Chapter 24
Laparoendoscopic Single-Site Surgery

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Abbreviations

CL	Conventional laparoscopy
LESS	Laparoendoscopic single site surgery
MIS	Minimally Invasive Surgery
OPUS	One-port umbilical surgery
RA	Robotic-assisted

Introduction

Minimally invasive surgical techniques continue to be pushed throughout pediatric urology. A badge of honor for today's surgeon is the diminutive size or appearance of an incision rather than the usual metrics of speed and efficacy which are considered more of a required competency. Laparoendoscopic single site surgery (LESS) offers perhaps the greatest advantage in terms of cosmesis compared to other techniques [1, 2] which may be especially important to the pediatric population who have a lifetime in front of them in regards to perception of body image and associated self-esteem. Although LESS poses its own set of challenges and limitations, it is a valuable approach and technique that can be used for multiple procedures.

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P. C. Gargollo (ed.), *Minimally Invasive and Robotic-Assisted Surgery in Pediatric Urology*, https://doi.org/10.1007/978-3-030-57219-8_24

Background

The nomenclature of LESS has been controversial and varied. It has been called single access/port/site/incision/trocar surgery, one-port umbilical surgery (OPUS), and embryonic natural orifice transluminal endoscopic surgery [3]. The Urologic NOTES working group has recommended that LESS be designated the terminology of choice to define laparoendoscopic procedures performed through a single port, multiple port, and single multiport platform used via a single incision or location anywhere in the abdomen, flank or the back [4].

The first form of laparoendoscopic single site surgery was done in the late 1960s for tubal ligations. Electrocauterization and excision of a portion of each fallopian tube was performed through a fiberoptic laparoscope (Fig. 24.1) [5]. Single-port laparoscopic surgery had been reported for cholecystectomy and appendectomy since 1998; however, the approach did not gain momentum because of technical challenges. The initial report of a single port nephrectomy in an adult occurred in 2007 [6]. Although a multitude of pediatric cases soon followed, it could be argued that the first form of pediatric urological LESS surgery was the retroperitoneal single site surgery that was described by Lima in 2005 where a single flank 12 mm incision was located 1 cm under the XII rib. A balloon 12 mm Hasson trocar was then inserted; After the creation of the working space with a peanut, using a 10 mm coaxial operative telescope, the renal pelvis and the proximal ureter were inspected, isolated and then exteriorized at skin level with a vessel loop for performance of the pyeloplasty [7].

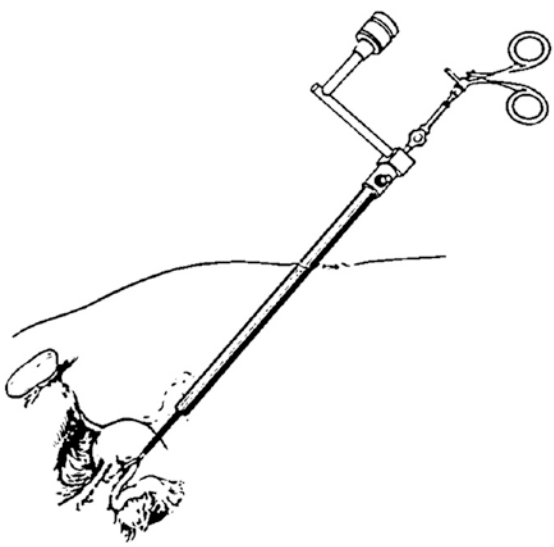

Fig. 24.1 Operating laparoscope for tubal ligation. (*Used with permission of Wolters Kluwer Health, Inc.*)

Overview

The relevant background for pediatric laparoscopy including physiological considerations, anesthesia, and relevant anatomy are covered in prior chapters. However as a general rule to LESS, patient positioning is slightly altered for upper tract surgery. Port placement is radically different and counterintuitive to the hallmark of conventional laparoscopy which stresses triangulation on the target area. For flank transabdominal approaches to renal surgery including nephrectomies, heminephrectomies or pyeloplasties, the patient is positioned as close to the edge of the bed to help minimize clashing of instruments extracorporally [8]. For pelvic transperitoneal surgery, the patient is positioned supine, often with slight trendelenberg, and the dissecting surgeon would stand on the side of the bed allowing better dexterity of their dominant operating hand [9].

