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Single-site retroperitoneoscopy in pediatric metastatic lymphadenopathy☆,☆☆

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ABSTRACT

Background: Retroperitoneoscopic surgery (RS) is increasingly used for the diagnosis, staging, and treatment of solid tumors, but rarely in pediatric surgical oncology for retroperitoneal lymph node dissection (RPLND). Herein, we use single-site RS for RPLND in children and compare the perioperative outcomes with those for the transperitoneal laparoscopic approach (TPLA).

Methods: A single institution retrospective chart review was performed for patients undergoing single-site RS and TPLA (January 2018 till June 2019). We compared patient demographics, diagnoses, operative times, complications, postoperative analgesia, and length of hospital stay between both groups.

Results: Eight patients (median age of 16.5 years) undergoing single-site RS for RPLND and five patients (median age 17 years) undergoing TPLA RPLND were compared. Groups were comparable in age, median operative duration (232 vs 234 min, $p = 0.77$), and complications (1 vs 1, $p = 0.72$). Median postoperative hospital stay and total morphine equivalent doses used postoperatively were significantly lower in the RS group, (0.5 vs 2 days, [$p = 0.03$] and 0.1 vs 0.4 mg/kg [$p = 0.01$], respectively). Eight patients underwent ipsilateral modified template RPLND for paratesticular RMS (six single-site RS and two TPLA) and lymph node metastases were found in 50% of these patients. The rest were resections of metastatic lesions for germ cell tumor and neuroblastoma (two single-site RS and three TPLA).

Conclusions: Single-site RS is a safe and feasible technique in carefully selected pediatric surgical oncology patients. RS provides an excellent view of the retroperitoneum, requires less postoperative analgesia, and is associated with faster recovery.

Level of evidence rating: IV

Minimally invasive surgery is increasingly used in the management of pediatric oncology patients. Standard access to the retroperitoneal space is generally obtained using an abdominal transperitoneal approach. However, a retroperitoneoscopic approach has been well established by urologists for performing pyeloplasties and nephrectomies [1,2].

Retroperitoneoscopic surgery (RS) was first described by Bartel in 1969, who visualized the retroperitoneum using a rigid endoscope [3]. Since then, various methods have been described for accessing the retroperitoneal space, from blunt digital dissection to balloon dilation with carbon dioxide (CO_2) insufflation [4]. RS allows for definitive surgical treatment, staging, lymph node sampling and diagnostic procedures in the workup of patients with retroperitoneal tumors. Its use in pediatric surgical oncology patients has started to gain popularity but has generally been limited to adrenalectomy [4,5].

Compared with open surgery, the transperitoneal laparoscopic approach (TPLA) is associated with quicker recovery, earlier return of bowel function, and shorter hospital stay [6,7]. TPLA usually requires three or four 3- to 5-mm port incisions and may require an additional incision for liver retractor placement. To retrieve sizable tumors, the umbilical port incision is then usually extended. However, tumors and lymph nodes in the retroperitoneal space pose a different challenge in terms of adequate exposure and visualization.

The theoretical advantage of a retroperitoneoscopic approach is that it provides direct access and thus excellent visualization of tumors or lymph nodes in the retroperitoneal space without peritoneal violation. It also avoids the need for bowel manipulation, and thereby potential injury and the risk of adhesion formation. Some studies have reported RS through a full-prone or modified-prone jackknife position [5,8], but this

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might decrease working space, may be less ergonomic, and present an awkward anatomy because of the reversed orientation. Furthermore, conversion to anterior laparotomy in the event of vascular injury or need for further abdominal exploration is severely limited in the prone position.

The aim of the current study is to review the supine, single-incision RS approach for retroperitoneal lymph node dissection in pediatric oncology patients.

1. Materials and methods

1.1. Study design

The local institutional review board approved this study and informed consent was waived. We retrospectively reviewed medical records of all children who underwent single-site RS and standard TPLA from January 2018 to June 2019 at our institution. Variables ascertained were age, gender, surgical procedure, duration of surgery, intraoperative events, total oral morphine equivalents (OME) administered (mg/kg), length of hospital stay, primary cancer diagnosis, and histological diagnoses. All opioid medication doses were converted to oral morphine dose equivalents for comparison [9].

