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SYSTEMATIC REVIEWS

Intraoperative laparoscopic complications for urological cancer procedures

Sergio Fernández-Pello Montes, Ivan Gonzalez Rodríguez, Rodrigo Gil Ugarteburu, Luis Rodríguez Villamil, Begoña Diaz Mendez, Patricio Suarez Gil, Javier Mosquera Madera

Sergio Fernández-Pello Montes, Ivan Gonzalez Rodríguez, Rodrigo Gil Ugarteburu, Luis Rodríguez Villamil, Begoña Diaz Mendez, Patricio Suarez Gil, Javier Mosquera Madera, Urology Department, Cabueñes Hospital, 33203 Gijón, Asturias, Spain

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Correspondence to: Sergio Fernández-Pello Montes, MD, Urology Department, Cabueñes Hospital, Calle de los Prados, 395, 33203 Gijón, Asturias, Spain. spello84@hotmail.com
Telephone: +34-98-5185000

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Abstract

AIM: To structure the rate of intraoperative complications that requires an intraoperative or perioperative resolution.

METHODS: We perform a literature review of Medline database. The research was focused on intraoperative laparoscopic procedures inside the field of urological oncology. General rate of perioperative complications in laparoscopic urologic surgery is described to be around 12.4%. Most of the manuscripts published do not make differences between pure intraoperative, intraoperative with postoperative consequences and postoperative complications.

RESULTS: We expose a narrative statement of complications, possible solutions and possible preventions for most frequent retroperitoneal and pelvic laparoscopic surgery. We expose the results with the following order: retroperitoneal laparoscopic surgery (radical nephrectomy, partial nephrectomy, nephroureterectomy and adrenalectomy) and pelvic laparoscopic surgery (radical prostatectomy and radical cystectomy).

CONCLUSION: Intraoperative complications vary from different series. More scheduled reports should be done in order to better understand the real rates of complications.

Key words: Intraoperative complications; Laparoscopy; Surgical complication; Urology; Cancer

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Core tip: We decided to perform this literature review to light and to arrange the intraoperative rates of laparoscopic urological cancer complications, which are such as messy in the different manuscripts published. This idea leaves from an urological team which performs more than 150 laparoscopic procedures per year since 2005.

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INTRODUCTION

The consequences of errors during laparoscopic surgery are unpredictable and can vary from no adverse effects to fatal events. An adverse event is the result of the combination of an active failure and a penetration of all the defences and safeguards which ought to be in place to prevent it, in these terms, safe surgery is dependent on systems designed to prevent all errors. Most of the intraoperative complications are consequence of consecutive and cumulative errors without individual consequence but globally result into a complication. Surgeon, team, technique, technology/device and organization errors are different kind of mistakes that can finally explain an intraoperative complication[1].

Some risk factors have demonstrated statistical significance to develop a surgical complication related to laparoscopic surgery for urological cancer: type of procedure (*i.e.,* partial nephrectomy, radical cystectomy or radical prostatectomy), abnormal renal function and more than 4 h of surgery. Other conditions as body mass index, ASA score, previous abdominal surgery or surgeon experience have not demonstrated significant association. However there is a trend to decrease of complications when surgical experience increases[2].

General rate of perioperative complications in laparoscopic urologic surgery is 12.4%. The rate of complication of Laparoscopic Radical Nephrectomy is 14%, Laparoscopic Partial Nephrectomy is 23%, Laparoscopic Nephroureterectomy is 22.1%, Laparoscopic adrenalectomy 10%, Radical Prostatectomy 6.7% and Radical cystectomy 33.3%-48.3%. General Intraoperative complications were rated in 4.7%. Nevertheless, most of the manuscripts published do not make differences between pure intraoperative, intraoperative with postoperative consequences and postoperative[2,3].

We pretend to review the rate of intraoperative complications that requires an intraoperative or perioperative resolution. In some cases we describe the possible resolution and the possible prevention.