LESS can be considered more difficult for multiple reasons including: (1) Instrument clashing, (2) Lack of triangulation, (3) Difficulty in visualization with parallel instrumentation/optics, (4) Reduced operating space. The cause of this difficulty, when compared to conventional laparoscopy, is placement of all instruments and trocars through a single incision or port.

There is a great variety of multi-trocar single ports as well as adapted devices or approaches. The shown multi-trocar single ports are not exhaustive (Figs. 24.2, 24.3, and 24.4). Adapted devices include use of an abdominal wound protector with a glove port (Fig. 24.5) [10–14]. Incisional adaptive approaches include (1) making an extended skin incision of approximately 2–3 cm in a transverse or longitudinal direction through the umbilicus or peri-umbilically with subsequent placement of multiple trocars via separate stab incisions through the underlying fascia (Fig. 24.6) [15] or (2) making a longitudinal or transverse 2.5 cm incision through the umbilicus, disarticulating the umbilical stalk and then placing one trocar via the open umbilical ring and the lens and additional instruments directly through adjacent

Fig. 24.2 Covidien SILS™. (*©2019 Medtronic. All rights reserved. Used with permission of Medtronic*)

Fig. 24.3 Olympus Triport+™. (*Image Courtesy of Olympus America Inc.*)

Fig. 24.4 Applied medical GelPOINT™ advanced access platform. (*©2019Applied Medical Resources. All rights reserved. Used with permission of Applied Medical*)

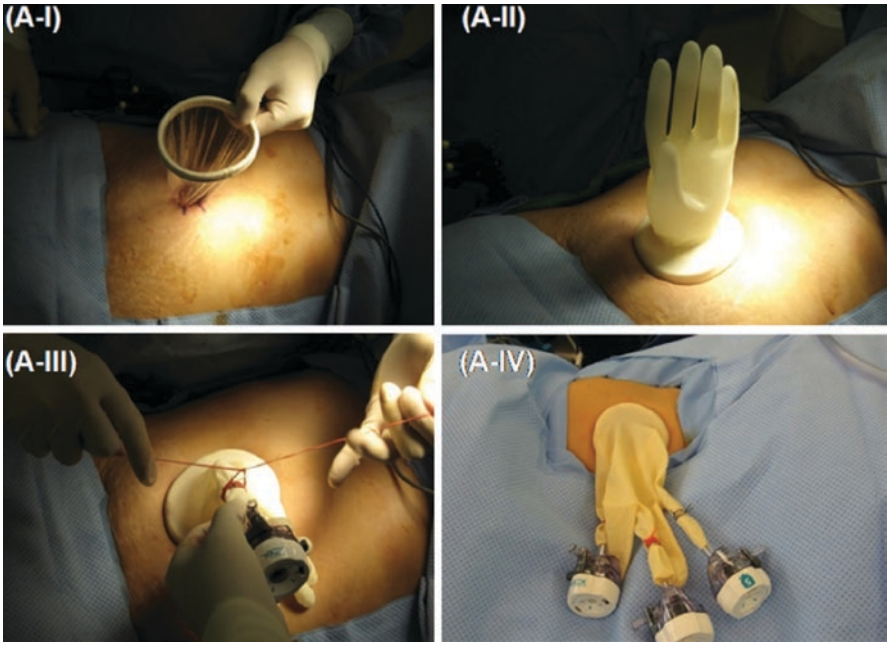

Fig. 24.5 (**AI-IV**) A self-constructed glove port, created from a wound protector and glove, for single-incision laparoscopic surgery. (*Used with permission of Elsevier*)

Fig. 24.6 Single incision technique with one 10-mm and 2 5-mm trocars. (*Used with permission of Elsevier*)

fascial stab incisions, without additional trocars (Fig. 24.7) [16]. This approach is cheaper since less trocars are used but can be difficult since exchange of instruments is limited to the one trocar; a lens and a grasper are generally kept intracorporeal for the duration of the procedure on either side of the trocar. Additional needlescopic instruments can often be used such as a percutaneous alligator grasper (Fig. 24.8) through any percutaneous location desired for technical feasibility.