1.2. Surgical approach to single-site retroperitoneoscopic technique

After induction of general anesthesia, the patient is placed in a supine position with a bump placed on the operative side. Both the surgeon and assistant stand on the same side, with the laparoscopic monitor on the opposite side of the patient. A single incision is made along Langer's line at the midpoint between the iliac crest and the costal margin measuring 2.0–2.5 cm. The underlying musculature is spared by blunt splitting of the obliques and transversalis. Using a combination of sharp and blunt finger dissection, the retroperitoneal space is opened, taking care to avoid violating the peritoneum. Thereafter, a GelPOINT Advanced Access Platform laparoscopic system (Applied Medical, Rancho Santa Margarita, CA, USA) or a QuadPort access device (Advanced Surgical Concepts, County Wicklow, Ireland) is placed and connected to a CO_2 insufflation device to a pressure of 15–18 mmHg (Fig. 1). Both access systems have a sealing device that allows surgical access with frequent instrument exchanges through a flexible fulcrum while maintaining CO_2 insufflation.

1.3. Statistical analysis

Continuous variables were compared using the two-tailed Student's t-test. Categorical variables were compared using the nonparametric chi-square (χ^2) test. The Kruskal–Wallis test has been applied to compare the medians between the two groups. A significance threshold of $p < 0.05$ was used for all tests. Statistical analysis was performed using GraphPad Prism version 7.0, GraphPad Software (La Jolla, CA, USA) and SAS 9.4 (Cary, NC, USA).

2. Results

During our study period, eight patients underwent single-site RS for retroperitoneal adenopathy. The median age at surgery was 16.5 years (interquartile range [IQR] 12–18 years; range 5–20 years). Table 1 summarizes patient characteristics.

Of the eight patients, six patients underwent staging for paratesticular embryonal RMS with ipsilateral modified template RPLND; one patient had an external iliac vein pelvic lymph node dissection during right adrenalectomy for high-risk metastatic neuroblastoma (Figs. 2 and 3); and one underwent excision of persistent retroperitoneal lymphadenopathy after inguinal orchiectomy and chemotherapy for a testicular germ cell tumor. Median operative time for all eight cases was 232 min (IQR, 207–281 min), and the median hospital stay was 0.5 day (IQR, 0–1 day). Median total OMEs used after surgery were 0.1 mg/kg (IQR, 0.0–0.1 mg/kg).

No major intraoperative adverse events were encountered. One patient in the RS group had a breach of the peritoneum during dissection to create the retroperitoneal space. This resulted in suboptimal insufflation with CO_2 of the retroperitoneal space. The incision was extended to allow repair of the peritoneal breach and completion of retroperitoneoscopic dissection.

Five patients underwent TPLA and had a median age at surgery of 17 years (IQR, 4–19 years; range 3–21 years). Two underwent staging for paratesticular embryonal RMS with ipsilateral modified template RPLD; two underwent resection of metastatic lesions for persistent retroperitoneal adenopathy after inguinal orchiectomy and chemotherapy for a testicular germ cell tumor; and one patient underwent resection of metastatic retrocaval adenopathy in a patient with metastatic neuroblastoma. Table 2 summarizes the patient and operative characteristics of the TPLA group. Median hospital stay was 2 days (IQR, 1–2 days) and median morphine equivalent dose was 0.4 mg/kg (IQR, 0.3–0.8 mg/kg). Median operative time for the four TPLA patients was 234 min (IQR, 204–264 min). Only one patient in the TPLA group had to undergo conversion to open surgery owing to inability to safely dissect the conglomerate of adherent retroperitoneal lymph nodes off the ureter. There were no significant differences in complications or nonopioid medication use between both approaches. Table 3 summarizes the perioperative outcomes and compares RS to TPLA.