MATERIALS AND METHODS

A literature review of Medline database was completed. There were no limits of date. English published papers were reviewed, for non-English papers only the abstract were visualized. A combination of the following key words was used: laparoscopy, intraoperative complications, pathologic processes, radical nephrectomy, partial nephrectomy, nephroureterectomy, adrenalectomy, radical prostatectomy and radical cystectomy. From the diverse literature manuscripts and abstracts searched, the authors selected 40 manuscripts to review. The research was focused on intraoperatory laparoscopic procedures inside the field of urological oncology. Laparoscopic complications for other non-oncological conditions were excluded (pyeloplasty, simple nephrectomy, living donor nephrectomy, adenomectomy or bladder augmentation), likewise postoperative complications were also excluded. Only pure laparoscopic procedures were included; removing hand assisted, ablative or single port approaches. Most of the manuscripts were high volume retrospective monoinstitution series, there are some review articles, a few meta-analysis of retrospective data and single cases of extremely rare conditions.

RESULTS

We expose the results with the following order: retroperitoneal laparoscopic surgery (radical nephrectomy, partial nephrectomy, nephroureterectomy and adrenalectomy) and pelvic laparoscopic surgery (radical prostatectomy and radical cystectomy).

Retroperitoneal laparoscopic surgery

Radical nephrectomy: The general rate of intraoperatory complications during a laparoscopic radical nephrectomy varies from 1.7% to 16%. The conversion to open surgery due to notorious bleeding or technical difficulty is 2.5%. The intraoperatory complications can be systematized as follows.

The rate of complications linked with trocar placement varies from 0.09% to 0.27%. There are no normalized devices to perform the pneumoperitoneum and most of the surgeons use the Veress needle, the optical port and the Hasson port, with a rate of injuries of 0.18%, 0.27% and 0.09% respectively[4].

The injuries reported are bowel, solid organs, vessels from the abdominal wall and diaphragm. Intraoperatory laparoscopic repair by suturing and hemostatic agents (fibrin glue, bio glue, bio patches) are used in many cases[5].

The Mayo Clinic series described two complications related to specimen handling and retrieval. One specimen was fractured by the Endo-Catch bag when the kidney was not completely entrapped prior to closure. The other specimen was a partial nephrectomy in which part of the tumor was fragmented during dissection. In this fragmented specimen fractures were seen within the tumor but the whole mass was still completely removed and surgical margin status was negative[6].

It is the most frequent intraoperative complication with a rate of 2.37%[3]. Most described lesions are small and large bowel injuries during the aperture of the Toldt line (0.8%) and duodenum during the right hilium dissection, these lesions should be repaired immediately when noticed and in most cases intracorporeal knots are adequate, minor thermal injuries may be managed with observation. Resection and anastomosis or ileostomy/colostomy is in some cases necessary. Prevention of these lesions could be maintaining the electric devices with 1-2 cm far from the bowel during the aperture of the field, followed by

blunt dissection as aspiration devices when the proper plane line is opened. There are also described indirect lesions of the bowel by local ischemia due to accidental enclosure of mesenteric artery; it required end to end vascular anastomosis and bowel resection. It is also reported partial ischemic lesions of splenic flexure of large bowel managed conservatively[6,7].

Laparoscopic operations involving the left kidney and adrenal gland may be complicated by pancreatic injury owing to the proximity of the pancreatic tail to the surgical field[8]. Pancreatic injury is described in 0.69% left laparoscopic urology procedures and 2.1% during left radical nephrectomy. No cases of injury of the right side of pancreas have been described for urological procedures. In most cases the injury was not noticed during the intervention and the solution was conservative with nasogastric tube, parenteral nutrition and somatostatin, according with the general surgeon experience, most of the pancreatic fistulas closes within 2 wk[9]. If detected intraoperatory, endovascular stapler can be used or over sewn, also tissue glue can be used as adjunctive agent[8]. Possible prevention methods are a complete mobilization of spleen, transecting the splenophrenic attachments and allowing the pancreas and spleen to move together; just like being attentive when the features significantly distort the normal anatomy.

The injury of the spleen is reported in 1.4% of left radical nephrectomies. In most cases can be managed conservatively with electric devices and haemostatic agents but if the lesion is large might requires open conversion. The prevention could be a gentle traction to avoid tearing[6].