Fig. 24.7 Single 2 cm longitudinal incision with working trocar via umbilical ring and telescope/grasper placed through adjacent stab incisions. (*Used with permission of Elsevier*)

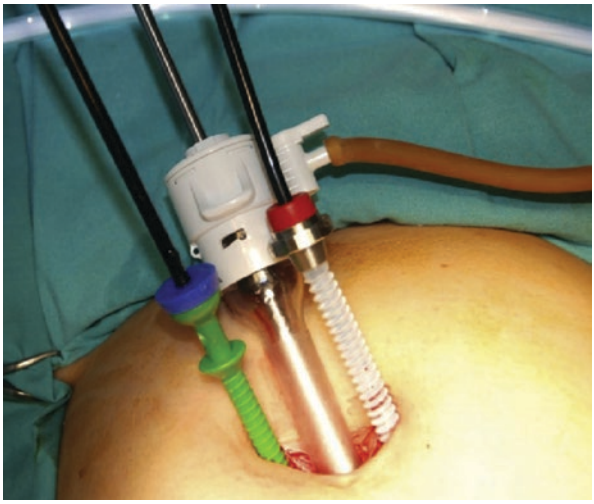

Fig. 24.8. Teleflex Minilap™ Alligator Grasper using a 2.3 mm sheath. (*Image courtesy of Teleflex Incorporated. ©2010 Teleflex Incorporated. All rights reserved*)

Fig. 24.9 Flexible 5 mm telescope with charged couple device chip at the tip (Olympus EndoEye). (*Image Courtesy of Olympus America Inc.*)

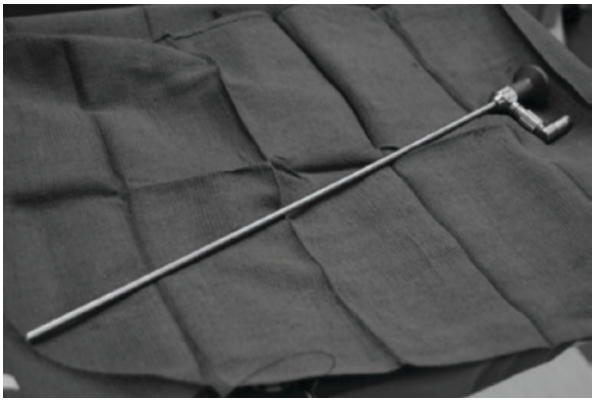

Fig. 24.10 Bariatric length telescope with right angled light connector

Fig. 24.11 5 mm articulating dissector (Covidien SILS™ Dissect). (*©2019 Medtronic. All rights reserved. Used with permission of Medtronic*)

There is no one optimal approach or port, and preference is certainly related to surgeon experience. However, when using an adaptive incisional technique, the direction of the umbilical incision must take into account the area of interest whether that is the pelvis (transverse incision) or lateral structures (longitudinal incision).

Multiple technological advancements have arisen to overcome the inherent limitations of LESS. Better optics and specialized instrumentation have been used in all specialties. Flexible tip laparoscopes were created where the tip can be angled towards the operative site (Fig. 24.9) [4, 17]. This allows for appropriate visualization during the procedure while remaining outside of crowded port space and internal laparoscopic instruments. In our experience, utilizing a bariatric length telescope with a right-angled light connector is sufficient (Fig. 24.10). Multiple articulating instruments have been created as well in the forms of dissectors, graspers, scissors or a hook (Fig. 24.11). However, we have found that aside from a multi-port and a bariatric length telescope, specialized instrumentation is not necessary for the overwhelming number of procedures specific to pediatric urology [18]. Perhaps more

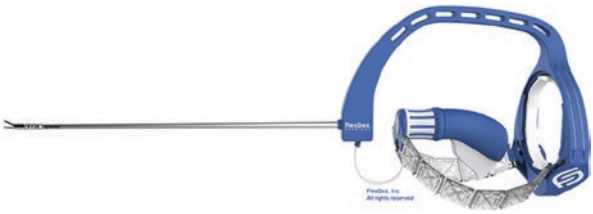

Fig. 24.12 5 mm articulating needle driver (Flexdex™). (*Used with permission of FlexDex, Inc. All rights reserved*)

complex reconstructive procedures which require intracorporeal suturing may require advanced tools (Fig. 24.12) but extirpative procedures do not, based on multiple case series [19].

