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The embedded nipple: An optimal technique for re-implantation of primary obstructed megaureter in children

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Abstract *Objectives:* To present a novel ureteric re-implantation technique for primary obstructed megaureter (POM) that ensures success in the short- and long-term, as conventional techniques are not ideal for megaureters especially in children, with ureteric stenosis and reflux being common complications after re-implantation.

Patients and methods: Between 2009 and 2012, 22 paediatric patients with POM were enrolled. We performed a new technique for re-implantation of these ureters to ensure minimal incidence of ureteric strictures and easy subsequent endoscopic access. We performed follow-up voiding cystourethrography (VCUG) at 6 months postoperatively.

Results: The cohort comprised 14 boys and eight girls, with a median age of 22 months. Six patients underwent bilateral re-implantation. The mean (range) duration of indwelling ureteric catheterisation was 7.8 (4–14) days. There were no complications in the perioperative and postoperative periods. There was no reflux on follow-up VCUG in any of the patients. One patient developed Grade I reflux after 1 year and presented with a urinary tract infection. Diagnostic cystoscopy was performed in 13 patients showing that the nipple was directed similarly to the native ureteric orifice.

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Conclusion: The embedded-nipple technique for re-implantation of POM guarantees successful results and permits easy subsequent ureteroscopic access when needed.

Introduction

The abnormally dilated ureter (megaureter) is classified as: refluxing megaureter, obstructed megaureter, non-refluxing non-obstructed megaureter, or megaureter with obstruction and reflux [1]. It is a clinical problem in both children and adults. Primary obstructive megaureter (POM) is due to abnormal peristalsis of the distal ureter that creates a functional obstruction. Most of these megaureters are treated conservatively, but surgical intervention for such refluxing or obstructed ureters is frequently indicated when febrile UTI or pain occur, or when there is progressive hydronephrosis or deterioration of split renal function [2].

Conventional techniques for tunnelling re-implantation are not feasible in these intact large ureters, especially in young children, because it is difficult to achieve a 5:1 tunnel length to width ratio as recommended [3,4]. Submucosal tunnelling can be used in these dilated ureters only after remodelling of the ureter via trimming or folding to an acceptable width suitable for tunnelling. As tailoring carries the risk of jeopardising the blood supply of the ureter, preservation of the adventitia is suggested. Plication can be improved by tapering the ureter over a catheter by the placement of horizontal mattress sutures and the excess ureter folded on itself. Extravesical submucosal implantation of the intact dilated ureter has been tried with acceptable long-term results. Although, all these reports show successful results with low complication rates the proposed techniques are surgically cumbersome, especially in the relatively small bladder of children [5].

To date, an optimal procedure for re-implanting POM is not available. The present study proposes a novel technique that might be ideal, as shown by the short- and intermediate-term follow-up data. The objective of the present study was to describe a novel anti-reflux technique for POM and review the perioperative outcomes and complications of this technique performed at our institution.

Patients and methods

After approval by the Institutional Review Board of the Alexandria Main Hospital at the Faculty of Medicine, the electronic records for 22 paediatric patients with POM between 2009 and 2012 were evaluated. The chief complaint was abdominal pain associated with recurrent febrile UTI.

Preoperative studies included: renal ultrasonography (US), voiding cystourethrography (VCUG), diethylene-triamine-penta-acetic acid (DTPA) diuretic renogram, and in some MRI was also performed. Renal US was used to measure the diameter of renal pelvis and distal ureter, and the characteristics of the renal parenchyma. The hydroureteronephrosis (HUN) grade was defined according to the guidelines of the Society of Fetal Urology. VCUG was performed to exclude VUR.

The diagnosis of POM was made according to the following: a distal ureter diameter of > 10 mm, a DTPA diuretic renogram showing an obstructed curve, and no VUR on VCUG. The indications for surgery were a combination of clinical, US, and DTPA findings. Breakthrough febrile UTIs in those patients under antibiotic prophylaxis were clinical criteria indicating surgery. Worsening HUN and/or a thinned out parenchyma were the US criteria for surgical intervention. Impairment of $> 10\%$ of differential renal function (DRF) or a DRF of $< 40\%$ were the criteria on DTPA findings for indicating surgery. Exclusion criteria included age of < 1 year, presence of neurogenic bladder, and redo ureteric re-implantation.

