ORIGINAL RESEARCH

The Learning Curve of Retroperitoneoscopic Urologic Surgery: A Systematic Review

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Introduction: Retroperitoneal laparoscopic (RPL) urologic surgery offers comparable surgical and functional outcomes to the traditional transperitoneal approach, with the advantage of circumventing the need to enter the intraabdominal space. This precludes the necessity to encounter small intestinal and colonic segments, encounter abdominal adhesions, and mobilize adjacent organs, translating to better peri-operative and post-operative conditions. However, RPL demands a strong knowledge of the retroperitoneal anatomy coupled with a level of laparoscopic dexterity, this results in a steep learning curve. Unfortunately, the evidence on the learning curve for RPL is diverse and scarce. The aim of this systematic review was to consolidate the available literature and determine the minimum required number of cases to efficiently and safely perform RPL.

Methods: This is a systematic review of the literature via PubMed, EBSCO and Science Direct of all studies published since 2000 to 2019. The search was conducted by combining the following terms, "Retroperitoneoscopy", "Retroperitoneoscopic", "posterior laparoscopy", "Learning", "Nephrectomy", "Adrenalectomy", and "Ureterolithotomy". Outcomes of interest were learning curve, mean operative time, mean intra-operative blood loss and mean hospital stay.

Results: After the screening phase and application of the eligibility and exclusion criteria, the review included a total of 6 studies on the learning curve for RPL. The learning curve for retroperitoneoscopic adrenalectomy was 40 cases and 24 to 42 cases, based on the evidence from Uitert, et al. (2016) and Vrielink, et al. (2017), respectively. For retroperitoneoscopic nephrectomy, the minimum required number of cases is 30 – 70, based on the studies by Pal, et al. (2017), Zhu, et al. (2018) and Tokodai, et al. (2013). Ercil, et al. (2014) demonstrated the learning curve for retroperitoneoscpic ureterolithotomy to be at 30 cases. Review of each literature showed that completion of the learning curves translated to better peri-operative and post-operative conditions (i.e. shorter operative time, lesser intra-operative blood loss, shorter hospital stay). Overall, the evidence in this review suggests that for posterior retroperitoneal laparoscopy, a mean learning curve of 31 to 56 cases is required to safely and efficiently perform the procedure.

Conclusion: Retroperitoneal laparoscopic surgery is a valid alternative to the traditional transperitoneal approach. It offers comparable anatomic and functional results, albeit better peri-operative and post-operative outcomes. However, its performance requires a strong knowledge and familiarity of working within the retroperitoneum which can be achieved through progressive experience in RPL. The evidence consolidated by this review suggests a learning curve of 31 to 56 cases prior to effectively performing the procedure.

Key words: Retroperitoneal laparoscopic urologic surgery, posterior laparoscopy, learning, nephrectomy, adrenalectomy, ureterolithotomy

Introduction

The historical approach and surgical proficiency in the management of urologic diseases have significantly improved with the advent of innovations in operative technique, technology and principles. Open surgery has, over the span of 20 years, been gradually superseded by minimally invasive surgery, as the later has been proven to provide the same, if not, better functional outcomes and post-operative conditions such as pain control, lesser morbidity, and shorter hospital stay.[1,2] Diseases of the genito-urinary system may be approached laparoscopically via the transperitoneal or retroperitoneal techniques. Retroperitoneal laparoscopy (RPL) was initially performed by Gagner in 1992, and since then has seen an upsurge in its utilization. The retroperitoneal approach obviates the need to enter the peritoneal cavity, mobilize adjacent organs, and encounter intraperitoneal adhesions which has resulted in a more efficient procedure. Compared to the transperitoneal approach, the retroperitoneal approach offers comparable surgical and functional outcomes with significantly less pain, less analgesic requirement, shorter hospital stay and shorter convalescence time.[3,4] Furthermore, working in the retroperitoneal space is not obscured by intestinal loops hence there is lower risk of post-operative ileus, pain, evisceration and adhesions.[4] However, retroperitoneal laparoscopy entails a renewed sense of surgical and anatomical familiarity for a successful surgery. Its relative novelty and rarity have resulted in a deep learning curve for both novices and experts in the field of minimally invasive surgery. Recent studies on the learning curve of retroperitoneal laparoscopic surgery of the kidney and adrenals have required approximately 24 – 42 procedures for a urologic surgeon to achieve competency.[5,6] Unfortunately, the current evidence on the minimum number of procedures to efficiently perform the procedure is varied and scant. Hence, the aim of this study was to consolidate the available data and attempt to formulate an acceptable learning curve for those interested in RPL urologic surgery.

