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Laparoscopic re-implantation of refluxing ureter in children: A feasibility study

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Abstract
Objective: To report our initial experience in the application of laparoscopy in the management of children with unilateral vesico-ureteric reflux (VUR) using the laparoscopic extravasical transperitoneal approach following the Lich–Gregoir technique, and to evaluate the results and benefits of this technique for such patients.

Patients and methods: Between February 2013 and August 2014, 17 children [13 girls and four boys, with a median (range) age of 60 (24–120) months] presented with recurrent febrile urinary tract infections and were diagnosed with unilateral VUR. They underwent transperitoneal extravasical laparoscopic ureteric re-implantation following the Lich–Gregoir technique. Postoperatively abdomino-pelvic ultrasonography was done at 1 month after surgery and voiding cystourethrography (VCUG) at 3 months after surgery, and in cases with persistent VUR or de novo contralateral VUR another VCUG was done at 6 months after surgery.

Results: The median (range) operative time was 90 (80–120) min and the postoperative hospital stay was 2 (2–5) days. Intraoperative and postoperative complications were minimal. Patients were followed-up for a median (range) of 6 (3–21) months. All the children had complete resolution symptomatically and on VCUG, without further intervention.

Conclusions: The laparoscopic extravasical transperitoneal approach for ureteric re-implantation, following the Lich–Gregoir technique, is feasible and very effective

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in the management of VUR. Prospective randomised studies are eagerly awaited to define the benefits of this technique to patients, as well as to determine the cost-effectiveness of this approach.

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Introduction

A retro-vesical ureteric diameter of $\geq 7$ mm from 30th week of gestation and onwards is considered to be dilated and can be defined as ‘megaureter’ [1]. VUR is one of the most common causes of ureteric dilatation [2] and $\sim 30\%$ of children with UTIs are diagnosed with VUR [3]. Physicians and paediatric urologists have become familiar with the management options for VUR, which include conservative, endoscopic, and surgical approaches [4]. Laparoscopic re-implantation has been introduced as a minimally invasive option for the management of VUR, but to date has not gained the popularity of other alternative methods [5].

In the present study, we report a prospective study of the use of laparoscopy in the management of children with unilateral VUR, using the laparoscopic extravesical transperitoneal approach following the Lich–Gregoir technique.

Patients and methods

Between January 2013 and September 2014, 17 children (13 girls and four boys), with a median (range) age of 60 (24–120) months underwent transperitoneal extravesical laparoscopic ureteric re-implantation following the Lich–Gregoir technique. All the children presented with recurrent febrile UTIs, despite continuous antibiotic prophylaxis. All the children were toilet trained and continent at the time of surgery. The patients’ demographic and perioperative data are given in Table 1.

Preoperative examinations for all patients included routine laboratory investigations, urine analysis and urine culture, abdomino-pelvic ultrasonography and voiding cystourethrography (VCUG), a DMSA renal isotope scan was done to demonstrate presence or absence of renal scarring.

Of the 17 patients, 14 had grade III VUR, two with grade II, and one had grade IV VUR. Two patients had a duplex system, one with history of ipsilateral upper partial nephrectomy and one with history of contralateral upper partial nephrectomy. One patient had a history of ipsilateral pyeloplasty.

The Faces, Legs, Activity, Cry, Consolability (FLACC) scale [6] was used to assess the effectiveness of pain management regimens in patients with postoperative pain in children from 2 to 84 months. For children aged $>84$ months a visual analogue scale (VAS) [7] was used. The pain management regimen included paracetamol (perfalgan®) 10 mg/kg/6 h. Rescue analgesia in the form of NSAIDs (Ibuprofen 10 mg/kg) was added when

Table 1  Patients’ demographics and perioperative data.

