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UROLOGY - ORIGINAL PAPER

# Modified ureteral orthotopic reimplantation method for managing infant primary obstructive megaureter: a preliminary study

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**Abstract**
*Purpose* To describe a modified ureteral orthotopic reimplantation method in infant with primary obstructive megaureter (POM) and report our initial experience.
*Methods* Thirteen children with POM (range 1–7 months) underwent modified transvesical ureteral implantation surgery. Treatment consists of transecting the ureter proximal to the obstruction and performing orthotopic reimplantation in end freely fashion with distal ureter protruding into the bladder, providing dilated ureteral diameter: ureteral exposure length in bladder ratio of 1:1.5–2. All patients underwent repeat ultrasound, radionuclide imaging and voiding cystourethrography. Cystoscopy was conducted in patients at 6 months after surgery.
*Results* The mean operating time was 40 min. There were one redo this procedure for recurrent obstruction and one Cohen reimplantation for Grade 5 vesico-ureteral reflux in one bilateral POM. Hydroureteronephrosis improved in other 11 patients, and the ureter diameter was significantly reduced from preoperative measurements. At the time of cystoscopy, thick and large volcanic-shaped ureteral orifice was found and urine ejected intermittently.
*Conclusions* The proposed 'modified ureteral orthotopic reimplantation' with no tapering or advancement for POM in infants is a simple, feasible and less invasive procedure that had good success rates in this small series. Further, larger studies are required to support or negate the usefulness of this technique.

**Keywords** Primary obstructed megaureter · Ureteral reimplantation · Ureteral orifice · Vesico-ureteral reflux · Infant

## Introduction

Primary obstructive ureter (POM) is an upper urinary tract malformation in children and occurs in 0.36 of 1000 to 1 of 1500 live births [1, 2]. The management of progressive POM in children remains controversial. While conservative management is required for the majority of megaureters, most cases of POM resolve spontaneously, or improve without loss of function or appearance of symptoms [3]. Some megaureters are associated with increasing dilatation, UTI and deteriorating renal function, and require surgical intervention [1, 2]. Ureteral tapering and reimplantation is an established treatment for persistent or progressive POM. For preventing VUR during reimplantation, Paquin proposed a tunnel length of five times the ureteric diameter [4]; however, classical reimplantation can be extremely difficult in a small infant bladder [5]. Hence, less invasive procedures have been proposed as alternatives and of late, several authors have favored refluxing reimplantation [6–9]. In the present study, we aimed to describe our modified surgical technique of ureteral orthotopic reimplantation in infants, where no tapering or advancement of the ureter was performed, and report the clinical outcomes.

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## Materials and methods

### Patient enrollment and characteristics

From January 2012 to January 2014, a total of 13 patients and 15 ureters were treated with modified ureteral orthotopic reimplantation for POM. The patients comprised 10 boys and 3 girls, with a median age at surgery of 3.1 months (range 1–7 months). Eight cases were left sided, 3 right sided and 2 bilateral. All cases were diagnosed prenatally. POM was diagnosed after confirming absence of VUR or ureteropelvic junction obstruction (UPJO) on VCUG and the presence of hydroureteronephrosis with megaureter on ultrasound. Preoperatively, patients were evaluated with at least two urinary system ultrasounds, VCUG, and either an MRU or renal scan study. Surgery was performed solely in those cases in which there was persistence of obstruction on the renogram along with the following conditions: ≥10 % deterioration of split renal function (11 cases), recurrent febrile UTI in spite of antibiotic prophylaxis (2 cases). The mean diameter of the megaureter was 1.19 cm (range 0.78–1.55 cm). Informed consent and treatment options were discussed with parents.

### Brief description of the employed techniques

After opening the bladder, we made an incision around the original ureteral orifice of POM (Fig. 1a). The distal narrow segment and grossly dilated proximal segment were dissected out (Fig. 1b). No attempt at tapering was performed; the proximal dilated ureter was reimplanted again at the original position protruding into the bladder in an end freely fashion, using interrupted 5–0 absorbable suture of the seromuscular layer of the ureter with bladder mucosa and part of detrusor (Fig. 1c, d). After that the distal narrow segment was excised. Then, the terminal ureteral mucosa was slightly turned outsides and sutured with the seromuscular layer of the ureter to form the neo-orifice (Fig. 1e). The length of protruding portion of ureter in bladder was equal to 1.5–2 times of the dilated ureteral diameter (Fig. 1f). No double-J stent was used.

