. The complication rate ranged from 0 to 50%. De novo VUR was reported in some of the included studies, with an incidence between 5% and 27%.

The findings in these two SR [9,22] are comparable to the findings of the current SR. As opposed to the other reviews, the current SR did not include studies in which cystoscopy + JJ stent placement was performed as ET of POM [9]. Although, internal diversion with JJ stent alone for treatment of POM, has been reported with decent outcomes and without the need for further intervention, it has been associated with a significantly high rate of comorbidity [10] [—] [12]. Moreover, contrary to Doudt et al. [9] we did not find any differences in terms of success of the ET of POM between patients younger than 1 year and older ones.

Implications for clinical practice

Historically, UR with or without ureteral remodelling has been the gold standard for treatment of progressive or persistent POM. It has stood the test of time, producing excellent and durable result with success rates over 90% in several studies [5,6,23]. In comparison to ET (dilatation with or without balloon or incision), open surgery with reimplantation of a grossly dilated ureter into a small bladder, can be technically challenging with significant morbidity [4—7]. Furthermore, the possible iatrogenic postoperative bladder dysfunction following UR has been reported by several authors [24—26].

A limitation to ET in infants is the risk of not be able to pass the balloon catheter into the obstructed segment of the ureter or failure to pass the paediatric cystoscope into the urethra. In our SR initial failure to perform ET occurred in 7% (24/330) of the obstructed renal units, with a preponderance of cases in the study by Chiarenza et al. [17]. Overall, most of these cases went on to UR.

During follow up, 28 cases (28 renal units) had a secondary balloon dilatation, either at removal of JJ-stent because the ureteral orifice could not accommodate the paediatric cystoscope or as a salvage procedure because of relapse of POM.

Overall, 14% (47/330) of renal units ended up with salvage UR following initial ET, due to relapse of symptomatic POM. In patients undergoing UR the salvage rate (re-do UR) was 17% (2/12) of renal units in the NRS [14] in this SR and in the literature reported to be within 3—5% [5—7,23].

There is concern that manipulation of the ureteral orifice when performing ET of POM, can results in iatrogenic vesicoureteral reflux (VUR). In the current SR, the overall incidence of de novo VUR was 8% (26/330 renal units). Compared to, patients undergoing UR for POM, the incidence of de novo VUR is reported to be between 3 and 13% depending on the surgical technique [5,6,23].

It should however be noted that most of the studies covered in this SR did not routinely screen for VUR [14], with most VCUGs being performed on indication of febrile UTI during follow up [17,18,20] therefore the true incidence of de novo VUR may be higher than what has been reported. In three case series, no events of de novo VUR occurred during follow up. Interestingly, no VCUG was performed in those case series during follow up [15,16,21]. Finally, de novo VUR may in some cases also be transient following ET of POM, and as stated by García-Apericio et al. [27] VCUG should not routinely be performed during follow up, but limited to cases where febrile UTIs are occurring.

Further research

It is imperative that studies with long-term follow-up of children diagnosed with POM treated with endoscopic dilatation/incision be conducted. More importantly, RCTs (endoscopic dilatation/incision vs. UR) providing pre- and postoperative measurement of renal function are needed.

Limitations and strengths

In this SR several strengths and limitations need to be addressed.

First, the quality of evidence from the included studies were average with retrospective case series design, small sample sizes, significant heterogeneity in primary endpoints and short follow-up being common.

Second, selection bias may be another limitation, as only three out of the eight studies clearly stated the use of consecutive patients. It is possible that patients in the remaining three studies [14,16,20] selected for ET had radiographic findings that were more likely to result in improvement or resolution of POM with conservative management alone (i.e., more acceptable DRF or stable HUN).

Third, we may have introduced bias based on language restriction and by excluding single case reports, single cases series less than 20 patients and mean follow-up less than 12 months.

The strength of this SR on the other hand is that it was performed by a group of experts including clinicians and methodologist (EAU Paediatric Urology Guideline Panel) according to PRISMA guidelines with results planned to be incorporated into the upcoming updated of the practice guidelines.

Conclusion

In conclusion, ET (dilatation with or without balloon or incision) for persistent or progressive POM in children is a minimally invasive alternative to UR with a modest success rate. The procedure could not be completed in 10% of the cases and 13% ended up with salvage UR following initial ET,

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because of relapse of symptomatic POM. Additionally, ET could be performed within a wide age span (15 days of age to 192 months of age), with equal success and complication rates.

Conflict of interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpurol.2023.09.005.