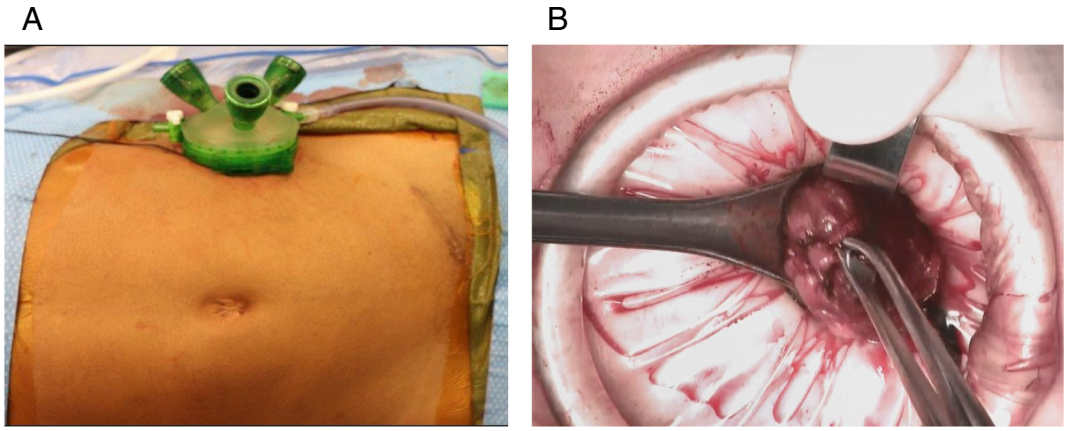

Fig. 1. (A) GelPOINT Advanced Access Platform laparoscopic system positioned in the left side of the abdomen at the midpoint between the iliac crest and left costal margin. (B) The Alexis wound retractor portion of the GelPOINT laparoscopic system, which helps facilitate the delivery of larger specimens.

Table 1
Patient characteristics of the eight patients that underwent single-site RS for retroperitoneal adenopathy.

No.	Gender (M/F)	Age at surgery (years)	Primary diagnosis	Neoadjuvant chemotherapy (yes/no)	Indication	Tumor size (cm)	Pathology (positive LN/total LN)	Postop follow-up (months)
1	M	13	R Paratesticular ERMS	No	Staging	NA	16/19	8
2	M	18	R Paratesticular ERMS	No	Staging	NA	1/21	22
3	M	10	L Paratesticular ERMS	No	Staging	NA	0/14	20
4	M	17	L Paratesticular ERMS	No	Staging	NA	2/11	8
5	M	20	L Paratesticular ERMS	No	Staging	NA	0/26	8
6	M	16	L Paratesticular ERMS	No	Staging	NA	0/14	9
7	M	5	Metastatic R adrenal NB and pelvic adenopathy	Yes	Local control	3.3 × 2.0 × 3.2	NB	16
8	M	18	R GCT retroperitoneal adenopathy	Yes	Local control	3.9 × 5.4 × 4.7	GCT	8

M: male, F: female, LN: lymph nodes, NB: neuroblastoma, E RMS: embryonal rhabdomyosarcoma, GCT: germ cell tumor, L: left, R: right, No.: number, NA: not applicable.

3. Discussion

We report our experience using single-site RS in a limited case series of pediatric surgical oncology patients. We found that single-site RS is comparable to standard TPLA in terms of operative times and intraoperative complications. However, patients who underwent single-site RS had significantly lower postoperative opioid requirements and shorter hospital stays compared to the standard TPLA group (Table 3), with no difference detected in nonopioid pain regimens used between the two groups. Furthermore, we have recently published implemented measures to reduce postoperative opioid prescription after oncologic surgery [10]. RS has become an important innovation in the field of minimally invasive surgery, although its use in pediatric oncology patients has been infrequently reported [4,5,8]. Single-site laparoscopic surgery in pediatric patients has gained popularity over the past few years [11], but the use of single-site RS has not been previously reported. Most uses of RS reported in the literature are for urological cases involving nephrectomies or pyeloplasties [1,2].