### Follow-up procedure

All patients underwent repeat ultrasound and VCUG at 3, 6 months and 1 year postoperatively to exclude obstruction or VUR. The diameter of the ureter was measured at the midureter level before and after voiding to determine its dilation. The cystoscopy was performed in patients at 6 months after surgery to evaluate the new ureteral orifice.

## Results

Patient characteristics and surgical outcomes were summarized in Table 1. The modified ureteral orthotopic reimplantation was successfully performed in all cases. Mean operative time was 40 min (range 30–100 min), and there were no intraoperative complications. Blood loss was minimal

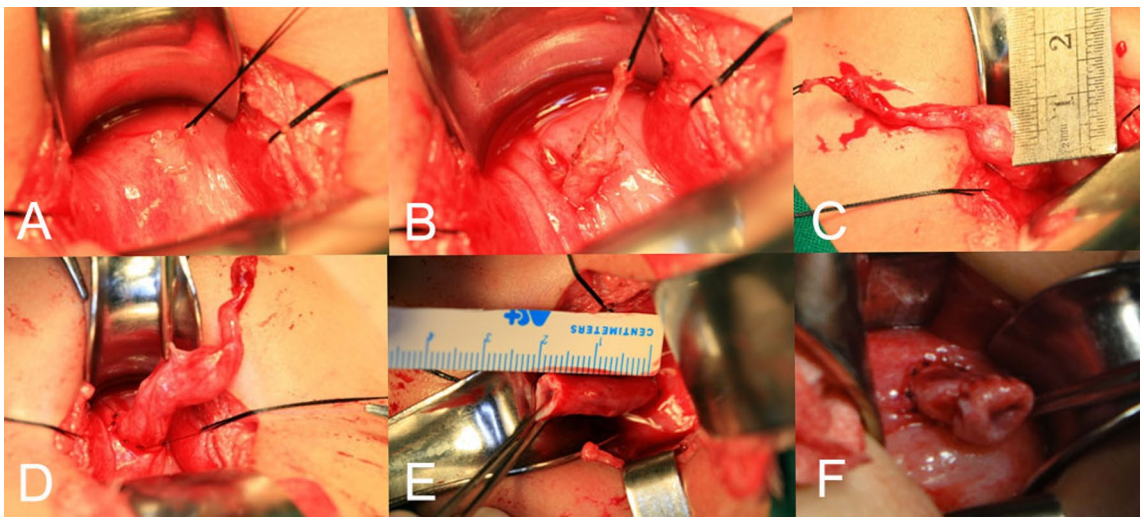


**Fig. 1** Surgical procedures of intravesical modified ureteral orthotopic reimplantation. An incision around the original ureteral orifice of POM was made (**a**). The distal narrow segment and grossly dilated proximal segment were dissected out (**b**). The dilated ureter diameter was measured (**c**). The seromuscular layer of proximal dilated ureter was sutured with bladder and part of detrusor, and the ureter was reimplanted at the original position with end protruding fashion (**d**). And then the distal narrow segment was excised, providing a ureteral diameter/ureteral exposure length in bladder ratio of 1:1.5–2 (**e**). Finally, the terminal ureteral mucosa was slightly turned outsides and sutured with the seromuscular layer of the ureter to form the neo-orifice (**f**)

**Table 1** Patient characteristics and surgical outcomes

| Variables | *N* (%) |
|---|---|
| Age, mean ± SD (months) | 3.1 ± 1.8 |
| Gender, *n* (%) | |
| Male | 10 (76.9 %) |
| Female | 3 (23.1 %) |
| POM laterality, n (%) | |
| Unilateral | 11 (84.6 %) |
| Bilateral | 2 (15.4 %) |
| Surgical time, min, mean (range) | 40 (30–90) |
| Follow-up period, month, median (range) | 37 (23–95) |
| Improved hydroureteronephrosis (%) | 11 (84.6 %) |
| Preoperative ureteral diameter (mean ± SD cm) | 1.19 ± 0.37 |
| Postoperative ureteral diameter (mean ± SD cm) | 0.47 ± 0.08 |
| Re-operations | 2 (redo reimplantation) |

in all cases. None of the patients developed postoperative wound infections. Of note, bladder spasms were minimal.

Median follow-up was 37 months (range 23–95 months). Among 13 patients treated for POM, hydroureteronephrosis improved in 11 patients (84.6 %). One patient with persistent hydroureteronephrosis developed Grade 5 VUR and experienced urinary tract infections and then was treated by Cohen reimplantation. One patient who exhibited worsening hydronephrosis suggestive of obstruction on follow-up ultrasound underwent orthotopic reimplantation again.

