Retroperitoneoscopic Ablative Renal Surgery in Children: The Feasibility of Using Three Trocars

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Purpose: We report the results of pediatric retroperitoneoscopic renal ablative surgeries, which were performed with only three trocars.

Materials and Methods: We retrospectively reviewed the charts of children who underwent laparoscopic urological procedures on the upper urinary tract at our institution between 2006 and 2012. These procedures consisted of nephrectomies, nephroureterectomies and heminephroureterectomies. The operations were performed retroperitoneoscopically with three trocars. The specimens were removed intact through the primary trocar site.

Results: A total of 30 retroperitoneoscopic ablative surgeries were performed in 13 girls and 17 boys. The mean patient age was 7.8 ± 4.3 years (range, 1-14 years). The interventions consisted of nephrectomy in 10 cases (33.3%), nephroureterectomy in 17 cases (56.6%) and heminephroureterectomy in 3 (10%) cases. The open conversion rate was 3.3% (1/30). The difference between the initial 10 cases and the latter 20 cases, in terms of mean operative time, was statistically significant (144.5 vs. 115.78 minutes, respectively, $P = .031$). Apart from 3 nephroureterectomies, all of the procedures (86.6%) were completed successfully using three trocars only, without the need for a separate extraction incision. The patients were hospitalized for a mean duration of 2.2 days (range, 2-4 days). None of the patients required blood transfusion. We did not encounter any major perioperative or postoperative complication.

Conclusion: Retroperitoneoscopic renal ablative surgery is a safe and effective treatment alternative for a variety of upper urinary tract disorders in children.

Keywords: laparoscopy; retroperitoneal space; methods; child; surgical procedures.

INTRODUCTION

Laparoscopic nephrectomy has progressively increased in popularity since its introduction by Clayman and colleagues in 1990.[1] Shorter hospitalization period, reduced postoperative analgesic requirement, rapid convalescence and better cosmetic outcome are the most distinguishing advantages of laparoscopic renal surgery. These benefits have been noted in both adult and pediatric populations.[2,3] The first pediatric laparoscopic nephrectomy and nephroureterectomy were reported in the 1990s by Figenshau and colleagues and by Ehrlich and colleagues, respectively.[4,5] The initial reports dealt mainly with the transabdominal route. Throughout the following years, retroperitoneoscopic procedures became popular. Currently, the proponents of transperitoneal and retroperitoneal approaches for laparoscopic renal surgery cite the advantages and disadvantages of each approach.

Laparoscopic renal surgery in children has gained acceptance in our department after having experienced its safety, efficacy and advantages in adults. We prefer the retroperitoneoscopic route and utilize three trocars when dealing with upper urinary tract pathologies in children. The more direct and rapid access to the kidney and renal vasculature and the lower risk of bowel complications are the major reasons for this preference. In this study, we retrospectively reviewed the charts of children who underwent retroperitoneoscopic renal surgery with three trocars at our clinic, due to a variety of upper urinary tract disorders.

MATERIALS AND METHODS

We retrospectively reviewed the charts of children who underwent retroperitoneoscopic urological procedures on the upper urinary tract at our institution between 2006 and 2012. Demographic and perioperative data were abstracted from a prospectively structured database. These procedures consisted of renal ablative surgeries, including nephrectomies, nephroureterectomies and heminephroureterectomies.

Diagnoses were established clinically with ultrasonography and nuclear imaging results. In cases with duplex systems, voiding cystourethrography (VCUG) was also performed to rule out vesicoureteral reflux. The indications for laparoscopy were the same as for open surgery. The indications for nephrectomy were a nonfunctioning kidney secondary to obstructive uropathy, ectopic ureteral insertion, urinary stone disease and multicystic dysplasia. Heminephroureterectomy was performed in children with a dysplastic upper pole and a corresponding large ureterocele or ectopic ureter. Nephroureterectomy was indicated for those patients who had high-grade vesicoureteral reflux and an ipsilateral, nonfunctioning, and dysplastic kidney. All of the patients with nonfunctioning kidneys had recurrent urinary tract infections or pain.