Operative technique

All patients were operated upon under general anaesthesia. The technique described in the study involves dissection of the ureter down to the vesical end, where it is separated and brought anterior to the vas deferens in male or round ligament in female patients. The ureter is drawn into the bladder through the detrusor muscle using a splitting puncture, rather than detrusor cutting, allowing the formation of a new hiatus. The new hiatus is made in the bladder wall as close to the bladder base as possible using dissecting forceps. The planned nipple is designed with a length to width ratio of 2:1. A fixing suture is taken passing through the bladder wall, base of the ureter and its distal edge after spatulation of the intravesical ureter opposite to the suture to its middle, and the suture is then tied (Fig. 1).

A raw area in the bladder wall opposite and equal to the nipple is made using diathermy (Fig. 2). A transverse embedding suture is started at the base of the nipple passing through the following structures in sequence:
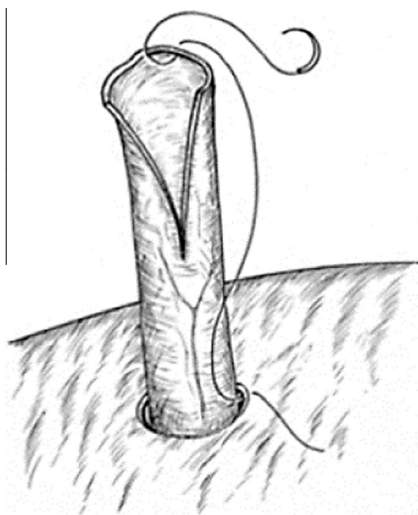
Figure 1 The planned nipple is designed with a length to width ratio of 2:1.
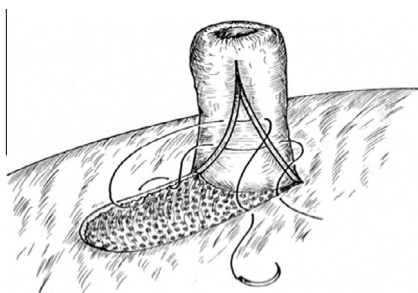
Figure 2 A raw area in the bladder wall opposite and equal to the nipple is made using diathermy.

trough mucosal edge, trough bed, both ureteric walls, opposite trough bed, opposite trough mucosal edge, mucosal edge distally, trough bed, both ureteric walls distally, trough bed, trough mucosa, then the suture is tied, while a 6–8 F ureteric stent is placed in the ureter (Fig. 3). The nipple is formed with the edges of ureteric walls embedded into the raw surface of the trough. A second distal suture may be required according to the nipple length, and lastly the ureteric stent is fixed.

The patients were followed-up with US at 1, 3, 6 and 12 months postoperatively, and then annually. A VCUG was performed at 6 months postoperatively.

Outcome variables analysed were: the diameter of the renal pelvis and distal ureteric diameter on US, presence of postoperative VUR, and complications. Qualitative data were analysed using the chi-square test or Fisher's exact test, and quantitative data were analysed using the Mann–Whitney U-test for unpaired data and the Wilcoxon test for paired data.

A comparative analysis was performed between patients who underwent the embedded-nipple technique and an age-matched control group of 18 children with POM who underwent tailored ureteric re-implantation during the same study period and by the same surgical team, for operative and postoperative outcome (See Table 1).

Results

Embedded-nipple ureteroneocystostomy was performed in 22 patients during the study period and six underwent bilateral re-implantation. Ureteric stenting was used in all patients. The mean (range) operative time was 88 (72–145) min and duration of ureteric stenting was 7–8 days (range 4–14 days). The mean (range) hospital stay was 4 (2–9) days.

There were no major complications in the perioperative and postoperative periods. The early and late complications that did occur are listed in Table 3. Early complications occurred in five patients; four had mild-to-moderate haematuria that was managed conservatively and one had prolonged ileus. There was no evidence of urinary extravasation in that patient; however, this patient had undergone bilateral ureteric re-implantation for bilateral POM associated with renal impairment, which might have contributed to the prolonged postoperative ileus. UTI was diagnosed in four patients after re-implantation.