The aim of this systematic literature review was to consolidate all available data on the learning curve in retroperitoneoscopic urologic surgery to establish a minimum number of cases to achieve surgical proficiency.

Methods

This systematic review was composed based on the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA). Studies included were conducted from 2000 to 2019, without language or publication restrictions. Studies eligible to be included in this review are those studies on retroperitoneal laparoscopic surgery, which may include, one or both of the following: simple or radical nephrectomy, partial nephrectomy, adrenalectomy, ureterolithotomy, and pyelolithotomy. The outcomes of interest will be the minimum number of cases to achieve proficiency, total operative time, intraoperative blood loss, conversion rate, inta-operative and/or post-operative complications and the length of hospital stay. This review will only include studies published from 2000 to 2019, without language or publication restriction. This review will not discriminate operator experience and will include all eligible studies regardless of surgeon experience, both novice and experts in laparoscopy. Systematic and comprehensive literature searches were conducted via PubMed, EBSCO and Science Direct. The search terms utilize were "Retroperitoneoscopy", "Retroperitoneoscopic", "Posterior laparoscopy", "Learning", "Nephrectomy", "Adrenalectomy", "Ureterolithotomy". In addition, references in the reference sections of the identified publications were also included in the search efforts. To demonstrate their search strategy via PubMed, filters were "year" as 2000 to 2019, "text availability" as abstract, free full text, and full text, "publication date" as 20 years. Search box input as "retroperitoneoscopic AND learning". Evidence search was limited to human data, animal studies were excluded from the study. Characteristics of each study were tabulated and presented as means, according to number of participants, type of intervention or retroperitoneal surgery done, minimum number of cases to achieve proficiency, blood loss, conversion rate, hospital stay, and post-operative complications. The data collection and extraction were done by the primary investigator thru review of the published

manuscripts of the involved papers. No external sources for funding were utilized for this review.

Evidence Synthesis

After utilizing the aforementioned search terms, a total of 27 studies were taken from PubMed, Science Direct and EBSCO for the initial screening phase. Figure 1 demonstrates the selection process. Additional 5 studies were identified through other sources. After duplicate studies were removed, there were a total of 25 studies screened, 8 were excluded due to ineligibility, while another 11 studies were removed from the group due to inaccessibility of the full-text. A total of 6 studies were included in the final qualitative synthesis. The demographics of each study are shown in table 1.

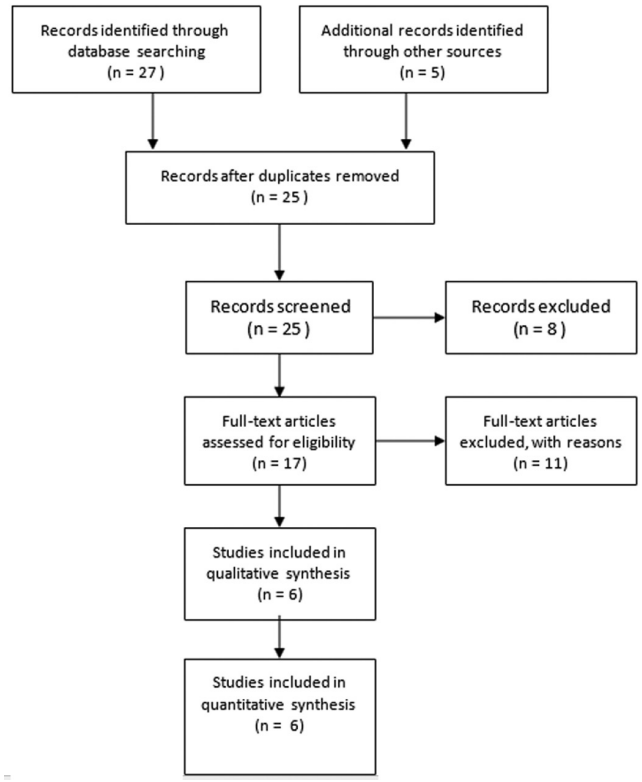

Figure 1: Selection and acquisition process.