We previously reported our experience with single-site video-assisted thoracic surgery by using a modified uniportal video-assisted system [12,13] and now translate this experience into single-site RS surgery. We had initially started using the QuadPort access device as our single-site surgery device, but then switched to the GelPOINT Advanced Access Platform laparoscopic system. Both access systems allow multiple port placements via a single incision and allow sufficient freedom of movement of various laparoscopic instruments. The wound protector component of this system offers sufficient circumferential abdominal wall wound retraction and stretches the wound to better facilitate retrieval of larger specimens (Fig. 1). We preferred the GelPOINT Advanced Access Platform system because we perceived it to have greater flexibility in port placement and movement as opposed to the semirigid fixed prepositioned access ports in the QuadPort access system. Median age at surgery for patients undergoing single-site RS was 16.5 years (IQR, 12–18 years), which is within the range of the reported mean age for patients undergoing multiport retroperitoneal surgery in previous studies [4,14]. Thus far, none of the patients with paratesticular rhabdomyosarcoma that underwent a negative RPLND relapsed, with a median follow-up of 12 (IQR 9–16) months. We encountered no difficulty in adequately visualizing the retroperitoneal space (Fig. 3). The retroperitoneoscopic approach has the added advantage of providing an excellent retrohepatic/retrocaval view, while avoiding use of a liver retractor, whereas standard TPLA provides a limited retrocaval view, especially of the suprarenal inferior vena cava (Figs. 3D and E). A direct comparison of the lymph node yield between both approaches is not possible in this series since some procedures were therapeutic and therefore only targeting involved lymph nodes, while other procedures were for staging procedures harvesting all lymph nodes in a template.

In our limited RS case series, no patient required conversion to open procedure; however, one (12.5%) had a breach of the peritoneum with CO_2, which occurred when creating the retroperitoneal space by blunt dissection. Direct decompression of the CO_2 insufflation of the abdomen can be achieved through the same incision. The reported peritoneal breach with CO2 in one series was 43.8%, which mostly occurred during attempted placement of the second and third ports [4]. The same series also had an open conversion rate of almost 19% [4]. The use of a single-site port system lowers the risk of a peritoneal breach, because only one port is inserted and additional port sites are typically not required.

Some authors believe that RS RPLND offers faster direct access to the retroperitoneum without the need to manipulate bowel through a Mattox or Cattell maneuver and easier dissection than for a TPLA [15]. Median operative time for patients undergoing single-site RS was 232 min (IQR, 207–281 min), which is longer than operating times reported in a previous study for patients undergoing the standard TPLA RPLND for the same surgery in adults [16]. Although this technique is technically challenging with a steep learning curve, especially with smaller working space through a single incision, these technical issues

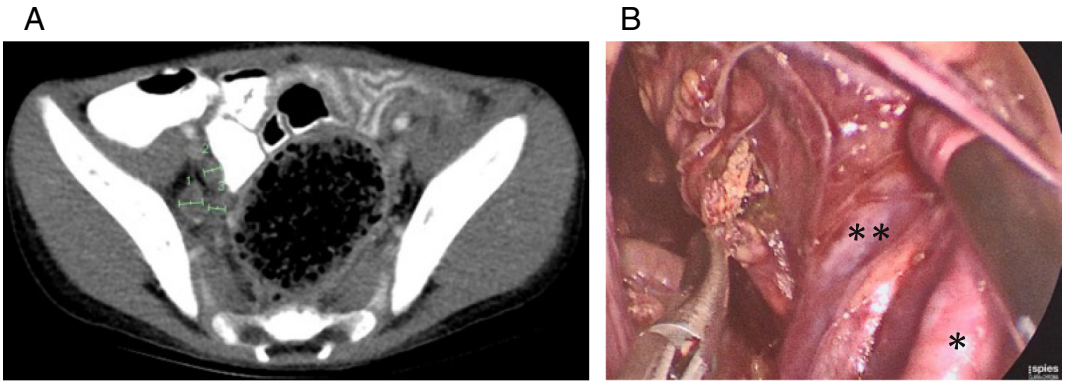

Fig. 2. Adequate visualization of retroperitoneal distal pelvic vessels in a patient with pelvic adenopathy. (A) Computed tomography showing right pelvic adenopathy coursing along the right pelvic sidewall. (B) Distal external iliac artery (*) and vein (**) retracted laterally to expose necrotic pelvic adenopathy.