| Age, months | Sex | Diagnosis | Side | Grade of VUR | No. of trocars | Need for additional trocar | Operative time, min | Hospital stay, days |
|-------------|-----|-----------|------|--------------|----------------|---------------------------|-------------------|-------------------|
| 36          | Female | Refluxing | Left | IV           | 4              | No                        | 90                | 2                 |
| 120         | Male   | Refluxing | Right | III          | 4              | No                        | 120               | 5                 |
| 84          | Female | Refluxing | Left  | III          | 3              | No                        | 120               | 5                 |
| 24          | Female | Refluxing | Left  | LESS         | 3              | Yes                       | 120               | 5                 |
| 60          | Female | Refluxing | Left  | III          | 3              | No                        | 120               | 2                 |
| 60          | Female | Refluxing | Left  | III          | 3              | No                        | 120               | 2                 |
| 54          | Male   | Refluxing | Right | III          | 3              | No                        | 120               | 2                 |
| 24          | Male   | Refluxing | Left  | III          | 3              | No                        | 90                | 2                 |
| 41          | Female | Refluxing | Left  | III          | 3              | No                        | 90                | 5                 |
| 48          | Female | Refluxing | Right | III          | 3              | No                        | 80                | 2                 |
| 84          | Female | Refluxing | Right | III          | 3              | No                        | 80                | 2                 |
| 96          | Male   | Refluxing | Left  | II           | 3              | No                        | 80                | 2                 |
| 48          | Female | Refluxing | Right | III          | 3              | No                        | 80                | 2                 |
| 60          | Female | Refluxing | Right | III          | 3              | No                        | 80                | 2                 |
| 48          | Female | Refluxing | Left  | III          | 3              | No                        | 80                | 2                 |
| 84          | Female | Refluxing | Left  | II           | 3              | No                        | 80                | 2                 |
| 60          | Female | Refluxing | Left  | III          | 3              | No                        | 80                | 2                 |
FLACC scores were $\geq 4$ and when the VAS scale score was $\geq 5$.

Postoperatively, abdomino-pelvic ultrasonography was done at 1 month after surgery and VCUG at 3 months, and in patients with persistent VUR or de novo contralateral VUR another VCUG was done at 6 months after surgery.

Procedure

Patients were placed on the operating table in a supine position with the pelvis elevated (Trendelenburg). A sterile Foley catheter was placed. In all patients, the peritoneum was approached using the open Hasson technique through an umbilical incision. Three ports (two 5 mm and one 3 mm) were used in most patients, where the secondary trocars were inserted at the lateral edge of the rectus abdominis muscle at the level of the umbilicus. Only in the first two patients was a fourth port used and in one patient a single SILS™ port (Covidien, Norwalk, CT, USA) was used. The position of the surgeon was at the head of the patient.

The ureter was identified at the pelvic side-wall and dissection was completed using sharp and blunt dissection until the vesico-ureteric junction, through the broad ligament in girls and from behind the vas in boys (Fig. 1).

A transabdominal hitch suture through the bladder wall was used to suspend the bladder and expose its posterior wall. The position of the bladder trough was marked with hook electrocautery and the muscle fibres were divided with either sharp scissors or by hook electrocautery until the mucosa bulged (Fig. 2). The bladder was filled with physiological saline to expose and identify the mucosa, which facilitated the creation of the seromuscular tunnel and detrusorrhaphy without perforation.

Intracorporeal tailoring of the ureter was not required. The ureter was then placed in the bladder trough, which was closed over the ureter by interrupted absorbable 4/0 sutures, ensuring not to make the new ureteric hiatus too tight to prevent ureteric obstruction (Fig. 3).

The peritoneal cavity was drained using a tube drain. The urethral catheter was removed on the first postoperative day in patients when the bladder was not opened and on the fourth postoperative day when the bladder was opened, where the tube drain was removed on the second postoperative day in most cases.

Results

The procedure was feasible in all patients with no need for any conversions to open surgery. The median (range) operative time was 90 (80–120) min. Intraoperative

![Figure 1](image1.png)  
**Figure 1** (A) Ureteric dissection through the broad ligament in girls. (B) Ureteric dissection from behind the vas in boys.

![Figure 2](image2.png)  
**Figure 2** Creation of bladder seromuscular tunnel.

![Figure 3](image3.png)  
**Figure 3** Ureter after re-implantation and closure of the bladder tunnel.
complications were minimal and only in one case was there an accidental colonic serosal thermal injury (blanching). Postoperative pain was controlled using paracetamol. The urethral catheter was removed at a median (range) of 1 (1–3) days and tube drain was removed at a median (range) of 2 (2–5) days. The median (range) hospital stay was 2 (2–5) days. Postoperative complications were graded using the Clavien–Dindo classification [8]. There was one grade IIIB complication, a pyogenic granuloma at the trocar site, which was excised surgically. Two patients had the grade I complication of high-grade fever, which was managed by appropriate antibiotic and antipyretic treatment. There was no grade IV or V complications. Patients were followed-up for a median (range) of 6 (3–21) months. The VCUG at the 3-month follow-up showed that 15 patients had achieved complete resolution, whilst VUR was downgraded in two cases and de novo contralateral reflux appeared in three cases. At the 6-month follow-up all the patients had complete resolution symptomatically and on VCUG without further intervention (Table 2).