Surgical technique

Surgery was performed with the patient in the lateral decubitus position, under general endotracheal anesthesia. The table was flexed to expand the space between the iliac crest and the twelfth rib. A nasogastric tube was placed to decompress the stomach. Appropriate padding was placed at all body pressure points. The abdomen and genitalia were prepared and draped in the standard sterile fashion. After making a 10-mm incision at the junction of the subcostal margin and the lateral edge of the sacrospinal muscle (Figure 1), the fascia was incised with electocautery. The space between Gerota's fascia and the psoas fascia was dissected gently to avoid an inadvertent peritoneal tear. Retroperitoneal working space was created using either balloon dilators or Foley catheters (with the finger of a rubber glove tied at the tip). Hence, the perinephric fat gets freed from the areolar tissue and peritoneal layer becomes mobilized away from the dissection plane. The balloon device or Foley catheter was left inflated to develop the retroperitoneal space adequately and to tamponade any bleeding. Depending on the age of the patient, retroperitoneal pressure of 10-12 mmHg was maintained. Once an adequately distended retroperitoneal space has been created, two additional 5-mm trocars were introduced under laparoscopic guidance, in the posterior and anterior axillary lines, respectively. A camera lens (30 degrees) was inserted through the 10-mm trocar. Scissors and grasper were introduced through the other ports. Psoas muscle served as the initial landmark during retroperitoneal dissection. Then, the ureter and the inferior aspect of the kidney were exposed. Next, the ureter was mobilized up to the lower kidney pole. After being transected at the level of the iliac vessels, the ureter was manipulated in order to ease the dissection of re-

nal pedicle. Then, the renal artery and vein were individually controlled with Hem-o-lok clips. Two clips were applied on the proximal side of the vessels while the specimen side was controlled with one clip. After their transection, the kidney was completely freed.

The ureteral stump was closed using either Hem-o-lok clips or a sealing device (LigaSureTM, Covidien, Mansfield, MA, USA). If there was a history of reflux (while performing the nephroureterectomy), the ureter was completely dissected and clipped at the level of ureterovesical junction. In heminephroureterectomy, the vessels from the different poles were dissected and were selectively transected using ligation. The kidney poles were separated using LigaSureTM.

The data are presented as means and standard deviations (SD), if not otherwise indicated. The level of statistical significance was set at $P < .05$. The statistical analysis was performed using he statistical package for the social science (SPSS Inc, Chicago, Illinois, USA) version 18.0.

RESULTS

A total of 30 retroperitoneoscopic ablative surgeries were performed in 13 girls and 17 boys at our clinic between 2006 and 2012. The mean patient age and mean body weight were 7.8 ± 4.3 years (range, 1-14 years) and 23.6 kg (range,10-50 kg) respectively. The interventions consisted of nephrectomy in 10 cases (33.3%), nephroureterectomy in 17 cases (56.6%) and heminephroureterectomy in 3 cases (10%). Only one patient undergoing nephrectomy required open conversion due to access problems and suboptimal visualization of the renal pedicle. Of the procedures, 11 were on the right side, and 19 were on the left side. The mean operative time was 125.08 min (range = 70-180 min). The mean duration of surgery was 144.5 min for the initial 10 cases. The latter 20 cases lasted 115.78 min on average. The difference between these 2 patient groups (initial vs. latter) in terms of mean operative time was statistically significant ($P = .031$). The comparison of the operative times between girls and boys (128.3 min vs. 124.5 min, respectively, $P > .05$) and children below and above 5 years of age (125.2 min vs. 122.14 min, respectively, $P > .05$) did not reveal any statistically significant difference.

Overall, 26 out of 30 (86.6%) procedures were completed successfully using three trocars only, without the need for an additional incision to remove the specimens. The excised specimens were removed from the 10-mm trocar site. Out of 20 nephroureterectomies and heminephroureterectomies, the procedure was completed by 3-trocars only in 17 cases (17/20, 85%), including the removal of the ureter and the specimen. A separate lower abdominal incision was then made to remove the kidney and ureter in the remaining 3 patients undergoing nephroureterectomy.

