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Laparoscopic Access Techniques

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1. Introduction

The introduction of the first trocar, often following creation of the pneumoperitoneum is considered as crucial, and the most dangerous step of a laparoscopic procedure. Throughout the years individual methods of laparoscopic entry were described. The first person to create the pneumoperitoneum was German surgeon Georg Kelling (1866-1945). He performed this procedure on dogs. Among the methods actually used, arguably the most popular method of the closed laparoscopic entry probably was introduced in 1947 by Raol Palmer (1904-1945) French gynaecologist, who was also the inventor of an insuflator, which was adapted from a colposcopy pressure measuring device. He was followed by Kurt Semm (1927-2003) German gynaecologist, who invented also an automated electronic insuflation device. They both used in this technique the needle formerly developed in 1938 by a Hungarian, Janos Veres[1] (1903-1979) which had been primarly used for the creation of a pneumothorax. The last two, but not least to mention are Harrith M. Hasson, an American who described the open access laparoscopy in 1970, arguably considered as the safer than the classic closed (blind) method, and JR Dingfelder, who developed the direct laparoscopic trocar insertion technique in 1978.

2. Pneumoperitoneum techniques

There are numerous techniques of the intraperitoneal laparoscopic entry which can be found in various publications. However there are two main streams to be distinguished: the most popular methods with the creation of the pneumoperitoneum, and these performed without it. Some other techniques need to be mentioned, used mainly for retroperitoneal, or extraperitoneal access, however these should be considered as a part of the first mentioned group, and are more specific for disciplines other than surgery (urology).

2.1 Pneumoperitoneum

Pneumoperitoneum is a condition, when the whole intraperitoneal space is filled with gas (most often carbon dioxide). That causes an organ separation, and the space obtained this way is one of the crucial conditions for an introduction of necessary instruments, camera and the making of the intra-abdominal manoeuvres possible.

[1] Veres has been using his name with a double and single s, however his birth certificate states Veres.

2.1.1 Gases used

Actually the most popular gas used for laparoscopy is carbon dioxide. Other gases that are used for insufflation are nitrous oxide, argonium, helium, xenon, and also room air. It appears that there are significant differences between these, not only in physical matter. Many reports show the different effect on tumor biology during the laparoscopic procedure, and the helium, and especially the xenon seem to decrease tumor volume. The helium and the argonium are also found to be safer for the cardio-circulatory system.

2.1.2 Insuflator

Insuflator (laparoflator) is a device used for introduction of the gas under specified volume and pressure into peritoneal cavity. First, old devices were set manually, nowadays mainly automatic electronically controlled insuflators are used. These allow to set a precise flow of the introduced gas (in l/min), and at a constant pressure (12-14 mmHg). Some of the sets are equipped with bacteriological filters, and an endothermic system (to maintain adequate temperature of insufflated gas). In some cases a controlled desuflation is also used to remove a surgical smoke.

Fig. 1. Fully automated electronic insuflator at work.

2.1.3 Physiological consequences

Pneumoperitoneum is a specific situation, distinctly differentiating laparoscopy and open surgery. Recognition of physiological consequences of laparoscopy, as well as the pneumoperitoneum is crucial for safety of the techniques. Most of the consequences come from the use of the gas for the insufflation, especially the most popular carbon dioxide. Introduced gas (if endothermic system is not in use) causes a significant body temperature lost, it may also be the potential source of infection. Obviously it is not a single impact on the

human organism. The peritoneum has the well known ability to absorb gases, particularly the carbon dioxide which must be subsequently exhaled. Therefore a respiratory acidosis, as well as a sympathetic stimulation, and an arrhythmia may occur. In the high pressure pneumoperitoneum (significantly above 12 mmHg) the risk of decrease of the heart stroke volume, and a flow in the inferior vena cava, as well as in the mesenteric vein exists, therefore the risk of a portal hypertension occur. The impaired blood flow concerns may be present also in the veins of the lower limbs, increasing the risk of a deep venous thrombosis and pulmonary embolism. It is followed by an increase in the intracranial pressure with the risk of a low cerebral blood flow These conditions are potentiated also by the Trendelenburg position, typically used in laparoscopy. Nevertheless many authors are using high pressure entries (up to 30mmHg) advocating that these minimize the risk of injuries, and do not affect significantly a cardiopulmonary functions in healthy patients.