Liver injury and gallbladder injury are described in 1.1% and 1.4% respectively. There are no reports found about the mechanism of injury (except of the optic port placement[7]), management and prevention[3].

Chylous ascites is a rare complication caused by unrecognized interruption of the cisterna chyli or other major retroperitoneal lymphatic channels and establishment of a lymphoperitoneal fistula. It is described in surgery for renal cancer as the third cause[10]. The overall incidence of chylous ascites was 5.1% (32 of 622 cases), including 4 severe refractory cases (0.6%). The incidence was higher in those who underwent lymphadenectomy (13.9% with lymphadenectomy and 4.0% without lymphadenectomy). Only 1 patient underwent explorative laparotomy due to persistent severe chylous ascites despite 8-wk conservative management. Most cases were successfully managed conservatively by total parenteral nutrition and a low fat diet. To prevent this complication the authors suggested meticulous clipping of all perihilar and retroperitoneal fibrous fatty tissue during major vessel dissection, especially for left nephrectomy or extensive lymphadenectomy[11].

There are three mechanical devices to control the renal hilium: vascular staples, metallic clips and polymer clips. It is described the estimated total device-related complications in 1.1% for staples, 2.0% for metallic clips and 0.2% for polymer clips.

Food and Drug Administration report of 2172 cases does not conclude that one device is safer than another. Analysing the intraoperative complications over the total complications there are 352 failures noted: staples (63%-223 total complications: 1% death, 22% severe bleeding, conversion to open surgery 35%), metallic clips (33%-111 total complications: 1% death, 2% severe bleeding, conversion to open surgery 7%) and polymer clips (5%-18 total complications: 17% death, 22% severe bleeding, conversion to open surgery 44%)[12].

The leading causes of failure reported in stapling devices were staple line malformation (47%) and locking up (29%). In titanium clips, jamming/feeding difficulties (27%) and trouble closing or "scissoring" clips (26%) were the most common. In locking clips, dislodgement (44%) was most frequently reported.

The presence of accessory polar arteries not identified during the hilium dissection is a common cause of bleeding. Grasping the stump and positioning a clip are described as an intracorporeal solution[5].

Sometimes calcified and atherosclerotic arteries are the cause of absence of closure or arterial rupture. Preoperative TC examination is mandatory and these conditions must be taken into account because intraoperative resolution is difficult to perform[7].

Defining intraoperative haemorrhage as bleeding which requires intraoperative blood transfusion or open conversion, it was described as 2.2%-2.8% in the biggest series[2] and it is the second most frequent intraoperative complication for radical nephrectomy. Separately, venous bleeding is 1.8% and arterial bleeding is 1%. It is one of the most described causes of open conversion. Increasing pneumoperitoneum pressure and using Haemostatic agents (bio glue, fibrin glue, fibrin patches) could be used as first option; intracorporeal knotting solution requires high volume of cases and huge experience. No air emboli were noted in the literature review[13].

The pleural injury is described in 0.4%-0.6% of upper abdominal laparoscopy. Eleven cases were noticed during radical nephrectomy (9 radical and 2 cytoreductive). When noticed, the surgeon can directly watch the defect or can indirectly watch the diaphragm billowing, which is named floppy diaphragm. Sometimes the damage of pleura is unnoticed anyway and sometimes is intentional because of tumoral infiltration. The rupture can be treated intracorporeally with running suture, with a technique defined by Cleveland Clinic[14]. There is also the possibility of conservative management with torax tube and postoperative surveillance. When the rupture is unnoticed the management should be conservative with thorax tube, this condition used to be done when organs as spleen or liver are covering the defect[14,15].

Partial nephrectomy: Most of the considerations for radical nephrectomy could be added to partial

nephrectomy in terms of adjacent organs and diaphragm for upper pole masses, instead, the control of the hilum and the parenchymal bleeding have distinctive features for this kind of technique. The rate of intraoperatory complications is 5.5% and the rate of open conversion is 2%-6%[16].

There are many devices designed to control de ischaemia of the kidney (laparoscopic bulldog, Satinsky clamp and the Rumel tourniquet), including the possibility of no hilar control for small exophytic masses not exceeding the diameter of 2 cm[17]. Injury of the renal vessel may compromise the entire procedure as well as the long term results.