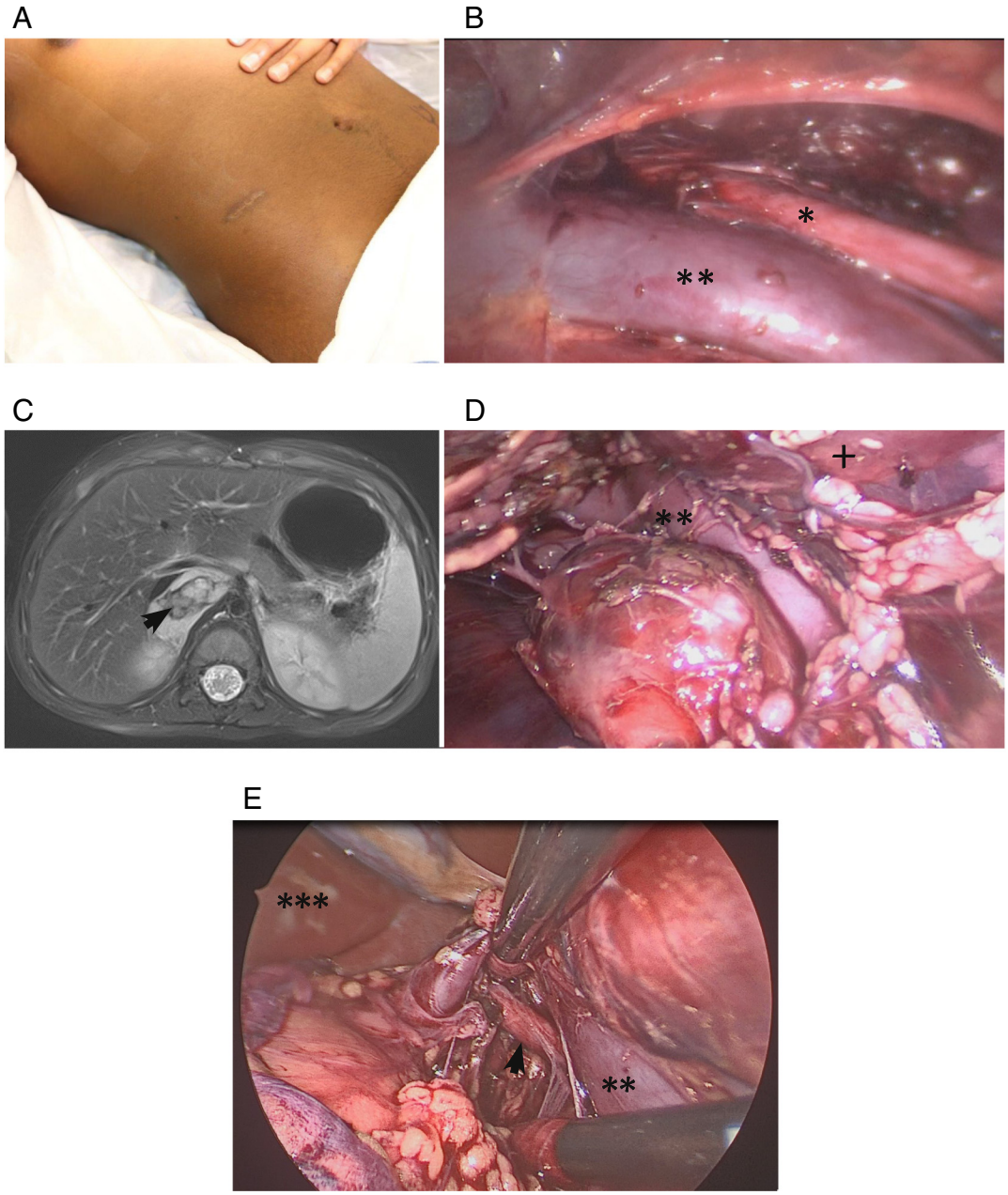

Fig. 3. Adequate visualization of retroperitoneal structures through a single 2- to 2.5-cm flank incision (A) on a patient lying in a supine position. (B) Retroperitoneoscopic view of the inferior vena cava (IVC) (**) and aorta (*). (C) Computed tomography scan revealing the right adrenal mass (arrow), with its retroperitoneoscopic view (D) revealing the adrenal mass and suprarenal retrohepatic IVC (**) without the need for a liver (+) retractor. (E) A standard transperitoneal laparoscopic approach for a lymph node dissection revealing the IVC (**) and renal artery (arrow), with the liver (***) being retracted in background.