2.1.4 Complications

One of the main advantages of laparoscopic surgery, when compared with open surgery is the lesser complication rate. Nevertheless, what is obvious, the minor, severe or even fatal complications may also occur. Serious ones such as a gas embolus (0,001%), the major vascular injury (0,003-1,33%), or visceral injury (0,04-4%) have been described in various publications, and are rather rare. Minor (0,1-0,5%) complications are the port site infection, subcutaneous emphysema, or bleeding from the epigastric vessels. Management depends on the type of the complication. Major vascular injury as the laceration of the abdominal aorta, or illiac vessels (caused mainly by a poor technique, but also too low pressure of a pneumoperitoneum) is an indication for an urgent laparotomy. Minor complications can be easily controlled, as in a case of the epigastric vessels injury with a Foley catether.

2.2 Closed laparoscopic access

Arguably is the most popular technique used for a laparoscopic entry, especially popular with gynaecologists. The closed method is also called a blind method, because of the first trocar which is pushed through the abdominal wall without the sight control. Prior to this step a pneumoperitoneum with the use of the Veres needle is made to avoid complications such as organs or main vessels injuries.

2.2.1 Instrumentarium

The Veres needle is undoubtedly the most characteristic instrument for a closed laparoscopic entry. Disposable or not disposable, they are available in many sizes, also equipped with the movable blunt tip to avoid incidental injuries. The Veres needle is connected through the isolated cord, often equipped with bacterial filters to an insuflator. It is possible to close the gas flow with the valve placed on the stalk of the needle. There are also other more sophisticated Veres needle modifications, like the units equipped with pressure sensor, or fiberoptic minilaparoscope. The first trocar which, in this method, is pushed through the abdominal wall into the peritoneal cavity, should also be equipped with the blunt tip, automatically popping out while reaching the peritoneal cavity (or an analogical protective tube around the trocar blade). It must be also equipped with a gas valve which allows passing the gas inside. The introduction of the first trocar is the last step of the closed laparoscopic entry procedure.

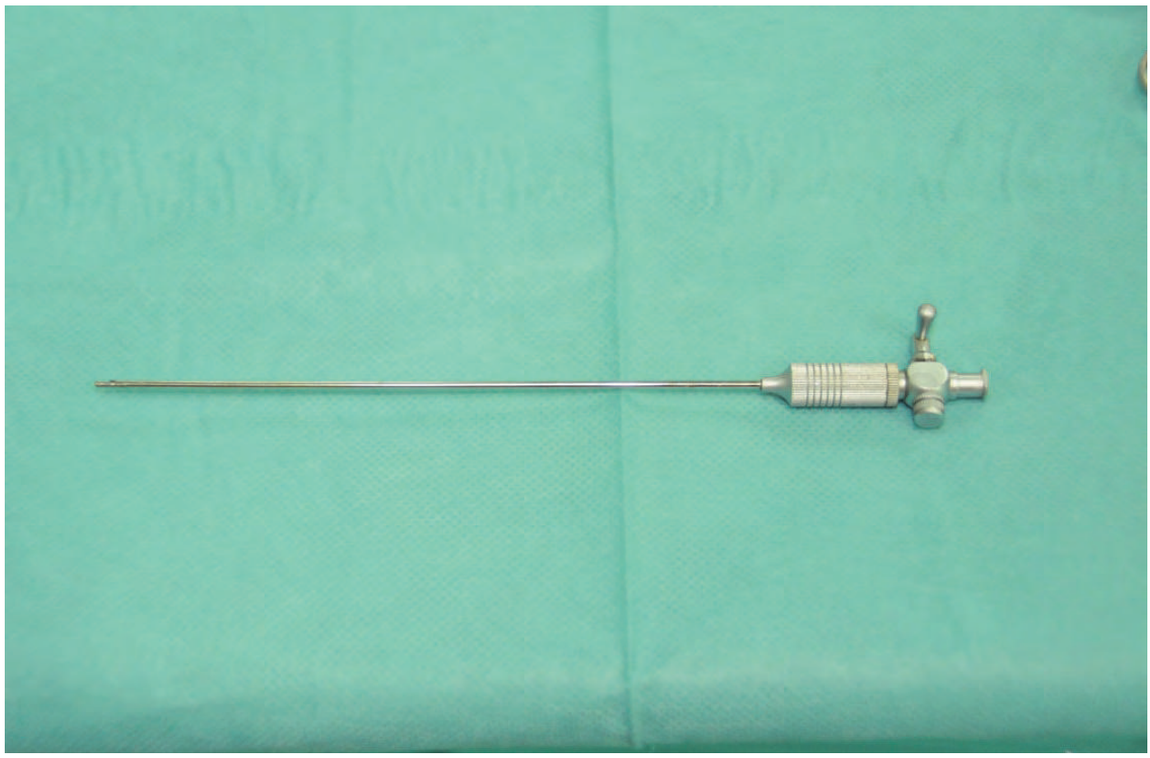

Fig. 2. Nondisposable Veres needle with blunt tip.