The patients were hospitalized for a mean duration of 2.2 days (range, 2-4 days). None of the patients required blood transfusion. The perioperative and postoperative courses were devoid of major complications. Despite peritoneal violation in one case, the procedure was completed without open conversion.

DISCUSSION

Diagnostic laparoscopy for impalpable testes has pioneered the concept of laparoscopic urological surgery in children and since then considerable progress has been achieved in this field.[6] Despite this development, laparoscopy has been adopted more slowly in children than in adults as a method for treating urological problems. The high success rates of open procedures, in addition to longer hours of surgery, more challenging learning curve and increased expenditure associated with laparoscopy are the most probable reasons for this delay. However, the ability to treat children effectively in a minimally invasive fashion has been positively influenced by improvements in instrumentation and increasing experience and creativity of minimally invasive surgeons. Better cosmetic results, magnified visualization of the operative field, reduced length of hospital stay and diminished postoperative pain are considered as the main advantages of laparoscopic surgery.

After Clayman and colleagues documented its feasibility in 1991,[1] laparoscopic nephrectomy has been widely accepted as the standard of care in the adult population. Thereafter, laparoscopic renal surgery began to gain popularity among pediatric urologists. The initial series of pediatric nephrectomies and nephroureterectomies were reported by Figenshau and colleagues and by Ehrlich and colleagues, respectively.[4,5] Koyle and colleagues reported their experience about laparoscopic nephrectomy in infants.[7] Subsequent studies

have demonstrated the efficacy of laparoscopic nephrectomy, partial nephrectomy, heminephrectomy, and nephroureterectomy in children, for a variety of upper urinary tract disorders.

Laparoscopic nephrectomies in children have commonly been used to remove non-functional renal units secondary to obstructive uropathy (posterior urethral valves, ureteropelvic junction obstruction), vesicoureteral reflux, or ectopic ureteral insertion. Although initially described using a transperitoneal approach, the advantage and disadvantage of both transperitoneal and retroperitoneal access in children have been frequently debated.[8-13] The retroperitoneal route has several potential advantages. This access allows for more rapid and direct access to the kidney and the renal hilum without dissection of intraperitoneal structures. It avoids direct entry into the peritoneal cavity; hence, minimizes the risk of intestinal complications, such as adhesion formation, bowel injury and postoperative ileus although there is still a risk of bowel injury during retroperitoneal approach. Also by staying extraperitoneal, any possible postoperative fluid collection (urinoma, hematoma) would be isolated in the retroperitoneal space. Retroperitoneal route has been handicapped by the limited area of port placement and reduced working space when compared with the transperitoneal approach.

El Ghoneimi and colleagues reported their initial experience with retroperitoneal laparoscopic renal procedures. Of their 39 patients undergoing laparoscopic nephrectomy and partial nephrectomy, only two required open conversion.[9] In a systematic review of 51 articles, including nearly 689 pediatric patients undergoing retroperitoneal or transperitoneal laparoscopic nephrectomies, nephroureterectomies and partial nephrectomies, Kim and colleagues did not found any significant difference in terms of the overall complication rates between the transperitoneal and the retroperitoneal approach, excluding conversion to open surgery as a complication.[14] The differences between the two groups (transperitoneal vs. retroperitoneal) in terms of vascular and bowel complications were also insignificant.[14] In our series, consisting of 30 upper urinary tract interventions, apart from one open conversion, the perioperative and early postoperative courses were uneventful, without any major complications and none of the patients required blood transfusion.