Two patients (19%) developed a late complication in the form of acute pyelonephritis, one of whom had confirmed reflux on VCUG (Grade II). All other patients showed no reflux on follow-up VCUG. No cases of ureteric obstruction were documented by postoperative US. Significant improvement of HUN was seen in 19/22 patients (Table 2). In three patients, HUN remained stable during the follow-up period with no clinical symptoms. In no case was there evidence of newly developing hydronephrosis or worsening of a previously established one beyond the 1-year postoperative US denoting absence of ureteric obstruction. The success rate was 86.3% for HUN improvement. The median (range) follow up was 38 (18–42) months.

Diagnostic cystoscopy was performed in 13 patients showing the embedded ureteric nipple was directed similarly to the native ureteric orifice.

On comparing the outcomes of patients who underwent the embedded-nipple technique and patients with tailored re-implantation, there were no significant differences in hospital stay, success rate, follow-up duration, and complication rates (Table 4). The embedded-nipple technique had a significantly shorter operative duration compared with the tapered re-implantation ($P = 0.003$). None of patients who underwent embedded-nipple re-implantation required redo surgery; however, two patients with tapered ureteric re-implantations needed secondary ureteric
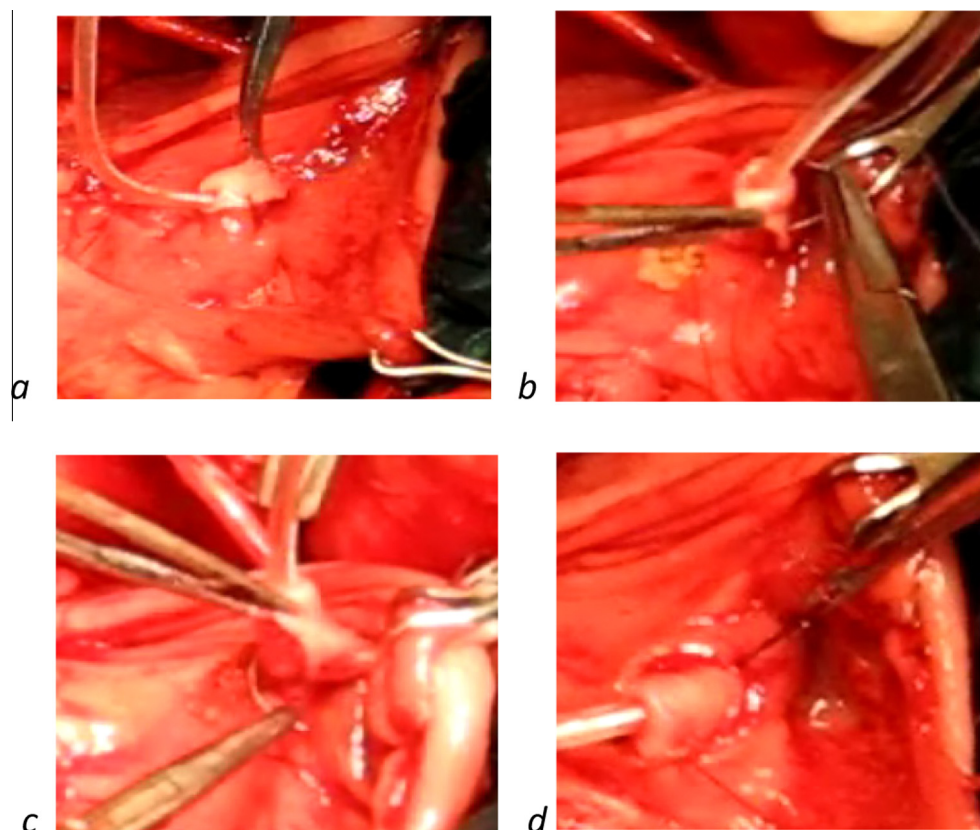
Figure 3 Operative steps of embedded-ureter technique for re-implantation. (a) Fixation of spatulated of ureter to bladder wall. (b) Fixation of proximal part of the nipple to diathermised part opposite to the nipple. (c) Fixation of distal part of the nipple to the bladder wall. (d) Final appearance of fixed nipple to the trough in the bladder wall.

