Our experiences with robot- assisted laparoscopic surgery in pediatric patients: the first case series from Turkey

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ABSTRACT

Objective: Robotic surgery is a leading treatment option for minimally invasive surgery and has an increasing popularity in pediatric population, as well. In this article, we reported our case series of robot-assisted laparoscopic surgery in pediatric population.

Material and methods: We retrospectively reviewed 29 consecutive pediatric patients who underwent robot- assisted procedures between May 2014 and October 2016. Patient demographics, hospitalization time, estimated blood loss, robotic time and total operative and peri-, and post-operative complications were evaluated.

Results: A total of 24 ureter units (18 patients) with grade 1-5 vesicoureteral reflux in 13 female and 5 male, 1 male patient with vesicoureteral stenosis were underwent robot- assisted laparoscopic ureteral reimplantation (RALUR). All patients had complete resolution after surgery. Robot-assisted laparoscopic pyeloplasty (RALP) was performed in 6 patients with ureteropelvic junction obstruction. All patients had complete resolution after surgery. Completely intracorporeal robotic assisted laparoscopic augmentation ileocystoplasty (RLAIC) was applied to two patients with neurogenic bladder. The symptoms and preoperative hydronephrosis were regressed on the first month of follow-up. Robot-assisted laparoscopic reduction cystoplasty (RALRC) was performed in 14-year-old boy with a bladder diverticula and recurrent urinary tract infection. The last case was eleven- year-old female patient with non-functioning kidney. She had recurrent urinary tract infections and was treated with robotic assisted laparoscopic nephrectomy (RALN).

Conclusion: Robot-assisted laparoscopic surgery is safe and efficient in pediatric population. Although open surgery is still the gold standard for many pediatric diseases, inherent reconstructive advantages of robotic assisted laparoscopy have a chance to change this view.

Keywords: Augmentation ileocystoplasty; children pyeloplasty; nephrectomy; pediatric robotic surgery; ureteral reimplantation.

Introduction

Robotic surgery leads the way among minimally invasive surgical treatments. Its use is increasing in the pediatric age group.^[1] All surgical treatment alternatives are more difficult to perform since they are realized within a narrow area. Robot-assisted laparoscopic surgery has some features which facilitate the work of the surgery with advantages of movement scaling, higher optical magnification, stereoscopic vision, increased mastery of instrumentation, and tremor filtration.^[2]

During childhood, almost all surgical treatments can be performed as robot-assisted procedures, however most frequently robot-assisted pyeloplasties have been realized. This surgical procedure resembles any other laparoscopic approach.^[3] Pediatric urologists often prefer pyeloplasty when they start to perform robotic surgery. Ureteral reimplantation is also a suitable and applicable reconstructive surgery for robotic approach.^[4] Augmentation ileocystoplasty is a complicated reconstructive procedure with longer operative times, hence it should be preferred if performed by experien-

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ced hands for indicated cases. Non-reconstructive surgeries as nephrectomy are properly realized using laparoscopic approaches rather than resorting to robotic procedures.^[5]

In this study, we reported our series of robot-assisted laparoscopic surgery in a pediatric patient population.

Material and methods

A total of 110 patients who underwent robotic surgery using da Vinci SI robotic surgery system between May 2014, and October 2016 after obtaining approval of the ethics committee of our hospital were evaluated. The operations were performed with 8-mm ports of da Vinci SI robotic surgery system used for adults. Optical instruments used during surgery had lenses used for adults which provided 0° and 30° angles of vision preferred based on the type of surgery performed. Only cases of robotic surgeries realized in pediatric patients were selected. A total of 29 consecutive patients who had undergone robot-assisted pyeloplasty (n=6), ureteral reimplantation (n=19), augmentation ileocystoplasty (n=2), reduction cystoplasty (n=1), and simple nephrectomy (n=1) were included in the study. All procedures were performed via transperitoneal route by a single surgeon experienced in both open pediatric surgeries, and robotic reconstructive surgeries in adults. Surgical indications, pre- and postoperative radiograms, amount of blood loss, complications, and duration of hospitalization were recorded.

Patients with vesicoureteral reflux (VUR) were evaluated preoperatively using DMSA (/dimercapto succinic acid) scanning, ultrasound (US), and voiding cystourethrography (VCUG). US, and VCUG were performed at postoperative 1. and 3. months. Surgical success was defined as absence of any evidence of reflux on VCUG, and lack of any febrile urinary system infection.