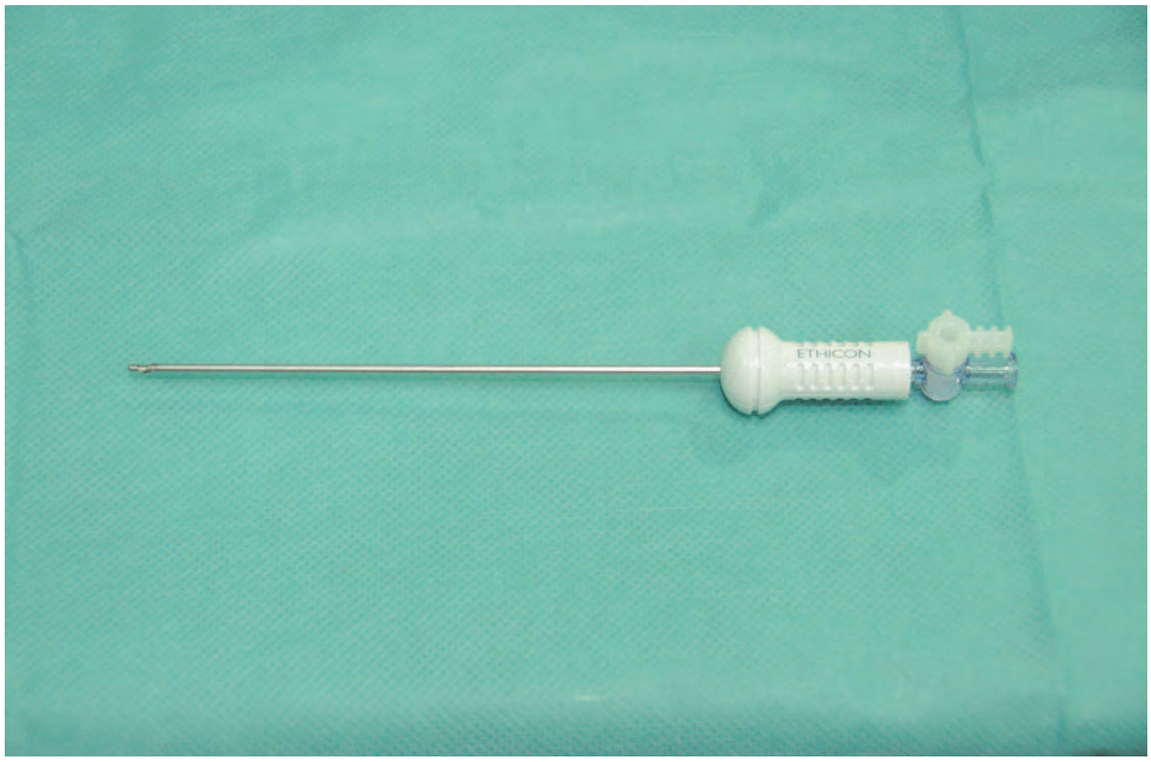

Fig. 3. Disposable Veres needle with blunt tip.