Table 2
Patient characteristics of the five patients that underwent TPLA for retroperitoneal adenopathy.

No.	Gender (M/F)	Age at surgery (years)	Primary diagnosis	Neoadjuvant chemotherapy	Indication	Tumor size (cm)	Pathology (positive LN/total LN)	Postop follow-up (months)
1	M	19	L GCT retroperitoneal adenopathy	Yes	Local control	NA	2/5	11
2	M	17	R Paratesticular ERMS	No	Staging	NA	6/39	23
3	M	21	R GCT retroperitoneal adenopathy	Yes	Local control	NA	1/1	23
4	M	4	R Paratesticular ERMS	Yes	Staging	NA	0/2	23
5	F	3	Metastatic L adrenal NB and retrocaval adenopathy	Yes	Local control	1 × 1.1 × 1.6	NB	20

M: male, F: female, LNs: lymph nodes. NB: neuroblastoma, E RMS: embryonal rhabdomyosarcoma, GCT: germ cell tumor, L: left, R: right, No.: number, NA: not applicable.

Table 3
Perioperative outcomes between single-site RS and standard TPLA groups. The Kruskal–Wallis test has been applied to compare the medians between both groups.

	Single-site RS $n = 8$	Standard TPLA $n = 5$	H-statistic $(1, N = 13)$	p-value
Age at surgery, median years (IQR)	16.5 (12–18)	17 (4–19)	0.005	0.94
Operative time, median min (range)	232 (207–281)	234 (204–264)	0.09	0.77
Total oral morphine equivalent dose, median mg/kg (IQR)	0.1 (0.0–0.1)	0.4 (0.3–0.8)	6.94	0.01
Total Acetaminophen dose, median mg/kg (IQR)	20.3 (9.1–40.7)	17.1 (15.6–27.4)	0.05	0.83
Total Nonsteroidal Anti-inflammatory dose, median mg/kg (IQR)	7.5 (0.0–14.4)	11.0 (10.5–18.2)	0.26	0.61
Hospital stay, median days (IQR)	0.5 (0–1)	2 (1–2)	4.82	0.03
Complications	1[a]	1[b]	N/A	0.72

RS: retroperitoneoscopic surgery, TPLA: transperitoneal laparoscopic approach, RPLD: retroperitoneal lymph node dissection, IQR: interquartile range, M: male, F: female, min: minutes.
[a] Breach of peritoneum.
[b] Conversion to open.

will likely abate with increasing experience and also reduce operative times [17]. In our opinion, the learning curve for supine single-site RS is less steep than for prone RS, because it allows the surgeon to view the anatomy from the conventional perspective. The theoretical advantage of a retroperitoneoscopic approach is that it avoids the necessity of bowel mobilization and potential development of an ileus or future adhesion formation [15]. In addition, inadequate desufflation of CO_2 in the standard abdominal TPLA may lead to significant referred C4 dermatome shoulder-tip pain owing to diaphragmatic phrenic nerve irritation [18]. The incidence of laparoscopic-induced shoulder-tip pain, which can be a significant burden to patients, is 35%–80%, ranging from mild to severe, and can last for more than 72 h after surgery [18,19]. This potential side effect can be avoided by using a retroperitoneoscopic approach, as long as the peritoneum is not breached. We believe that these features contributed to the lower utilization of narcotics and shorter length of stay found in this study (Table 3). Furthermore, operating on patients using the single-site RS in a supine position rather than a prone position has the theoretical advantage of quicker access to the abdomen if a vascular complication arises.