Discussion

VUR management can include either conservative or interventional methods (either minimally invasive or open surgery) [2]. Minimally invasive endoscopic subureteric injection has been introduced as a less morbid alternative to open surgery in the management of VUR, but the long-term results show that it carries a risk of 21.5% of relapse after 3 years [9,10]. Laparoscopic extravesical transperitoneal ureteric re-implantation is an evolving technique with the advantages of being minimally invasive and appears to have a high durable success rate, as Riquelme et al. [11] reported no relapse after a follow-up period of up to 49 months.

We conducted the present prospective study to evaluate the effectiveness of laparoscopic extravesical transperitoneal ureteric re-implantation in the management of unilateral VUR in children.

Putman et al. [12], in a study that included 80 patients, described open unilateral ureteric re-implantation as a procedure of 40–145 min duration, entailing an abdominal incision, with a mean (range) hospital stay of 31.25 (20–120) h; this period was shortened to a 6.6 (3.25–11.2) h when performed as an outpatient procedure. Narcotic analgesia was used to overcome postoperative pain. In our present study, postoperative pain was controlled using only paracetamol without the need for narcotics, and the median (range) hospital stay was 2 (2–5) days. The median (range) operative time was 90 (80–120) min and this may shorten with the rising learning curve.

The largest series, to our knowledge, reporting the application of laparoscopic extravesical transperitoneal approach in managing VUR was published by Castillo et al. [13]; 42 children were included in the study with a mean operative time of 74 min and mean hospital stay of 4 days. There were no postoperative complications, with a mean follow-up of 31 months. The success rate was 100%. These results are comparable to our present results, with a median (range) operative time of 90 (80–120) min, minimal postoperative complications, median (range) follow-up of 6 (3–21) months and a shorter hospital stay at a median (range) of 2 (2–5) days.

Saperston et al. [14] reported that, in their institution, it was less expensive to treat unilateral VUR with unilateral extravesical re-implantation than with subureteric Deflux® (dextranomer/hyaluronic acid)

| Follow-up duration, months | VCU at: | Symptoms at: |
|----------------------------|---------|--------------|
|                            | 3 months | 6 months | 3 months | 6 months |
| 21                         | Free     | NA         | No       | No       |
| 20                         | Downgraded | Free | No       | No       |
| 19                         | Free     | NA         | No       | No       |
| 18                         | Free     | NA         | No       | No       |
| 12                         | Contralateral reflux | Free | No       | No       |
| 8                          | Free     | NA         | No       | No       |
| 7                          | Free     | NA         | No       | No       |
| 6                          | Downgraded | Free | No       | No       |
| 3                          | Free     | NA         | No       | No       |
| 3                          | Free     | NA         | No       | No       |
| 4                          | Free     | NA         | No       | No       |
| 7                          | Free     | NA         | No       | No       |
| 4                          | Free     | NA         | No       | No       |
| 5                          | Free     | NA         | No       | No       |
| 3                          | Free     | NA         | No       | No       |
| 5                          | Free     | NA         | No       | No       |

NA, not assessed.
injection, especially if unilateral re-implantation was performed as an outpatient procedure. In the present study, we found that in our institution as most of the laparoscopic instruments are reusable, the running cost for laparoscopic extravesical ureteric re-implantation for treating cases of VUR could be less than that for subureteric Deflux injection. However, this is just an impression that needs further study.

Although the role of robot-assisted surgeries, especially in reconstructive procedures, is rapidly evolving its use in managing VUR is still limited due to the high cost and complexity of the technique [15].

The present study has two strong points: first, being a prospective study adds more reliability to its results; and second, all cases were performed by a single skilled and experienced surgeon in laparoscopic surgery.

Conversely, the present study also has some limitations that include: the limited number of patients, relatively short follow-up period, and also a comparative analysis with open extravesical re-implantation and minimally invasive subureteric endoscopic injection was not performed.

Prospective randomised studies are eagerly awaited to define the benefits of this technique to patients, as well as to determine the cost-effectiveness of this approach.

**Conclusion**

The laparoscopic extravesical transperitoneal approach for ureteric re-implantation is highly effective and could be considered as an alternative to open surgery in the management of VUR. Long-term, comparative randomised studies are still needed for proper evaluation of this technique.

**Conflict of interest**

None.

**Source of funding**

None.

**Appendix A. Supplementary data**

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.jpurol.2016.11.004.