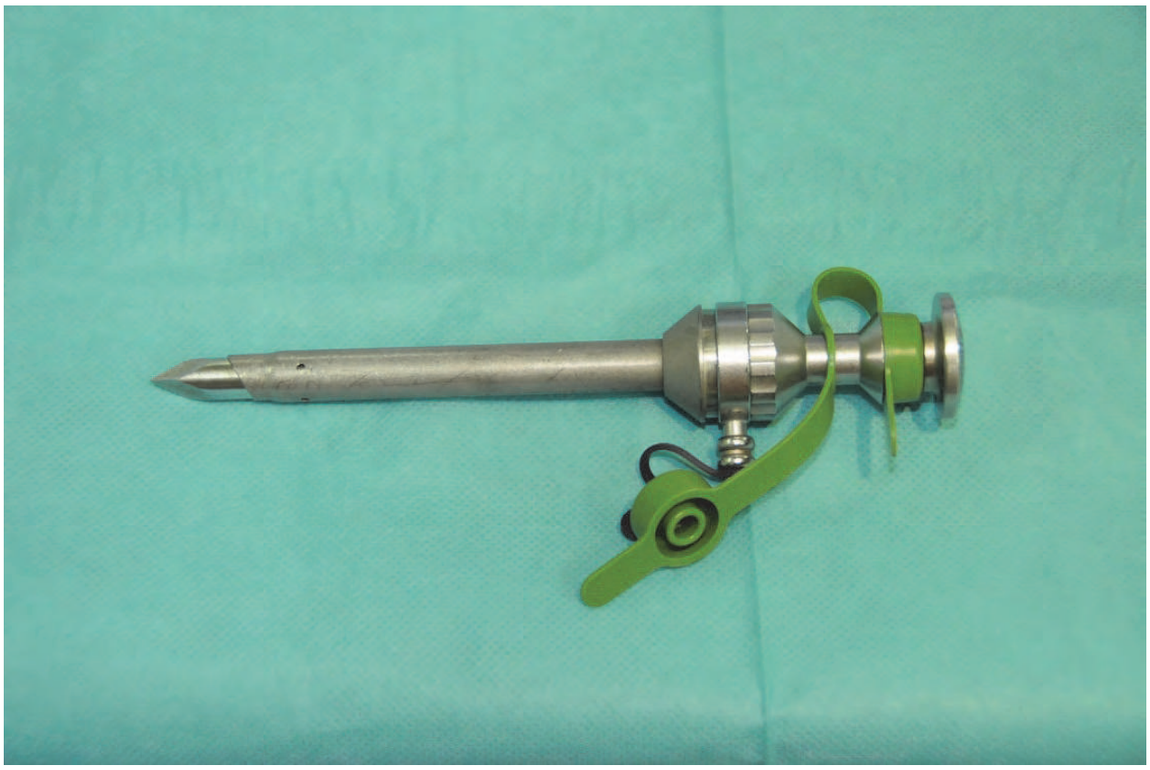

Fig. 4. Classic nondisposable trocar.

2.2.2 Key steps

In the first step of this technique a small (up to 2 cm) incision, above, under, or in the lateral (most often left side) of the umbilicus is made.

Many authors recommend then to lift the anterior abdominal wall (using Mikulicz forceps or Backhaus clamp), or stabilize it before the Veres needle is inserted. It is considered that only three attempts for successful pneumoperitoneum estabilishment are acceptable, fourth attempt should be made in an alternative site. One of these sites is the Palmer's point localized about 3 cm below the left costal margin in the midclavicular line. This is the site especially recommended in extremely obese and thin patients, and always requires prior stomach suction by a nasogastric tube. Contraindications for using this site are hepatosplenomegaly, portal hypertension, and other pathologies in this region. Other less popular alternative sites are anterior and posterior vaginal fornix, and IX-X intercostal space.

It is considered that the Veres needle should be inserted in angle from 45° in non-obese to 90° in obese patients. There are various methods like hanging drop of saline test, the "hiss" sound test, aspiration and syringe test, that are believed to prove correct localization of the needle, however in view of recent findings these do not have any support in evidence.

As said before, the last step of the blind laparoscopic entry is the introduction of the first trocar, the manoeuvre especially critical in an aspect of potential major vessels, or organ injuries. It is strongly recommended to elevate the anterior abdominal wall with the hand, or Backhaus clamp during the trocar insertion, which helps to avoid major complications. The

insertion should be made just after the removal of the Veres needle to avoid escape of the insufflated gas. The trocar should be gripped for its handle 90° angle to the surface of abdominal wall, and introduced carefully with the rotary motion. Just after the insertion of the first trocar, the insufflation cord should be connected to maintain the pneumoperitoneum.

Fig. 5. Skin incision in a closed technique.