When considering financial aspects of LESS, some authors have commented on the cost of LESS as compared to conventional laparoscopy, open procedures, or robotics [20, 21]. For nephrectomy, the robotic approach has been noted to be the most expensive while open the least expensive in comparison to LESS; further details are summarized in upcoming paragraphs.

Noh et al. summarized supply costs in 2013 using orchiopexy as an example: a 5 mm Covidien Step™ trocar for diagnostic laparoscopy costs $92, followed by an Olympus Triport at a cost of $395, bringing to a total of $487 in access supply costs for a single LESS procedure. This would compare to $276 if three 5-mm ports were used. If two 3 mm trocars at $54 each were used, the cost would be $238. Although many authors do not rely on the use of a flexible-tip laparoscope, in that publication Noh et al. reported that the cost to invest in the purchase of two scopes was $41,722, in addition to $17,712 for the required video system, and $3842 for sterilization trays [22].

Technical Considerations

Overall LESS requires a greater deal of dexterity, patience and persistence. There are slight alterations in technique including (1) Crossing of instruments may be required, (2) Setting grasper retraction followed by the insertion of other working instrumentation may be required to minimize clashing (3) Energy devices such as scissors or the harmonic scalpel must be used by either hand since the angles of approach are limited (4) Placement of the telescope is variable but usually the inferior position of a multi-port is preferable. Additional technical considerations will be described as they apply to separate procedures on the following pages.

Applications and Outcomes

Retrospective studies comparing LESS to other surgical approaches are summarized in Table 24.1.

Table 24.1 Retrospective series comparing LESS approach to others

First author	Year	Where	Case matched	# in series	OR time (min)	LOS (days)	Analgesia	Other	f/u amt	Outcome
Nephrectomy/nephroureterectomy										
Woldrich [21]	2011	USA	No	LESS – 7 CL – 11 Open – 8	192 219 127	2 1 1	Narcotics equivalent *Open got more toradol*	Included multiple concomitant procedures *Hospital costs: LESS 96.8% of CL, open 54.4%*	–	1 LESS converted to open 2/2 bleeding (excluded from analysis)
Kocherov [33]	2011	Israel	Yes	LESS – 4 CL – 4	72.5?	*1.1* *1.9*	*0 mg/kg* *0.46*	–	–	–
Kim	2012	USA	No	LESS – 11 CL – 11 RA – 11 Open – 39	*133* *162* *188* *94*	*1.3* *1.4* *1.8* *3.2*	*0.18 mg/kg* *0.10* *0.23* *0.63*	–	–	–
Tam [35]	2013	China	Yes	LESS – 8 CL – 12	*156* *99*	2.9 2.6	0.08 mg/kg 0.28		"3 mo – 3 yr"	1 wound infection in CL
Bansal [20]	2014	USA	No	LESS – 8 RA – 24	*174* *227*	1 2	*LESS had more blocks* Comparable narcotics, toradol	*RA hospital charges cost 30% more*	18.8 22	1 abscess needed outpatient antibiotics in LESS. 1 retention, 1 stump leak in RAL

(continued)

Table 24.1 (continued)

First author	Year	Where	Case matched	# in series	OR time (min)	LOS (days)	Analgesia	Other	f/u amt	Outcome
Heminephroureterectomy										
Neheman [37]	2019	USA + Israel	No	LESS – 10 CL – 7 RA – 18 Open – 24	*140* *190* *256* *154*	*1* *1* *2* *3*	*Toradol only used in MIS* *Open needed more morphine and acetaminophen*	More MIS cases over study period. Epidural for all open, local for all MIS. 8 concomitant procedures.	–	1 LESS patient had ipsilateral moiety atrophy
Pyeloplasty										
Naitoh [41]	2014	Japan	Yes	LESS – 14 CL – 14	243 229	–	*Pain score lower for LESS on POD3, 4*	–	–	No issues
Khambati [42]	2015	Canada	Yes	LESS – 7 CL – 28	233 210	2.2 2.8	–	No cost difference	15.7 –	1 LESS conversion to open due to dissection issue 1 LESS near loss of renal function
Varicocelectomy										
Bansal	2014	USA	No	LESS – 11 CL – 32	*46* *55*	0	*81.8% received narcotics* *31.2% received narcotics*		*15* *22*	1 LESS got hydrocele 1 CL got hydrocele
Khambati [42]	2015	Canada	Yes	LESS – 5 CL – ?	54 48	0				No issues