Surgical indications in patients with ureterovesical, and ureteropelvic obstruction is the presence of progressive hydronephrosis in consecutive US examinations, and abnormal findings detected on diuretic renal scanning in symptomatic patients. Following surgery, US was performed at 1th and 3th month, and MAG-3 was performed at 3th month. Surgical success was defined as regression of grade of hydronephrosis, and normalization of half-life of radiopharmaceutical substance as detected on MAG-3 renal scanning.

Patients with neurogenic bladder, and bladder diverticula were preoperatively evaluated using videourodynamics, and US, and in case of need DMSA scanning. In the postoperative surgery, bladder capacity, and contours of the bladder were controlled using videourodynamic evaluation. Cystograms were obtained at 1. months in patients who underwent augmentation ileocystoplasty, and on 7. day in patients in whom reduction cystop-

lasty was performed. At the same time, decrease in the grade of hydronephrosis was controlled at 1, 3, and 12. months using US. Preoperatively computed tomography, and DMSA scanning was applied in patients who underwent simple nephrectomy.

Statistical analysis

Our study retrospectively analyzed surgical outcomes of robot-assisted laparoscopic surgery, and because a lack of data groups which required statistical analysis, any statistical analysis could not be performed.

Results

Extravesical robot-assisted ureteral reimplantation (RALUR) was applied for 18 patients with vesicoureteral reflux, and, one patient with ureterovesical junction obstruction (UVJO) in line with the method suggested by Casale et al.^[6] (Figure 1). Median patient age was 6.8 (2-16) years. Thirteen female and 6 male patients had grade 1-5 VUR. RALUR was performed for a total of 24 ureteral units including bilateral RALUR realized in 5 patients. The patient who was operated with the indication of Grade 1 reflux, had also Grade 5 reflux on the contralateral ureter. The patients who had undergone surgery with the indication of VUR had previously received watchful waiting, continuous antibiotherapy or subureteral injections. The patients with grade 5 VUR also underwent excisional ureteral tapering procedure. Urethral catheter, and silicon drain were removed on postoperative 1. day, and all patients were discharged on 2. postoperative day. Apart from a patient who applied with pain on 4. postoperative day, any intra-, and postoperative complications were not observed. US performed for the patient with admission complaints of pain disclosed the presence of hydronephrosis, and ureteral stent was implanted through antegrade route. Ureteral stent was removed on 15. postoperative day, and evaluation of ultrasonograms obtained at 1. month demonstrated normalization of urinary system findings. As a consequence VUR disappeared in all patients. Median follow-up period was 15.7 (4-30) months, during follow-up period complaints of the patients disappeared. Renal MAG-3 scanning of the patient operated with the indication of UPJO revealed normal renal drainage.

Robot-assisted laparoscopic pyeloplasty (RALP) was applied for one male, and five female patients with ureteropelvic junction obstruction (UPJO). Median patient age was 4.5 (1-8) years. Two patient underwent right, and 4 patients left pyeloplasty (Figures 2a, and b). Transmesocolic approach was preferred for patients with left UPJO. Silicon drain, and urethral catheter were removed on postoperative first day, and all patients were discharged on 2. postoperative day. Silicon drains were not used for the last three operated patients. Ureteral stents were removed on postoperative 20. day. Median follow-up period was 13.2 (9-15) months. In all patients, any complication was not observed during follow-up period. In all patients at postoperative 1 month

regression of complaints due to hydronephrosis was observed, and at postoperative 3. month diuretic renograms revealed improvement in renal functions.

Intracorporeal robot- assisted laparoscopic augmentation ileocystoplasty RLAIC was performed for 2 patients who were followed up with the indication of neurogenic bladder (Figure 3). These patients were 11, and 12 years of age. Preoperatively their total bladder capacities were 150, and 180 mL, while postoperatively it raised to 340, and 350 mL, respectively. Any intraoperative complication was not observed. Oral fluid intake was started on 3. postoperative day, and silicon drain was removed on 4. postoperative day. Both of these patients were discharged on 15. postoperative day after removal of urethral catheters. Median postoperative follow-up period was 20.5 (18-23) months. At 1. postoperative month regression of preoperative hydronephrosis was noted. Cystography revealed intact bladder contours, and increase in bladder capacity.