Posterior retroperitoneal laparoscopic surgery is gradually gaining popularity among urologic laparoscopists. This is mainly due to the fact that it offers a working space without the nuances of encountering the intra-abdominal space, i.e. the small intestinal and colonic segments, having to deal with intra-abdominal adhesions, and the systemic effects of an elevated intra-abdominal pressure.[4,5] Unfortunately, operative proficiency with this technique requires anatomic understanding of the retroperitoneal space, and a level of laparoscopic dexterity, which translates to a deep learning curve. The studies included in this review involved some of the more common urologic procedures done via retroperitoneoscopic laparoscopy, including donor and simple nephrectomy, adrenalectomy and ureterolithotomy. The learning curve and associated peri-operative outcomes of each study are illustrated in table 2.

Adrenalectomy

The review included 2 studies on retroperitoneoscopic adrenalectomy, by Uitert, et al. (2016)[8], and Vrielink, et al. (2017).[7] The indications for retroperitoneoscopic adrenalectomy in both studies were heterogenous with the more common indication being primary aldosteronism due to a functioning adenoma followed by a non-functioning adenoma. Other indications included Cushing's syndrome, pheochromocytoma, metastatic diseases to the adrenal gland and rarely adrenocortical carcinoma. The study by Uitert, et al. (2016)[8] was a prospective observational study wherein they compared the learning curve of an experienced

Table 1. Characteristics of the reviewed studies.

Study	Year	Type	N	Mean Age (years)	BMI
Uitert, et al.	2016	Prospective Observational	290	51	28
Vrielink, et al.	2017	Multicenter chart review	181	57	27.1
Pal, et al.	2017	Prospective Observational	102	45.4	24.6
Zhu, et al.	2018	Retrospective	121	50	24.1
Tokodai, et al.	2013	Retrospective Chart Review	120	54.25	23.65
Ercil, et al.	2014	Retrospective	50	46	26.7

Table 2. The learning curve and peri-operative outcomes.

Study	Operator Experience	Procedure	Learning Curve	Or Time (Mean, Mins)	Blood Loss (Ml)	Hospital Stay (Days)
Uitert, et al.	High-Volume	Adrenalectomy	40	57	5	3
Vrielink, et al.	High-Volume	Adrenalectomy	24 - 42	89	48.7	2
Pal, et al.	High-Volume	Donor Nephrectomy	35	249.1	60.4	n/a*
Zhu, et al.	High-Volume	Donor Nephrectomy	32 - 70	129.1	44.4	11.2
Tokodai, et al.	High-Volume	Donor Nephrectomy with handport	30	185	92	10.7
Ercil, et al.	High-Volume	Ureterolithotomy	25	88.58	63.9	5.59

* Not stated

laparoscopist in performing retroperitoneoscopic adrenalectomy. A total 290 laparoscopic, 113 retroperitoneal and 177 transperitoneal surgeries were included in their study. Their results showed that after the initial 40 cases of retroperitoneoscopy, perioperative outcomes approached that of the traditional transperitoneal laparoscopy, with shorter operative time (57 mins vs 90 mins), shorter post-operative hospital stay (3 vs 4 days), lesser intra-operative blood loss and comparable postoperative complications. Vrielink, et al. (2017)[7] conducted a multicenter study on the learning curve for posterior retroperitoneoscopic adrenalectomy. The surgeons in their series were adept at doing transperitoneal laparoscopy. The population had mean age of 57, mean BMI of 27.1 and a mean tumor diameter of 2.5cm. A total of 181 retroperitoneal surgeries were included, and based on their results, between 24 to 42 procedures were required to complete the entire learning curve for RPL adrenalectomy. Proficiency with the procedure was associated with a mean operative time of 89 minutes and 18.8% perioperative and post-operative complications, majority of which were Clavien grade I.

Nephrectomy

Aside from the mentioned advantages of working in the retroperitoneal space, retroperitoneoscopic nephrectomy has the additional advantage of early and direct access to the renal pedicle. Pal, et al. (2017)[12], Zhu, et al. (2018)[13] and Tokodai, et al. (2013)[11] conducted studies on the learning curve for posterior retroperitoneoscopic nephrectomy and are included in this systematic review. The study by Pal, et al. (2017)[12] is a prospective observational study of 102 donor nephrectomies done via the retroperitoneoscopic method. Their population had a mean age of 45.4, mean BMI of 24.6 and the surgeons were from high-volume laparoscopy centers adept at transperitoneal laparoscopy. Their series found that the learning curve of pure retroperitoneal donor nephrectomy was 35 cases, this was associated with mean operative time of 249.1 minutes and mean intra-operative blood loss of 60cc. There were minor post-operative complications and only 2 conversions to open surgery in their series. The study by Zhu, et al. (2018)[13] is a retrospective study of 121 patients who underwent retroperitoneoscopic donor nephrectomy. Their study population had a mean age of 50, mean BMI of 24.1, and the surgeons were from high-volume laparoscopy centers. Their methodology was divided into 3 phases, the initial learning curve phase, the expert competence phase and the mastery phase. Based on their study, the minimum number of cases required was 32 cases with at least 70 cases to effectively perform retroperitoneal laparoscopic donor nephrectomy. This learning curve was associated with a mean operative time of 129.4 minutes, mean intra-operative blood loss of 44.4 mL, a mean total hospital confinement of 11.2 days and a conversion rate of 6.2%. Lastly, the study by Tokodai, et al. (2013)[11] is a retrospective study on 120 retroperitoneoscopic donor nephrectomy using a hybrid technique which involves 2 laparoscopic ports inserted through a hand-port device. Their population had a mean age of 54.25, mean BMI

