

Laparoscopy in urology

Introduction

The introduction of laparoscopic techniques in urology was gradual. The greatest development took place in the last decade (from the mid-1990s). In urological practice, laparoscopy was used for the first time by Cortesi in 1976 in the diagnosis of a non-palpable testicle, and for a long time it was also its only indication. This was followed by the use of laparoscopy for: pelvic lymphadenectomy, varicocele surgery and nephrotomy. ^[1]

Historical overview of the introduction of individual laparoscopic operations: ^[1]

[Expand]

Year and author	Laparoscopic operations
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Laparoscopy itself means surgery from the approach from the abdominal cavity, which is the most common, quick and clear. This can be used for pelvic organ surgery (bladder, descending pelvic nodes). For better access to the retroperitoneal organs (kidneys, adrenal glands), access from the retroperitoneum (so-called *retroperitoneoscopy*) is chosen. This is reserved for more experienced operators. From a short incision in the posterior axillary line, we subcostally penetrate the retroperitoneum with a finger and then introduce a port with a balloon at the end. After it is filled, sufficient operating space is created. Indications for retroperitoneal access are where problematic access from the abdominal cavity can be expected (conditions after peritonitis, adhesions after major abdominal operations). Relative contraindications are conditions after inflammation in the retroperitoneum (pyelonephritis) or the need to remove a large mass of tissue (kidney with a tumor). A suitable indication is e.g. ureterolithotomy, marsupialization of a kidney cyst, diverticulotomy of the kidney calyx, renal biopsy. ^{[1][2]}

A good overview in the operating field is ensured by distension of the abdominal cavity with CO2 gas (capnoperitoneum, capnoretroperitoneum). Carbon dioxide has less risk of embolization because it is absorbed into the blood without major metabolic consequences. Also, unlike oxygen, it is a non-flammable gas, which allows the use of electrocoagulation. ^{[1][2]}

The advantages of laparoscopy ^[1]

- small incision, less invasive
- minimal soreness
- reduced stress response
- shorter hospitalization and subsequent recovery
- often a better overview in the operative field (given by enlarging the image)

Disadvantages of laparoscopy ^[1]

- a relative disadvantage is the absence of touch

Operation Procedure

1. **Position of the patient - lumbotomy/semilumbotomy** position for kidney operations (nephrectomy, adrenalectomy, pyeloplasty) - the patient lies on the side opposite to the operated side. The **Trendelenburg position** (with a low inclination of the body towards the head) is more advantageous for pelvic operations because the bowel loops are drawn up towards the diaphragm by gravity. Laparoscopic procedures are always performed under general anesthesia.
2. **Establishment of capnoperitoneum (capnoretroperitoneum) -**
 1. **Closed approach - 'by a Veressi' needle** subcostal in the medioclavicular line or below the umbilicus. The Veressi needle consists of a blunt inner part and a sharp outer part. When the tissue resists, the blunt part is inserted into the sharp part, which subsequently pierces the tissue. In the cavity, the blunt part is pushed out again by a spring, which prevents damage to the abdominal organs. This is followed by filling the abdominal cavity with CO2 using an insufflator. This maintains a constant pressure, which should not exceed 12 mmHg.
 2. **Open approach** - an alternative is an incision through the abdominal wall and peritoneum, insertion of a trocar and direct connection of the tube. This approach is safer in terrain with adhesions from previous operations. It is also used for retroperitoneal access.
3. **Establishment of ports - trocars** - the trocar consists of an inner sharp part and an outer tube, most often 5, 10 or 12 mm wide. In the place where the Veressi needle was, we introduce a 10 mm port and the endocamera is guided through it (transfer of a two/three-dimensional image to the monitor). It can be straight or oblique - 30°. Other ports, individual instruments, through which the actual performance is conducted, are introduced behind the optical controls. Typically 3-5 ports are introduced at different locations depending on the type of operation.
4. **Choosing the right tools** - the choice of tools depends entirely on the operator. Some operations can be performed from a single common incision for instruments and camera, the so-called LESS (laparo-endoscopic single site surgery). It is a mini-invasive solution with a better cosmetic effect. A voice-activated camera is available in some workplaces. An ultrasound probe can also be introduced through the port to identify

structures or display flows using Doppler phenomenon. If necessary, a hand-assisted laparoscopy can be performed through a special membranous port (preventing gas leakage), where advantages such as palpation and disking with fingers or rapid compression of bleeding can be used. But it is necessary to make a larger incision (most often between the ports).