Severe intraoperatory bleeding is described to be 3.5%-3.8% in different laparoscopic series[18,19].

In order to prevent urine leakage and vascular fistula/pseudoaneurim, two layers of suture should be performed. First line approximation of the interstitial tissue with running suture with two absorbable clips at the beginning and the end of the suture to earn ischaemia time. Parenchyma repair is performed with a second running suture, secured with Hem-o-locks with the same plan as first described. To ensure from slipping first hem-o-lock is enforced with by a knot and two clips are sited at the end of the suture. It is also described the use of haired sutures for this procedure[16]. Replacing the knotting by Hem-o-lock sutures let speeding up the procedure. Haemostatic agents as fibrin glue, bio glue or patches can add haemostasis and minimize the bleeding.

Radical nephroureterectomy: Most of the considerations for radical nephrectomy could be added to nephroureterectomy with the special complications of nerve injury and vascular injury during the dissection of the distal ureter. There are 3 techniques described (open, endoscopic, pure laparoscopic) for the management of distal ureter and each one have got their one special intraoperative complications. The rate of intraoperatory complications is 5.4% and the rate of open conversion is 2.3%[20,21].

The complications and their prevention should be similar to radical nephrectomy, instead it is described a rate of neural injury of 0.8%, during the middle and distal ureter dissection. Also a perforation of diverticulum at sigmoid sigma was specifically reported[7].

Adrenalectomy: The average of complication during laparoscopic adrenalectomy in high volume laparoscopic series is 3.2%, varying between 2.1% and 7.8% in different laparoscopic series. The open conversion rate varies between 0.3%-9.6%, and most frequently explained by technique problems than bleeding[22-24].

For this procedure are described diaphragmatic lesions in 1.16%. The Cleveland series described 1 non intentional diaphragmatic lesion and 4 intentional lesions during a transthoracic adrenal approach. Laparoscopic repair was attempted and a goretex patch placement was performed for transthoracic adrenalectomy. A special laparoscopic technique is described for this issue[14].

It is the most common intraoperative complication described (1.3%-1.74%). The vessels involved by order are adrenal vein, cava vein and renal vein. In most cases is the cause of open conversion, when possible intracorporeal laparoscopic suturing is attempted[22].

It is the second intraoperative complication 0.04%-6.3%. The authors of the series consulted noticed 4 spleen injuries (controlled with hemostatic agents and two of them required open conversion), 2 hepatic injuries (controlled with hemostatic agents), 1 intestinal injury and 1 pancreatic laceration. Nevertheless, pancreatic injury has been described in 8.6% during left adrenalectomy[8].

Laparoscopic pelvic surgery

Laparoscopic radical prostatectomy (LRP) is probably considered the most complex technique of minimally invasive urologic surgery. Paradoxically intraoperative complications in these procedures are rare, regardless of the technique used, either transperitoneal, extra-peritoneal robot-assisted or single port. Laparoscopic radical cystectomy (LRC) is a more recent technique, with smaller series, and perhaps thereby, relatively contemporary publications report higher rates of complications. Published data are very incomplete, as most of the published series refer only to postoperative complications, without naming those occurring during surgery and resolved without further impact that increased surgical time.

Conversion to open surgery: Conversion from laparoscopic to open surgery should be considered a complication in itself, although it has many causes. The rate of conversion to open surgery for LRP is estimated at 0.2%-1%, with no demonstrated differences between classical laparoscopy and robot-assisted laparoscopy[25]. This meta-analysis shows data published since 1990, and probably in contemporary series the percentage is even lower, among other factors, because the lack of experience in open surgery in younger surgeons. In the first communications on the LRC conversion rates reached 10%[26], while contemporary series show conversion rates of 0%[27]. It is necessary to note that although the more recent series include learning curves have the advantage of the technique is mature, and surgeons already experienced in PRL.