Legend: Summary of series that compare the LESS approach for multiple procedures to conventional laparoscopy (CL), Robotic-assisted laparoscopy (RA), or open surgery. Variables highlighted in italics had significant differences between groups, as summarized in the text

Upper Urinary Tract Surgery

Nephrectomy

A number of case reports, case series, and retrospective chart reviews have been published describing the techniques and feasibility of using a LESS approach in pediatric patients undergoing unilateral simple nephrectomy, single-system nephroureterectomy, as well as bilateral simple nephrectomies. The first case reports were published in 2009 following the first reports in the adult literature [12, 23, 24], and a number of retrospective reviews comparing the LESS approach to conventional laparoscopy, robotic assistance, and open have followed [20, 21, 25].

Techniques described are relatively consistent with the use of transperitoneal, umbilical access and incisions are consistently reported at 1–2.5 cm. Most authors describe the use of commercially available ports, with Coviden SILS© and Olympus Triport© being common choices, and less commonly Karl Storz X-CONE, Advanced Surgical Concepts R-port, Applied Medical GelPOINT®, and the OCTO™ port. One series specifies that a 2.5 cm incision could be used for a SILS© port while 1.5 cm for TriPort© [26]. Adaptive ports were commonly reported to be preferred by Korean urologists [12–14], which used Alexis® retractors and modified sterile gloves. Of the series that used an incisional approach, one used it due to the lack of an available LESS port at the time of surgery [23], and the other used it for patients <10 kg without an appropriately sized LESS port [27]. Most authors described using a combination of both flexible and straight instruments, oftentimes preferring a flexible endoscopic camera with straight instruments vs a straight camera, 0 vs 30 degrees, and a flexible grasper. One exception to this was the use of an end-on light source on a 45-degree bariatric lens with routine straight laparoscopic instruments [8, 18, 19, 28]. Both LigaSure™ and Harmonic® tools were described for assisting with dissection. Hilar control was accomplished with Hem-o-lok® clips in a number of series, and another specified the use of an Endo GIA™ stapler [19].

There was almost no reporting of a need to extend incision sizes for extraction. Some publications described using aspiration or morcellation to assist with extraction [19, 24, 26, 29, 30]. Other series describe using EndoBags™ for retrieval, with one series specifically describing that the larger specimens were removed in a piecemeal fashion within the EndoBag™ [31].

Other technical considerations include that a number of series described using percutaneous retraction sutures to assist with hilar mobilization [20, 27], as well as the use of a percutaneous 2.3 mm alligator liver retractor [8], where needed. The series that included bilateral nephrectomies describe using an Ioban™ to protect the incision then repositioning the patient lateral decubitus contralaterally [8].

There are also a small number of series describing single-incision retroperitoneal approaches for nephrectomy. Incisions sizes are described at 1.1–2.5 cm, with about 50% port and 50% incisional techniques used. One series describe using only 1 instrument with their camera using a 1.1 cm incision [32]. Reported mean operative

times are 60–63 min, length of stay 1–1.5 days. Reviewed series do not describe experience with post-operative pain or aesthetic results [31, 32].

Demographics and perioperative outcomes were broad in the pediatric literature, with mean ages reported from 2 to 13 years old. The series with bilateral nephrectomies included the oldest of patients, consistent with age-appropriate pathologies. Most OR times ranged between 70–192 min, with nephroureterectomy 116–174 min, and bilateral cases ranging 128–342 min [8, 19, 28]. Definitions of OR time were not often specified. One series commented on a notable improvement in operative times over the study period, with the first half of cases averaging 102 min and the second half measuring 70, suggesting a learning curve can be expected [19]. Blood loss was consistently negligible or less than 50 cc, and length of stay was also consistent with most discharges on postoperative day 1, however one series did describe that they found nephroureterectomy discharges were slightly longer (1.5 day) and multiple papers including bilateral cases had longer LOS at 1–4.5 day mean stays reported, with medical/dialysis needs accounting for the longer stays [8, 19]. Many series looked at postoperative pain medication requirements and of those, about half report no postoperative narcotic requirement with the use of non-narcotics only [23, 27, 33, 34].