of 23.65, and their surgeons were experienced laparoscopic surgeons. The results of the study showed that the learning curve for retroperitoneal nephrectomy was 30 cases, and this was associated with mean operative time of 185 minutes, mean intra-operative blood loss of 92 mL, and mean hospital stay of 10.7 days. They only had 2 conversions to open surgery in their series.

Ureterolithotomy

The authors efforts identified only 1 study on the learning curve of retroperitoneoscopic ureterolithotomy (RPU). Ercil, et al. (2014)[14] conducted a retrospective study to evaluate the learning curve required to be competent in RPU. Their study had a total of 50 cases, the study population had a mean age of 46, mean BMI of 26.7, and the operating surgeons were from high volume center, adept at transperitoneal laparoscopic surgery. The ureterolithotomies were all in the proximal ureter with a mean stone size of 20.12 $\pm$ 5.18 mm. Their study showed that the learning curve for RPU was 25 cases, and this was associated with mean operative time of 88.58 minutes, mean intra-operative blood loss of 63.9mL and a mean hospital stay of 5.59 days.

The Learning Curve

Posterior retroperitoneal laparoscopic surgery has been shown in several studies to have equivalent outcomes to the transperitoneal laparoscopic approach. Benefits of operating in the retroperitoneal space include shorter operative time and shorter total peri-operative hospital stay, making retroperitoneoscopy a viable alternative to the traditional transperitoneal route.[5-7] However, due to its novelty in general urologic practice and training, coupled with the limited evidence base regarding training guidelines and minimum required cases to achieve surgical competency, an explicit learning curve is still lacking. This systematic review of the 6 aforementioned studies is an attempt to elucidate the required minimum exposure in retroperitoneal surgery to effectively perform the procedure. Regardless of the procedure, (i.e. adrenalectomy, nephrectomy, ureterolithotomy), the anatomy of the retroperitoneal space and the basic principles of retroperitoneoscopy are constant and applicable across the 3 procedures. By taking the mean learning curve of the 6 studies in this review, their evidence suggests that the learning curve to efficiently perform retroperitoneoscopic surgery with acceptable perioperative outcomes would be 31 to 56 cases.

Discussion

Retroperitoneal laparoscopic surgery affords comparable and acceptable surgical and functional outcomes compared to the traditional transperitoneal approach. Furthermore, peri-operative outcomes, health-related quality of life and patient convenience are reported to be better than the transabdominal approach.[9,10] However, as previously stated, retroperitoneal laparoscopy entails a strong knowledge base of the retroperitoneum as well as laparoscopic aptitude, thus creating a steep learning curve, which based on the reviewed literature is scant and varied. This systematic review attempts to consolidate the available evidence in order to elucidate a clearer picture of the learning curve necessary to efficiently and safely perform retroperitoneoscopy. This review is limited by the quality of the incorporated papers. Majority are retrospective studies with a relatively small population. Furthermore, 3 of the studies involved essentially normal kidneys for transplant purposes which questions its applicability to diseased kidneys. Another limitation of this review is that the operating surgeons in the reviewed papers are from high-volume centers which begs the question of the applicability to the general urologist.

Conclusion

In conclusion, this review exemplifies the learning curve for retroperitoneoscopy to be between 31 to 56 cases before a surgeon can efficiently and safely perform the procedure. Based on the reviewed evidence, completion of the learning curve has led to safer and comparable surgical outcomes, as well as acceptable peri-operative conditions. Unfortunately, the evidence

is scant and this opens the avenue for future studies with more stringent assessment protocols, larger study populations and better applicability to the general urologic practice.

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