Intestinal injuries: Bowel injuries during pelvic laparoscopy should be divided in intestinal rectal injuries and intestinal non rectal injuries. Non rectal intestinal lesions are rare in the RLP, from 0.02% to 0.14%[25]. In the series of LRC no bowel injuries are reported. It seems unlikely that no intestinal injury happen during cystectomy, so there is probably not a correct record of complications[26,27]. Overall intestinal lesions occur after the creation of pneumoperitoneum with a

Veress needle, in the blind placement of the first port, and can be largely avoided by creating the access by minilaparotomy. They can also occur in the blind part of the field, tearing with the clamps of the assistant. In these two first cases may be missed during surgery, causing significant postoperative morbidity. Less common are those caused by release of adhesions, which also tend to be diagnosed and easily treated with a suture without further consequences.

Rectal lesions occur during dissection of the backplane, usually in the most distal part of the lateral pedicles and the prostatic apex. It is the most frequent intraoperative complication of LRP and occurs in 1.1% of cases, but shows an important heterogeneity among published series, from 0.2% to 8%. This heterogeneity may be explained by the inclusion in publications of learning curves at the beginning of the art.

The series of robotic surgery show significantly lower rates of between 0.2% and 0.4%. These differences should be taken with caution, because in general the series of LRP are mature series, by surgeons with much previous experience, subsequent in time and with a very high number of cases per surgeon[28]. For anatomical reasons in LRC rectal injuries occur almost exclusively in male patients, and the authors have not found reports of rectal injury in women.

Rectal injuries reported in LRC are isolated. Older series report rates of up to 20%, but with very few cases, while contemporary series report a rate of about 0%-1%[27-30]. The data from this series, however, are probably incomplete, since only recorded injuries causing clinical complications postoperatively. Risk factors for rectal injury are: history of radiation therapy, hormone therapy, infection, previous prostate or rectal surgery and advanced tumor stage, all of them controversial. The surgeon's experience is inversely related to the risk of rectal injury, but this risk never disappears[31]. Most rectal lesions are diagnosed by direct vision, in which case it must be repaired immediately. There is consensus that the closure must be performed in two planes with absorbable suture and checked for leaks by blowing air through a rectal probe. For rectal injury during LRC, peritoneal flap placement on the rectal lesion is simple and generally must be performed, but is mandatory in cases where an orthotopic bladder is made. In the LRP interposing a flap of tissue between the bladder and rectal levels or performing a colostomy is not essential in primary watertight closures, although it seems advisable in patients with lesions larger than 2 cm or history of radiotherapy[32]. Injuries not diagnosed during surgery may present as early postoperative abdominal septic conditions, but more often they are diagnosed several days or even weeks after surgery by pneumaturia, fecaluria and urinary tract infections. An important gesture to avoid postoperative morbidity in rectal lesions is anal dilation. The rectum is a high-pressure reservoir. Anal dilatation decreases this pressure for at least the first few days, the critical period of healing[26]. Although its efficacy is not fully tested in the literature, many authors advise, and is a simple and quick gesture. Another controversial item is the utility of the previous bowel preparation, exclusively mechanical, or associating antibiotics. Although its value does not clearly shown, most authors still use[32].

For the treatment of rectal injury during prostatectomy the protocol described by Blumberg offers a simple and practical algorithm[33].

Ureteral injuries: The anatomical relations of the ureter make it susceptible to be injured during prostatectomy or cystectomy. Its frequency is very low in LRP series published between 3% and 0.04%, which is supported by population studies[34] without showing differences between the results of LRP and robot-assisted LRP. There is a clear inverse relationship with the number of cases performed by the surgeon, but often occur after overcoming the learning curve. The most common site of injury is the juxtavesical ureter; which is injured during the section of the posterior bladder neck or during dissection of the seminal vesicles[35]. If they are diagnosed during surgery, most cases require ureteral reimplantation or end to end anastomosis, which only determines an increased surgical time. The problem is that the majority of ureteral injuries go unnoticed, leading to increased postoperative morbidity, increased hospitalization time and often the need for further reoperation. As risk factors for ureteral injury during prostatectomy have been reported: history of infections, transurethral resection of the prostate, the presence of prostatic middle lobe and large prostate sizes. For more proximal lesions described risk factors include abdominal surgery, radiotherapy and extended pelvic lymphadenectomy[36]. Intraoperative ureteral injuries are not described in the literature as a complication of LRC, probably because the surgical technique can be adapted to the length of ureter feasible.