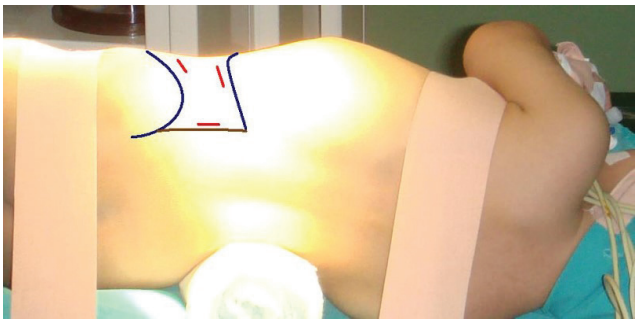

Figure 1. The places of three trocars.

In our series, the renal artery and vein were separately controlled with Hem-o-lok clips. Modi and colleagues evaluated the safety and efficacy of 5 mm Hem-o-lok clips while performing retroperitoneoscopic nephrectomies in children. They completed all 24 nephrectomies without any problems attributable to Hem-o-lok clip application.[15] We also did not encounter any clip dislodgement or other technical difficulties regarding clip application.

The reported mean operative time for retroperitoneoscopic nephrectomy, partial nephrectomy or nephroureterectomy ranges from 68 to 194 min in different series.[14,16,17] In their systematic review, Kim and colleagues reported that the average operative time was 129 min for the retroperitoneal approach which was shorter than that of the transperitoneal approach (154 min).[14] Pearce and Subramaniam compared the retroperitoneal and transperitoneal approaches for laparoscopic nephrectomy and observed a trend towards decreased operative duration over the course of the study period for retroperitoneoscopic nephrectomy while a similar decrease could not be documented for the transperitoneal route.[18] In our study, when all retroperitoneoscopic renal ablative surgeries were considered, the mean operative time was 125 min. When analyzed in detail, mean operative time decreased significantly after the initial 10 cases (144.5 min and 115.78 min, for the initial 10 and later 20 cases, respectively, $P = .031$).

Relatively limited working space and limited area for port placement may be accepted as the main disadvantages of pediatric retroperitoneal laparoscopy. Therefore, the ability to perform retroperitoneal laparoscopy in children requires a

learning period. In general, the first 20 cases may be considered as the threshold for complex laparoscopic procedures. In our series, as mentioned above, a significant decrease in mean operative time was observed after the initial 10 cases, which also reflects the learning curve and expertise gained over time. Relatively faster decline of the operative duration for retroperitoneoscopic procedures may partially be explained by the experience accumulated over 120 retroperitoneal laparoscopic procedures performed in adults in our department. Nevertheless, especially in the early phases of the learning curve, manipulating 3 trocars inside a child's retroperitoneum can be quite challenging. Using smaller instruments (3-mm trocars), depending on the child's age and body habitus, may increase the surgeon's manual dexterity.

In our series, out of 20 nephroureterectomies and heminephroureterectomies, the procedure was completed by 3-trocars only in 17 cases (17/20, 85%), including the removal of the ureter and the specimen and we did not encounter any major technical difficulty worth mentioning while doing that. Also, all nephrectomies were completed by 3-trocars, without a separate incision for specimen removal. Similarly, Kuzgunbay and colleagues performed retroperitoneoscopic nephroureterectomy and complete ureteral excision in a total of 13 children with end-stage reflux nephropathy. All of these operations were carried out using three trocars. They also supported the safety and feasibility of this technique in children.[19]

There are several limitations of our study. It is a retrospective review of the data. Also, there is a lack of a control open group for comparison of the results.

Laparoscopic surgery has become a valid alternative in the surgical treatment of certain pediatric urological disorders. We recognize the advantages of the retroperitoneoscopic approach and it has become our choice for excisional upper urinary tract surgery as well as for pyeloplasty, pyelolithotomy and ureterolithotomy.

CONCLUSION

Retroperitoneoscopic renal ablative surgery is a safe and effective treatment alternative for a variety of upper urinary tract disorders in children. We were able to complete the majority of the operations (87%) using three trocars only. Also, the operative times decreased with growing expertise and the latter 20 cases were carried out more rapidly than the initial 10 cases.

CONFLICT OF INTEREST

None declared.

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