Reported complications associated with LESS are uncommon and not shown to be significantly different from open or laparoscopic approaches where they were compared. Reported complications out of the >250 cases described include 1 conversion to open for bleeding, two port site infections requiring outpatient antibiotics, 1 ileus requiring PICC placement [18, 20]. Follow up information is limited with many publications having no postoperative follow up specified, and of those that do, the time frame is only 1–18 months [20].

Only a few retrospective case-matched cohort reviews are available to compare LESS nephrectomy vs open or other minimally invasive approaches, and findings do vary from series to series [20, 21, 25, 33]. Patients undergoing LESS have been found to have either equivalent or less narcotic requirements, equivalent or shorter length of stay, and longer operative times than open cases. Compared to conventional laparoscopy, both equivalent and shorter operative times have been reported, as well as shorter hospital stay for LESS patients [33]. As for the robotic approach, LESS has shorter operative time reported. Lastly, open cases have been found to have significantly lower hospitalization charges than LESS by about 56% [21], while robotic-assisted approaches have 30% higher charges than LESS procedures [20].

Hemi-Nephrectomy

The role of LESS has also been well-described in performing hemi-nephroureterectomies of upper or lower duplicated systems [30, 35–38]. Consistent with pathological incidences, upper pole moieties are more commonly removed than lower pole moieties. The technique has also been described for partial nephrectomy of a mass as well [11]. Approaches to surgery mirror those described above for

single-system nephrectomy, however the partial nephrectomy case report did use a larger fascial incision for extraction at 3 cm.

In the available literature, most patients were infants or a mean of 1–2 years old, consistent with the expected pathologies for this procedure. Mean operative times were similar to LESS single system nephrectomies at 58–140 min, EBL was minimal, and length of stay was 1 day. Regarding outcomes, one series had 11 months of mean follow up with no reported complications and normal postoperative imaging [36]. A multi-institutional chart review series reported one case (out of 10) that developed an ipsilateral moiety atrophy, at unspecified mean follow up [37]. Another series reported that a LESS hemi-nephroureterectomy attempted on a lower pole moiety was converted to open due to difficulty with dissection [35]. Another series reported one ipsilateral renal artery spasm as well as a transient urine leak [30].

Neheman's 2019 multi-institutional retrospective chart review compared LESS hemi-nephroureterectomy to the open approach as well as conventional laparoscopic and robotic-assisted approaches over the same time period (2007–2017) [37]. The LESS approach had a significantly shorter operative time than both conventional laparoscopy and robotics, and was found to have comparable EBL, LOS, narcotic requirements, and acetaminophen requirements to the other MIS approaches which all were superior to the open approach.

Pyeloplasty

LESS pyeloplasty is very well described with numerous series, mostly outside of the USA with most publications from China and Japan [26, 34, 39–45]. Techniques again mirror the approach to nephrectomy with 1.5–2.5 cm incisions, a dominance of commercial port usage with SILS©, TriPort ©, and GelPOINT® being commonly described. Of authors reporting on the use of port devices, both flexible and straight instruments were preferred. The largest series by far was published in 2017 by Liu et al. where 704 patients underwent a LESS approach for dismembered pyeloplasty and this series as well as one other by Bi et al. 2011 also used an incisional approach and both of these groups preferred straight laparoscopic instruments only [44, 45].

Unique technical considerations include again the use of percutaneous sutures to assist with retraction as well needlescopic ports for retraction and later drain placement [26, 34, 39, 41]. Drains were also placed via the port site [39], when used. Stent placement was accomplished by the use of a percutaneous angiocatheter vs a retrograde placement using pre-procedural cystoscopic ureteral access [39, 42].

OR times were reported at means of 110–243 min, with the largest series by Liu et al. describing a OR time of 110 min that did not include instrument placement or closures. This series did report a significant learning curve for LESS pyeloplasty with improvements from 175 min in 2010 procedures to 100 min in 2015. EBL was consistently reported at less than 100 cc, and length of stay from 2–7 days. Postoperative pain control spanned from no narcotics [34] to multiple days with a routine pain pump [43]. Complications as described by the Liu series which had

25 months of mean follow up included 8.1% minor complications requiring medication or observation (most commonly UTI > flank pain > ileus > urine leakage), and 2.0% major complications needing minimal invasive procedures (stenosis > stent block > urinoma, stent migration, serosal tear, bleeding requiring additional trocars). Success rates were reported at over 95% with most patients reportedly being evaluated with postoperative renal drainage nuclear studies [44]. Other series described similar outcomes except one article which did report a conversion to open for difficult dissection and another patient who had a near loss of renal function in the operated kidney [42].