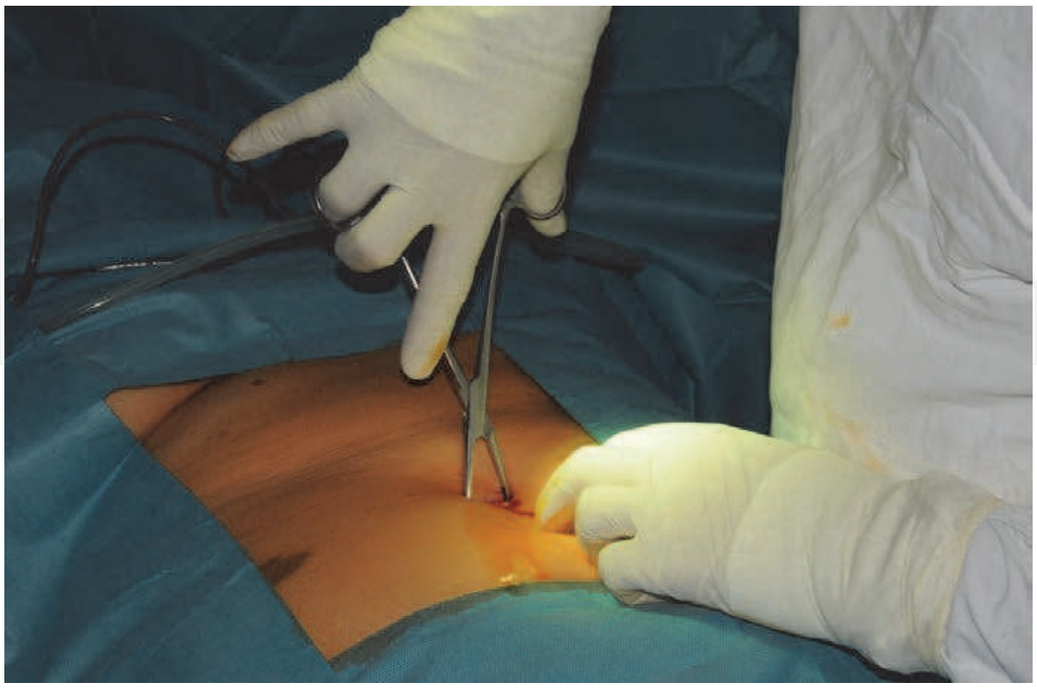

Fig. 6. Dissection of the anterior abdominal cavity wall in a closed technique.

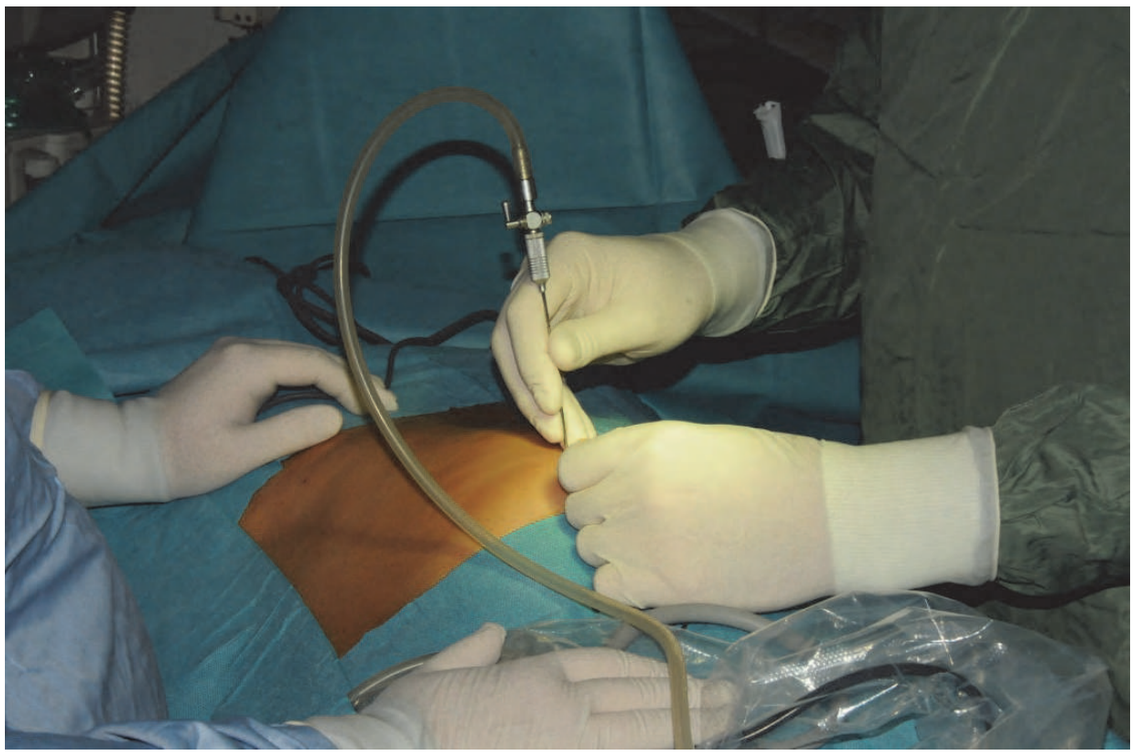

Fig. 7. Veres needle insertion.