4. Conclusion

Retroperitoneoscopic single-site RS in a supine position is an emerging technique that is comparable to the standard TPLA. RS is a feasible minimally invasive technique that can be safely employed in carefully selected pediatric surgical oncology patients when accessing the retroperitoneum.

References

[1] MacDonald C, Small R, Flett M, et al. Predictors of complications following retroperitoneoscopic total and partial nephrectomy. J Pediatr Surg 2018;54(2):331–4.
[2] Bachmann A, Ruszat R, Forster T, et al. Retroperitoneoscopic pyeloplasty for ureteropelvic junction obstruction (UPJO): solving the technical difficulties. Eur Urol 2006;49(2):264–72.
[3] Bartel M. Retroperitoneoscopy. An endoscopic method for inspection and bioptic examination of the retroperitoneal space. Zentralbl Chir 1969;94(12):377–83.
[4] Theilen TM, Paran TS, Rutigliano D, et al. Experience with retroperitoneoscopy in pediatric surgical oncology. Surg Endosc 2011;25(8):2748–55.
[5] Lee YT, Samsudin H, Ong CCP, et al. Posterior retroperitoneoscopic adrenalectomy for pediatric adrenal tumors. J Pediatr Surg 2019;54(11):2348–52.
[6] Velanovich V. Laparoscopic vs open surgery: a preliminary comparison of quality-of-life outcomes. Surg Endosc 2000;14(1):16–21.
[7] Pogorelic Z, Buljubasic M, Susnjar T, et al. Comparison of open and laparoscopic appendectomy in children: a 5-year single center experience. Indian Pediatr 2019;56(4):299–303.
[8] Benson Ham 3rd P, Twist CJ, Rothstein DH. Retroperitoneoscopic resection of a T11-L2 right-sided ganglioneuroma. J Pediatr Surg 2019;54(8):1719–21.
[9] Nielsen S, Degenhardt L, Hoban B, et al. A synthesis of oral morphine equivalents (OME) for opioid utilisation studies. Pharmacoepidemiol Drug Saf 2016;25(6):733–7.
[10] Mansfield SA, El Gohary Y, Kimble A, et al. A quality improvement intervention to decrease postoperative opioid prescriptions in pediatric oncology patients. J Pediatr Hematol Oncol 2019 [Online ahead of print].
[11] Seims AD, Nice TR, Mortellaro VE, et al. Routine utilization of single-incision pediatric endosurgery (SIPES): a 5-year institutional experience. J Laparoendosc Adv Surg Tech A 2015;25(3):252–5.
[12] Fernandez-Pineda I, Seims AD, VanHouwelingen L, et al. Modified uniportal video-assisted thoracic surgery versus three-port approach for lung nodule biopsy in pediatric cancer patients. J Laparoendosc Adv Surg Tech A 2018;29(3):409–14.
[13] Fernandez-Pineda I, Seims AD. Modified uniportal video-assisted thoracic surgery in children. J Minim Access Surg 2016;12(4):373–4.
[14] Kim C, McKay K, Docimo SG. Laparoscopic nephrectomy in children: systematic review of transperitoneal and retroperitoneal approaches. Urology 2009;73(2):280–4.
[15] Antoniou D, Karetsos C. Laparoscopy or retroperitoneoscopy: which is the best approach in pediatric urology? Transl Pediatr 2016;5(4):205–13.
[16] Nicolai N, Tarabelloni N, Gasperoni F, et al. Laparoscopic retroperitoneal lymph node dissection for clinical stage I nonseminomatous germ cell tumors of the testis: safety and efficacy analyses at a high volume center. J Urol 2018;199(3):741–7.
[17] Abdel-Karim AM, Elhenawy IM, Eid AA, et al. Laparoendoscopic single-site surgery for the treatment of different urological pathologies: defining the learning curve of an experienced laparoscopist. Arab J Urol 2017;15(3):187–93.
[18] Alexander JI. Pain after laparoscopy. Br J Anaesth 1997;79(3):369–78.
[19] Tsai HW, Chen YJ, Ho CM, et al. Maneuvers to decrease laparoscopy-induced shoulder and upper abdominal pain: a randomized controlled study. Arch Surg 2011;146(12):1360–6.