A few series have been published comparing the LESS approach to pyeloplasty with conventional laparoscopy in a case-matched cohort. OR times were comparable as were length of stay. One series found lower pain scores on POD3 and 4 for patients in the LESS groups, but otherwise equivalent postoperative pain reports.

Other

Additional renal procedures accomplished with a LESS approach include a number of reports for renal cyst decortication or ablation, reports of pyelolithotomy, and one on a calyceal diverticulectomy. Surgical materials, techniques and outcomes again mirror those described for the above procedures [19, 38, 42, 46].

Pelvic Surgery

Varicocelectomy

A number of small series and case-matched retrospective reviews have been described from authors around the world regarding LESS experiences with laparoscopic varicocelectomy, with the earliest report published in 2008 [18, 26, 30, 33, 34, 38, 42, 47, 48]. The largest series described included only 11 patients [47, 48]. Both unilateral and bilateral procedures have been described.

The most common techniques utilized Olympus TriPort©, GelPOINT®, or SILS©, and two series used an incisional approach. One series only used an incisional approach for patients under 10 kg while another preferred the technique for all pelvic procedures [18, 30]. Incisions were 1.5–2.5 cm. Flexible and straight instrumentation was preferred in all series except with the incisional approach in Patel's 2016 series, only using straight instruments with an offset 45-degree endoscopic camera [18]. Dissection technique was not described by most series but one did describe that the testicular artery was only spared if technically easy to complete [42].

Reported mean operative times were 26–85 min, EBL was minimal and most patients were discharged the same day. Most series reported no narcotic

requirements postoperatively except Bansal 2014 that found 81.8% of patients required some narcotics postoperatively [48]. Most series did not describe the duration of follow up but up to 15 months was available in the largest series with 11 patients that reported one hydrocele development as the only adverse outcome. One report of varicocele persistence was described, 2 hydroceles, 1 conversion from port to incisional technique secondary to pneumo leak, and 1 problematic postoperative pain experience were reported [18, 30, 48].

Series that retrospectively compared the LESS approach to a case-matched group of patients who had a conventional laparoscopic approach found the LESS patients either needed less *or more* postoperative narcotics and had shorter or equivalent operative time. Complication rates were not significantly different [48].

Orchiopexy

The use of LESS for laparoscopic orchiopexy has been described in case series including up to 18 patients [18, 22, 26, 30, 34, 47, 49], including both unilateral and bilateral, staged and non-staged procedures from multiple countries of publications. As would be expected, the technique would be initiated with a single trocar placement to perform diagnostic laparoscopy before proceeding with the LESS procedure.

Similar to the varicocelectomy procedures, a port device is most popular with TriPort being utilized the most in the literature, and two series preferring an incisional approach. Again the incisional approach was preferred in one series for patients under 10 kg while the other preferred an incisional approach for all gonadal/inguinal procedures [18, 30]. Also mirroring the techniques described for varicocelectomy, most surgeons preferred a combination of flexible and straight instrumentation while one series had comparable results with only straight instrument usage with a 45 degree offset laparoscopic camera.

Mean operative times were 37–89 min including bilateral procedures where performed, the majority of patients were discharged the same day, and almost no narcotic usage was required. Six series including 49 patients reported no adverse outcomes or complications with up to 12 months of follow up. One series which was the largest identified, including 18 patients, did report one vas deferens injury intraoperatively, and one scrotal cellulitis postoperative infection requiring outpatient antibiotic therapy [47].

Gonadectomy

Numerous small series have described the experience of LESS with gonadectomy, both unilateral and bilateral, including one with concomitant hysterectomy for a DSD condition [18, 19, 33, 34, 47, 50]. On similar trajectory, another case report described the technique in use for an ovarian detorsion and cystectomy [19].

Again, most published surgeons describe a preference to use a commercially available port and flexible and straight instruments for each procedure as described previously, however one series does endorse the use of an incisional approach with an end-on 45-degree lens camera with straight instruments [18].