[1][2]

Tools

Various shaped dissectors, forceps (Grasper, Clinch), mono- and bipolar coagulation are commonly used for the operation. **A harmonic scalpel** is also used, which is a tool capable of both coagulating and cutting tissue using high-frequency ultrasound. Tissue suturing and knotting with 2 needles is gradually being replaced by automatic sewing forceps, which significantly reduces operating time. Sutures can be placed intracorporeally or less often extracorporeally. Clamps made of titanium and absorbable polymer materials are used to clip vessels. For ablation of large organs, vascular staplers are used to treat large vessels. Tissue glue (e.g. bovine) can also be used on parenchymal organs. Organs or tissues are removed through trocars in special bags. They can be crushed in advance with a special tool (mixer), but in this case further histological processing is impossible. [1][2] The *Laparoscopic 'tower'* consists of a monitor (to which the image from the endocamera is transmitted), an insufflator (a pump for CO2 connected to a gas source), a video system and a light source, an electronic unit for coagulation and connected accessories (hose to insufflator, laparoscope - optics + camera). [2]

Contraindications

Gas distension reduces venous return, increases intra-abdominal pressure, intracranial pressure, decreases cardiac output and lung compliance, decreases renal perfusion - all of this may be contraindicated in certain patients. [1]

Absolute contraindications	Relative contraindications
acute peritonitis or intestinal perforation	
obesity	
hypovolemic shock	severe lung or heart disease
sepsis	abdominal aortic aneurysm
abdominal wall infection	larger umbilical hernia
uncorrected coagulopathy	ascites
history of extensive abdominal surgeries (adhesions)	extensive resistance in the abdominal cavity

Complications

The number of complications mainly reflects the experience of the operator and the type (difficulty) of the operation performed. The least demanding operations include Varicocele and Cryptorchismus. On the contrary, the most demanding operations include radical nephrectomy and retroperitoneal lymphadenectomy. Complications can be divided into intraoperative and postoperative complications. Complications arising intraoperatively can be resolved immediately laparoscopically or by converting to an open procedure. [1][2]

When inserting a Veressi needle, perforation or other damage to abdominal organs (intestines, bladder, spleen, liver, lungs) and cavities (pericardium, mediastinum), to subcutaneous emphysema, or even to embolism (when penetrating a blood vessel). As a result of embolization, there may be hypotension, cyanosis, arrhythmia, asystole and a disproportion of partial pressures in the exhaled air in favor of CO2. Embolization is usually the signal to end the operation. [1][2] abdomen, injury to the aorta or inferior vena cava, ureter, bladder. The rate of vascular complications has decreased with the introduction of endoclips and vascular staplers. [1][2]

The most common postoperative complications include bleeding and formation of hematoma. Furthermore, hernia at the site of trocar scars, local infection, deep vein thrombosis, pulmonary embolism or paralytic ileus. [1][2]

Robotic Operative

Compared to classic laparoscopy, the advantage of 3D imaging (each eye has its own image and the resulting 3D image is summed up by the brain), enlargement of the image of the operative field, elimination of tremors and fatigue. With articulated tools mounted on 3-4 arms (camera + 2 to 3 working arms) there is also better maneuverability and accuracy. In this way, nerve-saving procedures, but also procedures that save physiological functions such as continence and erection, can be achieved. This is a significant benefit of this technique due to the shift in the diagnosis of prostate cancer towards younger years. The operator sits at the console and operates mediated via video. The time to achieve sufficient experience required for robotic surgery is significantly shorter than for classic laparoscopy. The disadvantage is the high purchase price and the possibility of failure and subsequent repair (time delay). [1][2]

The most common indication is radical prostatectomy. It was first introduced in 2001 in some European centers. A year later, it was introduced in the USA, where today 80% of prostatectomies are operated in this way. Advantageously, the robot can also be used for other operations combining ablation and reconstruction, such as

kidney resection, cystectomy with neovesical formation, pyeloplasty or for narrowly indicated adrenal preservation operations.^{[1][2]}

In the Czech Republic, the DaVinci system is available at the ÚVN in Střešovice and at Na Homolce Hospital. Also in Brno, Mostiště, Ústí nad Labem, Olomouc.