Neurological injuries: Obturator nerve injuries occur in 2% of patients underwent LRP with significant variability among published series, from 0% to 4%. In robotic frequency series appears to be less, 0.4%, but this difference does not seem significant[25].

In the series of cystectomy no injuries obturator nerves are described[37]. The injury usually occurs during the performance of pelvic lymphadenectomy, and heterogeneity of the published data is probably due to variability in the indications and extent of lymphadenectomy. If the section is made with a cold cut with not much tissue destruction can be attempted immediately by epineural nerve repair points[38]. If a thermal injury occurs is probably necessary to discard the injured nerve ends, which prevents direct anastomosis without tension. In that case have been described good results by immediate repair with interposition of a segment of sural nerve[39]. In the event that goes unnoticed is easily diagnosed in the early postoperative by the functional impairment resulting

denervation of the adductor. Treatment is then based on the rehabilitation and physiotherapy, with varying results but almost never complete.

Vascular injuries: Vascular lesions in radical prostatectomy described in the literature are rare, 0.1%-0.7% for laparoscopic surgery, and the series of robot-assisted LRP are even more rare, the 0.03%-1%[25]. In cystectomy communications vascular injuries are also punctual, but in most of the series do not appear as a complication. Among the published data, it is noteworthy Castillo's series, with a percentage of 11% intraoperative vascular lesions, including iliac venous injury, iliac artery injury and one epigastric artery injury. Despite the high number of vascular lesions does not describe other intraoperative complications[40]. Generally the vascular injuries occur in the external iliac vein while performing lymphadenectomy. Unlike what happens in retroperitoneal surgery in most cases it is possible to repair by laparoscopic suturing, mainly without further consequences[26,40]. The keys for the control of a venous injury are: bleeding control with pressure, raising the pressure of CO_2, obtains a good control dissection and proximal and distal to the lesion ends and finally a careful suturing.

DISCUSSION

Most of the papers reviewed described retrospective personal or institutional series. In general, there is no clear separation between intra and postoperative complications, making difficult to centre in some aspects as technique errors in order to avoid them in the future. In this terms, it should be necessary to assess the surgical complications in normalized forms as Clavien for postoperative and Satava for intraoperative. The results on retroperitoneal laparoscopy are based on huge series with many years of experience with the exception of adrenalectomy which is both performed by general surgeons and urologists. In laparoscopic pelvic surgery, the results on prostatectomy are deep and the rate of intraoperative complications is lacking. The laparoscopic cystectomy is a less studied technique with current result still heterogeneous. In spite of the high index of perioperative complications, the rate of intraoperative complication is also lacking.

COMMENTS

Background

The authors decided to perform this literature review to light and to arrange the intraoperative rates of laparoscopic urological cancer complications, which are such as messy in the different manuscripts published. In general, laparoscopic complications are described as postoperative but it is infrequent to find manuscripts regarding specifically intraoperative complications and their possible prevention or solution. The authors think it is important the existence of a document to sum up this issue, mainly for urologist used to perform this kind of procedures by this approach. This idea leaves from an urological team which performs more than 150 laparoscopic procedures per year since 2005.

Research frontiers

Nowadays laparoscopy is one of the most frequent approach for the treatment of urological oncology field. It should be necessary the development of a systematic review to statistically report the complications of the most frequent procedures. It also should be necessary the cooperation between high volume institution to light the annual incidence and prevalence of the intra and postoperative complications, clearly separated in order to futures reviews.

Innovations and breakthroughs

A narrative review of the intraoperative complications for the most frequent urological cancer procedures. From people point of view, there is no other similar manuscript summarizing intraoperative laparoscopic complications in English medical literature.

Applications

To compare the local rate of complications with the general rate reviewed and to inform to young urologist that start in laparoscopy the possible problems that they can find.

Terminology

Laparoscopy: is an operation performed in the abdomen or pelvis through small incisions (usually 0.5-1.5 cm) with the aid of a camera. It can either be used to inspect and diagnose a condition or to perform surgery.

Peer-review

The manuscript is interesting and the authors have performed a good study.

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