We performed robot-assisted laparoscopic reduction cystoplasty (RALRC) for a 14-year-old male patient with bladder diverticulum, and recurrent urinary tract infection. In this patient, the port sites for camera, assistant, and robotic instruments were the same with those used in RLAIC surgery. The patient's postmictitional residual urine volume was increased (300 mL). Bladder diverticulum was excised and sutured. The patient was discharged on postoperative 3. day without any complication. On postoperative 7. day urethral catheter was removed after cystograms were obtained.

We performed robot-assisted laparoscopic nephrectomy for an 11-year-old female patient with the indication of non-functional kidney and recurrent urinary tract infection. On postoperative 2. day she was discharged without any complication.

Patient characteristics, hospital stay, estimated blood loss, duration of robotic procedures, and total operative times related to all surgical procedures are shown in Table 1.

Discussion

Open dismembered pyeloplasty described by Anderson-Hynes is a gold standard treatment for UPJ obstruction. Success rates have been indicated as 90-100 percent.^[2] Olsen et al.^[7] reported their series consisting of 13 diseases. Dependent on the shorter learning curve, RALP procedure requires much less experience. O'Brien et al.^[8] compared the outcomes of open, laparoscopic, and robotic pyeloplasties, and detected lower rates of hospital stay, and complications in the RALP group, while longer operative times were detected in the groups of RALP, and laparoscopic surgery. In another study by Barbosa et al.^[9] comparable success rates were reported for RALP, and open surgery groups, while longer operative times were indicated for the RALP group. In a series of 66 cases Bansal et al.^[10] reported ileus in 2, port site infection in 2, urine leakage in 1, and stent migration in 1 patient. In our series 6 patients were successfully treated without any complication. Despite our limited number of patients in our series, operative time, complication rates, and hospital stay were in compliance with the literature.

Treatment of vesicoureteral reflux comprises of surveillance, subureteric injection, open and laparoscopic approaches. In recent years experiences with RALUR have been accumulated, and various case series have been published. Marchini et al.^[11] reported lack of any difference among open, and robotic intravesical, and extravesical approaches as for VUR resolution, and operative times. When compared with open surgery, shorter hospital stay, and less frequent vesical spasms were observed in the intravesical robotic group. Akhavan et al.^[12] detected 92.3% success rate, and complications at a rate of 10% including febrile urinary system infection, ureteral obstruction, periureteral fluid collection, and ureteral injury. Smith et al.^[13] compared open surgery, and RALUR technique. In both groups higher success rates were reported. In our study, RALUR procedure was successfully applied for 18 patients followed up with VUR, and one patient with established UPJO. All patients were discharged on postoperative 2. day without complication. Antegrade ureteral stenting was applied in only one patient because of ureteral obstruction. Despite our limited number of patients, our relatively shorter operative time was comparable to the literature data.

Gundeti et al.^[14] firstly in the year 2008, performed intracorporeal RLAIC and Mitrofanoff appendicovesicostomy. They reported

Table 1. Patient characteristics, complications, pre-, and postoperative outcomes

	RALP	RALUR	RLAIC	RALRC	RALN
n	6	19	2	1	1
Age (years)	4.5 (1-8)	6.8 (2-16)	11.5 (11-12)	14	11
F/M	1/5	13/6	0/2	0/1	1/0
Complication	1	1	0	0	0
Hospital stay (days)	2	2	15	3	2
Amount of blood loss (mL)	Trace	Trace	325 (250-400)	200	Trace
Operation time (min)	57 (55-60)	59 (45-90)	340 (320-360)	180	90
Total duration (min)	105 (100-110)	103 (90-135)	390 (370-410)	225	135

F: female, M: male; RALP: robot-assisted laparoscopic pyeloplasty; RALUR: robot-assisted laparoscopic ureteral implantation; RLAIC: robot-assisted laparoscopic augmentation ileocystoplasty; RALRC: robot-assisted laparoscopic reduction cystoplasty; RALN: robot-assisted laparoscopic nephrectomy