Following the procedure, all ureters (excluding 2 cases of reoperation) were studied with ultrasound, all of which demonstrated a dramatic decrease in the degree of hydroureteronephrosis relative to preoperative studies. As early as 3 month post surgery, the diameter of the ureter was significantly decreased from 1.19 ± 0.37 cm prior to surgery to 0.47 ± 0.08 cm post surgery ($p < 0.05$). Ureter diameter was also reduced 6 and 12 months post surgery.

At the time of cystoscopy 6 months post surgery, the long-length ureter exposure was found to become large volcanic-shaped ureteric orifice with thick wall from which urine ejected intermittently in those patients who showed improvement without secondary VUR (Fig. 2a, b). We also found the volcanic-shaped ureteric orifice in one obstructive patient, but there was scar in the bladder anastomosis during reoperation, whereas a wide golf hole-shaped ureteric orifice was observed in one patient with secondary VUR (Fig. 2c, d).

## Discussion

Conventional management of POM involved initial cutaneous ureterostomy, followed by excision of the adynamic distal ureteric segment and reimplantation of the ureter [5, 6]. For preventing VUR during reimplantation, the Cohen technique is one of the most popular and reliable procedures with a wide range of application and simplicity [10–12]. However, sufficient tunnel length cannot be achieved in the case of severely dilated ureter or in pediatric patients with small capacity bladder. To enable this, multiple techniques have been proposed to taper the megaureter: Starr plication, Kalcinsky plication, Hendren's excisional tapering and psoas hitch [6].

Although excellent results have been achieved, the technical demands of performing a large megaureter repair and reimplanting it into the small neonatal and infant bladder can be quite challenging. And a tapered distal ureter in a long tunnel could theoretically provide a stiff segment. An associated dilated upper tract could lead to stasis, recurrent infections and loss of renal function in the long run. To avoid a potentially difficult reimplantation, refluxing reimplantation was proposed by Lee, and further favored by several authors [13–15]. However, Kaefer [15] reported the outcomes of refluxing reimplantation, and 14 out of 16 patients required reoperations. De Jong [16] did not favor this intervention when an obstructed megaureter was converted into a refluxing one. Babu [9] recently described a 'Mini reimplantation' with extravesical detrusor tunneling technique for POM, providing a modest ureter/tunnel ratio of 1:2. He reported the postoperative Grade 2–3 VUR was encountered in 2/13 patients but no redo cases.

To overcome the disadvantages of the existing procedures, we applied a simpler technique of ureteral orthotopic reimplantation for POM in infants. Using this intravesical approach, the new ureteral orifice was dragged into bladder from its orthotopic position before excising the distal narrow segment, which provides a ureteral exposure length in the bladder of approximately twice the dilated ureter diameter. Although this technique involves opening the bladder, it is easier to perform than a classical Cohen's reimplantation, as there is no cross-trigonal tunnel or tapering of ureter. Compared with the split-cuff ureteral nipple technique which has been described for ureteroneocystostomy in bowel segments for antireflux anastomosis [17, 18], our surgery is simpler without split-cuff maneuver and there is no conglutinating of ureteral nipple to the normal bladder wall rather than intestinal neobladder to form strictures. This technique demonstrated a success rate of 84.6 % for the treatment of POM. Our results are somewhat inferior to those reported in the published literature. This might be due to the inclusion of our initial experiences with this technique [15, 19].

In the present study, one patient with bilateral POM had persistent VUR during the follow-up. No volcanic-shaped ureteral orifice was found in cystoscopy as others, perhaps due to the short exposure length of distal ureter. In case of