Table 1 Patients' preoperative characteristics.

Variable	Value
Median (range) age, months	22 (12–86)
Gender, n	
Male	14
Female	8
Side, n	
Right	18
Left	10
Median (range)	
Pelvic diameter, mm	28 (10–48)
Distal ureteric diameter, mm	14 (10–22)
DRF, %	42.5 (20–62)

Table 2 US findings.

	Preoperative	Postoperative	P
Median (range) pelvis diameter, mm	28 (10–48)	9 (4–26)	0.003
Median (range) distal ureteric diameter, mm	14 (10–22)	6 (2–8)	0.001

re-implantation for the presence of high-grade reflux (one patient) and ureteric obstruction (one patient), which was statistically significant ($P = 0.048$).

Table 3 Postoperative complications after ureteric re-implantation.

Complications	N
Early	
UTI	2
Prolonged ileus	1
Haematuria	4
Urinary leakage	0
Late	
VUR	1
Ureteric obstruction	0
Pyelonephritis	2

Discussion

In the present study, we describe the technique of embedded-nipple ureteroneocystostomy for paediatric re-implantation of POM. The nipple procedure is a safe and simple anti-reflux technique, with a high success and low complication rate [6–9]. The present technique includes an additional step after nipple formation by fixing the nipple edges to the bladder wall. This step allows for a better anti-reflux mechanism that enhances what the nipple technique provides. In addition, embedding fixes the nipple, so that future instrumentation is easy.

Table 4 Comparison of the embedded-nipple group and the tailored re-implantation group for operative and postoperative outcomes.

Variable	Embedded nipple (n = 22)	Tailored re-implantation (n = 18)	P
Median (range)			
Age, months	22 (12–86)	20 (14–64)	0.62
DRF, %	42.5 (20–62)	33.8 (28–48)	0.07
Operative time, min	88 (72–145)	95 (92–192)	0.003[*]
Hospital stay, days	4 (2–9)	4 (2–6)	0.18
Follow-up duration, months	38 (18–42)	43 (10–66)	0.56
Success rate, %	86.3	83.3	0.12
Complication rate, n (%)			0.82
Early			
UTI	2 (9)	2 (11.1)	
Prolonged ileus	1 (4.5)	0	
Haematuria	4 (18.1)	3 (16.6)	
Urinary leakage	0	2 (11.1)	
Late			
VUR	1 (4.5)	2 (11.1)	
Ureteral obstruction	0	1 (5.5)	
Pyelonephritis	2 (9)	1 (5.5)	
Secondary ureteric re-implantation, n (%)	0	2 (11.1)	0.048[*]

[*] Significantly different.

At follow-up, achieving a non-refluxive and non-obstructive ureter with resolution of upper tract dilatation and recovery or stabilisation of renal function is considered successful [9].

Some techniques have been described to anastomose the dilated ureters more easily. It was reported that stenosis and obstruction could occur, as branches of the hypogastric and inferior vesical arteries are jeopardised during tailoring [10]. Hendren [11] reported reflux and stenosis rates of 5% and 7%, respectively. Another treatment choice is to plicate the distal ureter to decrease its diameter. Ehrlich [12] plicated 74 ureters and performed ureteroneocystostomy using the sub-mucosal tunnel technique.

Perovic [13] performed ureteroneocystostomy in 128 patients (167 megaureters), with a mean age of 22 months. He neither plicated nor tapered the ureters and he created the anastomosis using the extravesical submucosal tunnel technique. At a mean 2.5-year follow-up there were no significant complications other than stenosis in two patients and reflux in three. He concluded that megaureter spontaneously folds within the tunnel and it can easily be placed between the detrusor and the mucosa.

The present proposed technique is believed to be an optimal method for re-implanting POM ureters for the following reasons. First, the new ureteric orifice is subterminal, which is more vascular than the terminal orifices made in plication or tailoring techniques. This might explain the absence of ureteric stricture or obstruction in the present series. Second, the new orifice is sutureless and accordingly has a very low risk of early postoperative oedema with consequent obstruction or late stomal stenosis. Third, it provides an efficient non-obstructing anti-reflux

re-implantation without tailoring, allowing time for involution of the nipple concomitantly with the involution of the dilated ureter without any future discrepancy in the diameter of the lumen of both the nipple and the ureter.