Examples of operations

Laparoscopic kidney and upper urinary tract operations

Laparoscopic Nephrectomy^[1]

- the main indication is tumors, less often from benign causes for afunctional hypoplastic kidney, in cystic kidney
- it is performed transperitoneally and retroperitoneally, the procedure lasts 2-3 hours

Laparoscopic radical nephrectomy^{[1][2]}

- indicated for T1 and T2 tumors
 - limited to a size of 8-10 cm and limited to the kidney
 - oncological results same as open surgery
 - 5-year survival after surgery is comparable to open surgery (T1 - 98%, T2 - 92%)
- sometimes it is removed including the adrenal gland
- the advantage of laparoscopy is less damage to the immune system and subsequent better course of recovery and less risk of paralytic ileus
- usually operated from 4-5 ports (the kidney is extracted through an incision between 2 ports), the operation takes about 2 hours
- use of vascular staplers to sever renal vessels results in less blood loss

Laparoscopic donor nephrectomy^[1]

- maximum caution is required during handling, hand-assisted laparoscopy can be used
- trying to use coagulation to a minimum
- usually it is the left kidney (longer vascular pedicle)

Laparoscopic kidney resection^{[1][2]}

- belongs to conservation operations, only the tumor (usually for tumors up to 4 cm) with a healthy margin is taken
- the basis is to minimize blood loss, the renal vessels are choked at the hilum, this flow restriction is only possible for 20-30 minutes (warm ischemia time), which makes the operation quite demanding
- scissors, a harmonic scalpel are used, the edges of the parenchyma are sewn together, or a hemostatic mesh is applied

Laparoscopic marsupialization of renal cysts^[1]

- for large symptomatic cortical cysts in recurrence after previous percutaneous puncture and sclerotization

Laparoscopic pyeloplasty^{[1][2]}

- reconstructive procedure, resection plastic for pyeloureteral junction stenosis (with/without crossing vessels)
- success is comparable to open performance - 98%

Laparoscopic pyelolithotomy or ureterolithotomy^[1]

- removal of a stone from the pelvis or ureter, is rarely performed when other methods fail

Laparoscopic operations of the lower urinary tract

Laparoscopic surgery for VUR^[1]

- technically demanding surgery including extravesical reimplantation of the ureter, performed since the mid-1990s

Laparoscopic operations for stress incontinence - colposuspension^[1]

- recently TVT/TOT tapes are preferred
- this is the fixation of paracolpial sutures to Cooper's ligament (*lig. iliopectineum*) bilaterally, modification according to Burch

Laparoscopic radical prostatectomy^{[1][2]}

- is indicated for T1 and T2 stages of prostate cancer, in some cases also T3
- performance is performed transperitoneally or extraperitoneally from a prevesical approach
- includes prostate ablation and subsequent reconstruction (creation of vesicourethral anastomosis)
- the performance takes about 2 hours, the advantage is a clearer operating field and less postoperative morbidity (on the condition that sufficiently fine instruments are used)
- the aim is to reduce undesirable postoperative conditions - urinary incontinence (5-10%) or erectile dysfunction (damage to the nerves in the hypogastric plexus innervating the corpora cavernosa) with regard to the decreasing age of diagnosed patients
- the anastomosis heals on the inserted permanent catheter - the tightness of the anastomosis is checked by contrast cystography, the vessel is extracted after 7-10 days
- with a PSA level above 10 ng/ml, pelvic lymphadenectomy is also performed (obturator and iliac nodes)

Other

Laparoscopic varicocele surgery^[2]

- belongs to less demanding performances

Laparoscopic pelvic lymphadenectomy^[1]

- independently performed as part of staging in patients with prostate cancer
- is also a basic procedure in teaching laparoscopic surgery in urology

Laparoscopic retroperitoneal lymphadenectomy^[1]

- difficult due to the para-aortic location of the nodes
- indicated in patients with a testicular tumor
- this is one of the most demanding laparoscopic procedures

Laparoscopic adrenalectomy^{[1][2]}

- is indicated for all functional tumors of the adrenal glands and for nonfunctional tumors over 4 cm or those growing rapidly during follow-up, pheochromocytoma or other tumors limited to the kidney - most of them are benign, metastases from renal cancer
- in Cushing's syndrome it is performed bilaterally, the operation can be performed trans- and retroperitoneally
- the operation takes about 1-2 hours

Resources

1. HANUŠ, Tomáš and Petr MACEK. *Urology for physicians*. In Prague: Charles University, Karolinum Publishing House, 2015. ISBN 978-80-246-3008-3. Pp.281-287
2. Presentation Laparoscopy in urology <https://portal.lf1.cuni.cz/clanek-996-vzdelavaci-program-urologie-1-lf-uk>