Mean operative times are reported at about 60 min for unilateral gonadectomy cases and from 37.5 to 82 min for bilateral gonadectomy, and 189 min for the case report that included the hysterectomy as well [34]. One series reported the procedure to be done outpatient while others reported 1–2 day mean length of stays. Where described, no narcotics were required. Almost no follow up data was available, but no complications or adverse outcomes were reported.

Inguinal hernia or Hydrocele Repair

A technique that predates most LESS experience and literature, single-site laparoscopic percutaneous extra-peritoneal closure (SLPEC) of hernia sac/processus vaginalis has been widely performed for repair of inguinal hernia/hydrocele in children for the past few decades, with procedures dating as early as 2006 [9, 51–53]. The technique is most popularized in Eurasian countries, with one series by Chen et al. from 2017 reporting a systematic review that includes 11,815 surgeries done in Eurasian countries [52].

The technique's main similarity to LESS is the use of a transumbilical transperitoneal approach to groin surgery, where only a 5–10 mm incision for camera trocar placement is required at the umbilicus while percutaneous needles at the site of the inguinal hernia are used to hydrodissect, tunnel, and purse-string the patent processus vaginalis closed. Permanent suture is usually required. A similar approach, modified transumbilical two-port laparoscopic suturing (M-TTLS), utilizes two rather than one umbilical port placement to assist with suturing of the repair. This technique was compared to the SLPEC approach in a retrospective review by Wang et al. 2019 and found no significant differences in outcomes but did find M-TTLS to have longer operative times (13.3 min vs 10.8 min). No flexible instrumentation is described as a routine part of this procedure [53].

Mean operative times for SLPEC were reported from 11 to 18.3 min, and the 18.3 min operative time was specified as time from incision to dressings. Learning curve improvements in operative time were found to stabilize after 31 cases in another series by Wang et al. [9] Length of stay was reported from 1–2 days and no outcomes regarding postoperative narcotic requirements were describes.

Summarizing the largest systematic review by Chen which included 49 studies with up to 40 months of follow up, 0.70% of patients experienced a recurrence, 0.33% had a suture knot reaction, 0.32% had vessel injury, most commonly inferior epigastrics, 0.23% developed a hydrocele, 0.05% required a conversion. No testicular atrophy reported [52].

Lower Urinary Tract Surgery

Reports of the use of LESS in the lower urinary tract are rare, but procedures described include utricle excision, ureterolithotomy, distal ureterectomy, and urachal cyst excision [18, 47]. Only urachal cyst excision was reported in more than one patient, so generalizable technique, outcomes on the other procedures cannot be well described. However, success rates in the available reports are poor compared to renal, inguinal or gonadal surgery with the utricle excision requiring additional port placement for dissection, the ureterolithotomy converting to open for failure to progress, and the distal ureterectomy having a febrile UTI and ileus requiring prolonged admission and IV antibiotics [47]. Of three patients described to have a LESS assisted urachal remnant excision, 1 required a redo excision at 10 months postoperatively [18].

Miscellaneous Reconstruction

ACE

A small collection of series have been published describing the use of LESS for Malone antegrade continence enema creation [16, 18, 19]. An incisional approach is more commonly described, as well as a predominance of only straight instrument usage. Mean operative times range from 67 to 119 min, length of stay 1–2 days, and narcotic usage from none to needing narcotic only on POD1. Of 6 patients in these series, complications reported included 1 wound infection requiring outpatient antibiotic and 1 stenosis requiring anesthesia for Chait tube placement at unspecified follow up. No series comparing the technique to the open or conventional laparoscopic approach were identified.

Conclusion

LESS can performed for a variety of procedures, albeit with its technical challenges and learning curves. Multiple technological advances have ushered in greater opportunities to use LESS, including various multi-ports, articulating instruments, or needlescopic instruments. No technical approaches or instrumentation have yet been proven to be superior. There is no apparent increase in complications when comparing LESS to conventional laparoscopy or robotic surgery in current series. Depending on the technique or supplies used, it may reduce material costs, lead to less narcotic needs, and lead to either decreased, equivalent, or increased operative time. Aesthetic benefits are known to be significant.

We feel extirpative or minor reconstructive procedures are ideal for most surgeons as complex reconstructive procedures require a greater deal of flexibility. Authors reporting on the more complex procedures described above deserve merit for their achievements in LESS. In both procedure selection and technical considerations, surgeon familiarity and experience will take precedence.

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