Another advantage cited for the embedded-nipple techniques are the simplicity of the surgical technique and reduced operative duration. On comparing outcome in our present group of patients, the embedded-nipple technique had a significantly shorter operative duration compared with the tapered re-implantation ($P = 0.003$), this is probably due to the additional time spent in tailoring or plication, which is needed for megaureter tailored implantation. Endoscopy performed several months after re-implantation showed a well-formed smaller nipple, in some cases it looked like a 'volcano' type of normal ureteric orifice. Ureteric orifices could be identified easily and negotiated by endoscopic retrograde approaches.

We choose the term 'embedded nipple' to describe our technique, as the two lateral edges of ureter are embedded into a raw diathermised part of the bladder wall by a transverse mattress suture, we believe that this prevents the influence of urine exposure on the ureteric adventitia, which is embedded into the trough in the bladder wall that may result in an unpredictable amount of scarring. The anti-reflux mechanism in this technique is a double mechanism; nippling and embedding. The presence of the nipple allows for a shorter embedding nipple length. During bladder filling the detrusor is relaxed and compliant allowing urine to pass without resistance. In addition, passing the dilated ureter through a muscle-splitting incision may allow a better anti-reflux mechanism that adds to what the embedded-nipple technique provides without the fear

of causing obstruction with detrusor contraction during voiding augmenting the anti-reflux mechanism.

While the embedded-nipple technique reported here has been used in an effort to decrease reflux across the vesico-ureteric anastomosis, the technique could also theoretically predispose to stenosis at the vesico-ureteric junction. A trend towards increased stenosis with nipple anti-reflux techniques for the vesico-ureteric anastomosis has also been reported elsewhere [14].

In the present study, there was only one patient (4.5%) with low-grade reflux (Grade II), as confirmed by postoperative VCUG at 6 months, who was followed conservatively. In no case was there any evidence of ureteric obstruction or stenosis at the vesico-ureteric junction, as shown by the absence of newly developing hydronephrosis or worsening of a previously established one beyond the 1-year postoperative US. None of patients who underwent fixed-nipple re-implantation required redo surgery; however, two patients with tapered ureteric re-implantations needed secondary ureteric re-implantations. This was statistically significant ($P = 0.048$). This may be attributed to the presence of a dilated ureter in all our cases with no excision or tailoring, a subterminal sutureless ureteric orifice, in addition to the routine use of ureteric stenting in all cases, which may potentially have further improved our results with minimal risk of additional complications. While some studies have questioned the need for routine stenting [15,16], most have shown success with stenting in decreasing the rate of ureteric complications [17–20].

The ureteric complications in the present study are generally comparable to the range reported in other paediatric ureteric re-implantation literature [3,4,10–12]. The frequency of ureteric complications reported varies significantly, as would be expected given the variability in what is defined as a complication and the lack of standardised use of diagnostic studies to evaluate for urological complications, both within and across studies. The potential advantages of this embedded-nipple approach compared with those requiring submucosal tunnelling include: reduced operating time; reduced tissue handling, oedema and inflammatory reaction; reduced volume of suture material left *in situ*; and ease of any future retrograde endoscopic manipulation.

The present study has several limitations, including the fact that it is a retrospective case series. The small sample size restricts the number of variables tested for confounding. In addition, the absence of long-term follow-up is a limiting factor. Despite these limitations, the embedded-nipple technique seems to be more effective in preventing reflux in terms of outcome and complication rates. We are updating our database and future prospective randomised studies with a larger patient group and longer follow-up is ongoing to further elaborate on the feasibility and efficacy of this novel technique.

Conclusion

The embedded-nipple technique for re-implantation of POM yields improved results, effectively eliminating reflux and preventing obstruction, and permits easy subsequent endoscopic access when needed. Comparative studies with longer follow-ups are needed to assess the long-term outcomes of this technique.

Conflicts of interest

None.

Source of funding

None.

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