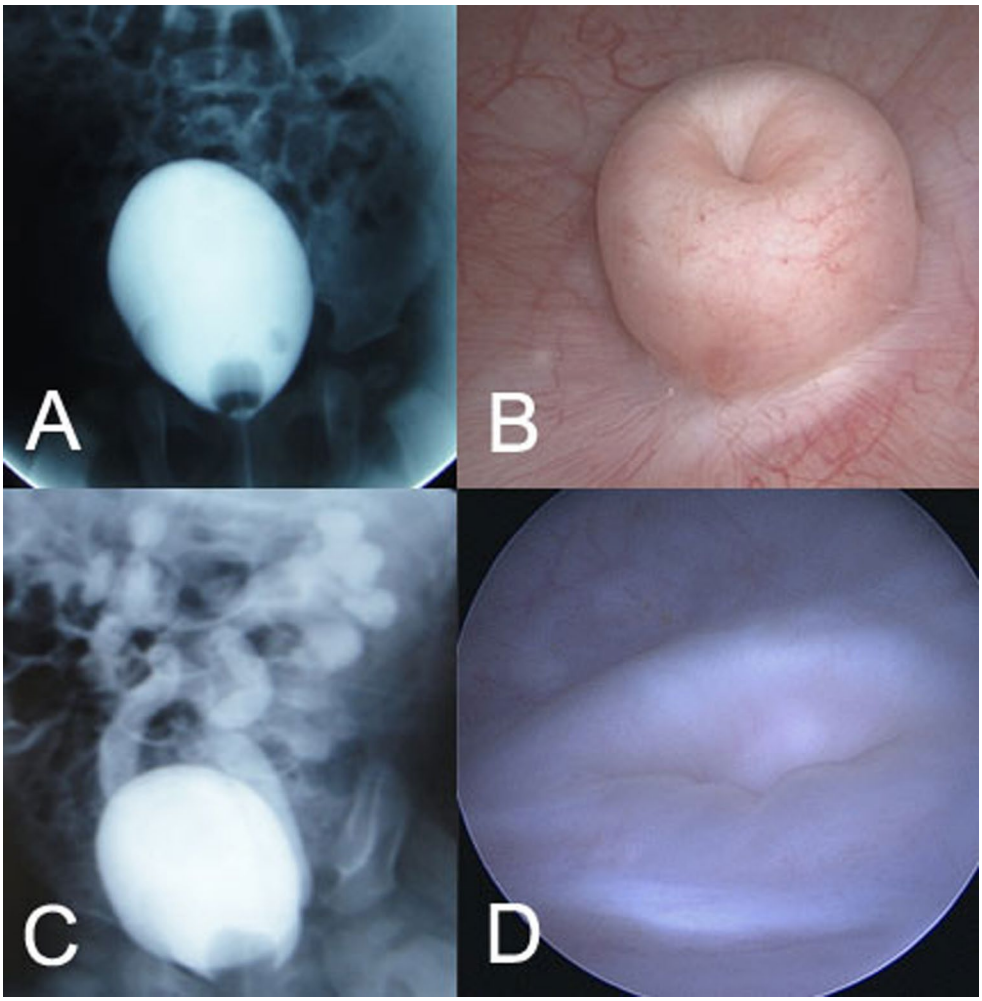


**Fig. 2** Postoperative follow-up. VCUG demonstrated no reflux (**a**) and bilateral reflux in one patient (**c**). Cystoscopy revealed large volcanic-shaped ureteric orifice with thick wall was formed in one patient who showed improvement (**b**). Wide golf hole-shaped ureteric orifice was observed in one patient with secondary VUR (**d**)

persistent VUR following this procedure, a repeat Cohen's reimplantation is feasible. Ureteral stricture at the neoureterovesical anastomosis occurred in 1 case and demonstrated severely dilated ureters on postoperative ultrasound scans. Reoperation was performed via the same procedure approximately 6 months postoperatively. Scar in the bladder anastomosis was found during reoperation. The 2 cases occurred early in our experience.

We have observed volcanic-shaped ureteral orifices with thick wall in successful cases, especially in one redo Cohen reimplantation (data not shown). Lyon pointed a volcanic-shaped ureteral orifice was more competent than a golf hole-shaped ureteral orifice [20]. The difference in force vectors exerted on the ureteral orifice may explain why the volcanic-shaped was noted to have less VUR, while the golf hole-shaped was observed to have significant problems with reflux. The study of Carlos [21] also proposed increasing ureteral thickness did increase the pressure required to collapse the ureter. Ureterovesical junction (UVJ) competence must be highly dependent on the shape, size and configuration of the ureteral orifice as suggested by Lyon. Additionally, our technique offers better shape and thickness of the ureteral orifice, which might prevent postoperative VUR in the case of no sufficient submucosal tunnel. This new understanding of the mechanisms of UVJ competence maybe will lead to experimentation with simpler and more effective surgical techniques employed for ureteral implantations.

This manuscript serves to demonstrate that this option is feasible and simple, can serve as an alternative method for relieving infant POM and is tolerated well by the majority of patients. Future larger studies comparing this technique with other procedures will be helpful in more clearly defining the role of this procedure in the infant population. Meanwhile, the effect of ureteral orifice in preventing vesicoureteral reflux needs to be addressed and further studied.

**Compliance with ethical standards**

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical approval** All procedures performed in the study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. Ethical approval was obtained from the ethics committee and review board of Provincial Hospital Affiliated to Shandong University.

**Informed consent** Informed consent was obtained from parents of all patients included in the study.

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