Figure 1. Position of the patient, and port entry sites in the right-sided robot-assisted ureteral reimplantation (RALUR)

results of RLAIC they performed on 6 patients with neurogenic bladder in the year 2010. Median operative time was 8.4 hours. In three patients postoperative wound site complications wound site infection, venous thrombus of lower extremity, and ipsilateral paresthesia of the lower extremity were observed. Dietary therapy was initiated within the first 24 hours, and the patients were discharged on the 7. postoperative day. Postoperative total bladder capacity was measured as 250-450 mL.^[15] Flum et al.^[16] reported their experience with RLAIC in 12 cases with neurogenic bladder. In addition, they performed Mitrofanoff or Monti procedures for 7 patients. Only one patient underwent open appendicovesicostomy. Median operative time was 365 minutes, and median amount of estimated blood loss was 110 mL. Median hospital stay was 6 days. Postoperative bladder capacity was measured as 488 cc. The following postoperative complications were reported as follows: ileus (n=2), thromboembolism (n=2), delayed bladder perforation (n=1), dehiscence on the line of ileovesicostomy (n=1), reoperation of the bowel because of obstruction (n=1), and sepsis (n=1). In our study, we applied total intracorporeal RLAIC procedure for 2 children with neurogenic bladder. Based on our literature review our total intracorporeal RLAIC procedures performed on two cases are firstly reported two cases from Europe. There was no intraoperative and postoperative complications.

Meeks et al.^[17] reported the first laparoscopic diverticulectomy experience in a pediatric case. Subsequently, Christman et al.^[18] reported 14 patients with symptomatic congenital bladder diverticula. In our study, only one patient had bladder diverticu-

Figures 2. a, b. Position of the patient, and port entry sites in the right-sided robot-assisted laparoscopic pyeloplasty (RALP) (a). Position of the patient, and port entry sites in the left-sided robot-assisted laparoscopic pyeloplasty (RALP) (b)

Figure 3. Position of the patient, and port entry sites in intracorporeal robot-assisted laparoscopic augmentation ileocecostoplasty (RLAIC)

lum. The patient complained of frequent urination, and volume of post-mictional residual urine was increased (300 mL). On cystograms, bladder was observed as two compartments. Upper segment of the bladder was resected, and RALRC procedure was applied. Following surgery his bladder capacity was adequate, and also his complaints regressed.

Laparoscopic simple nephrectomy was described by Koyle^[19] in the year 1993. In various studies, RALN was applied successfully.^[20,21] Nowadays, laparoscopic approach is more frequently preferred over robotic surgery.

In pediatric urology, robotic surgery provides some advantages as improved field of vision, tremor filtration, better cosmetic results, shorter hospital stay, and lower morbidity rates. However, in children narrower abdominal wall complicates the pediatric procedures.^[22]

In pediatric patient group, the most important problems encountered in the pediatric patient group when compared with the adult patient group consist of deficient number of pediatric ins-

truments, inadequate, and limited operating field. During placement of robotic ports ideally instruments should be inserted at 8 cm intervals. However, small-sized abdomen restricts this application. However for innovative da Vinci version instruments, an interval of 5-6 cm between ports may suffice.

In pediatric cases since skin, and subcutaneous tissue is thinner relative to adult patients, during placement of ports the risk of organ, and vascular damage increases. Therefore placement of ports in pediatric cases should be meticulously performed by experienced hands.

Besides in pediatric cases care should be taken to operate under lower intraperitoneal CO₂ pressure when compared with operations performed in adults. For children a pressure of 12 mmHg is appropriate for robotic procedures.^[23]

Similar to relevant publications, our series have demonstrated effectiveness, and reliability of many pediatric robot-assisted procedures. The most valuable aspect of our study is that the first two successful cases with intracorporeal RLAIC have been reported. The most visible limitation of our study is our small patient population. Despite our limited number of patients, we obtained higher success, but lower complication rates. As the number of patients undergoing robotic surgery increases, comparative data may be reported more effectively.

Robot-assisted laparoscopy is safe, and effective procedure to be performed in pediatric population. Although open surgery is the gold standard treatment for many pediatric diseases, inherent reconstructive advantages of robot-assisted laparoscopy have a chance to change these perspectives.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Etimesgut Military Hospital (Date: 10.02.2016/Approval No: 8000-10-16).

Informed Consent: Written informed consent was obtained from patient who participated in this study.

Peer-review: Externally peer-reviewed.

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