Fig. 8. Blind first trocar insertion in a closed technique.

Fig. 9. First trocar in its place.

2.3 Open laparoscopic access

Open laparoscopic access was developed by HM. Hasson as the alternative for the closed laparoscopic entry. The notable difference between techniques is, that the first trocar is inserted before the pneumoperitoneum is estabilished, and with a prior dissection of the anterior abdominal cavity wall, with an incision of the fascia and the peritoneum under the control of the sight.

2.3.1 Instrumentarium

The most specific part of the instrumentarium used in open laparoscopic entry is Hasson trocar. It consists of a canula and a blunt obturator, which helps to avoid injuries during an insertion, and a specific sealing cone with tabs to fix the sutures. Alternativelly a standard 10 mm trocar, without its blade may be used, however adequate sealing sutures must be used. The insufflation equipment remains the same as in the closed method.

Fig. 10. Modificated Hasson-like trocar.

2.3.2 Key steps

As described before, the first step in the open laparoscopic entry is the dissection of the anterior abdominal cavity wall. The skin incision is rather longer than in a closed laparoscopic entry, so it has to fit the wider Hasson trocar, it is localized typically as in closed technique. After the incision of subcutaneous tissue, the fascia (up to 5mm) and the peritoneum, pursestring sutures are placed, and after the exposition of the prepared hole, and optional finger control of the space, the Hasson trocar is placed into the peritoneal cavity.

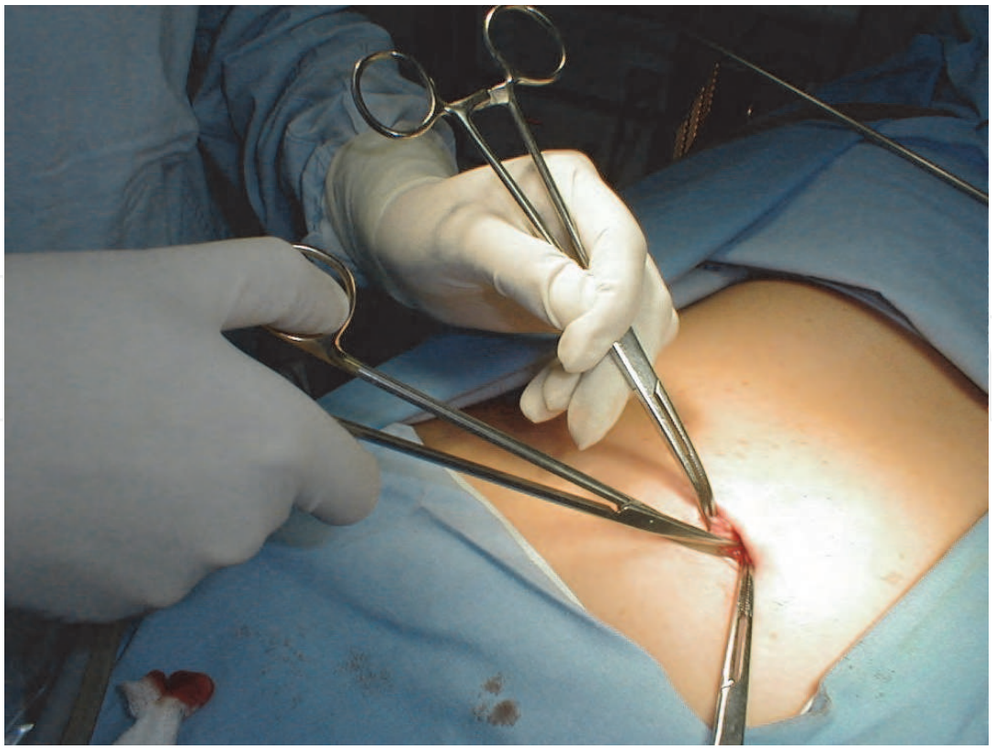

Fig. 11. Dissection of the anterior abdominal cavity wall in an open technique.

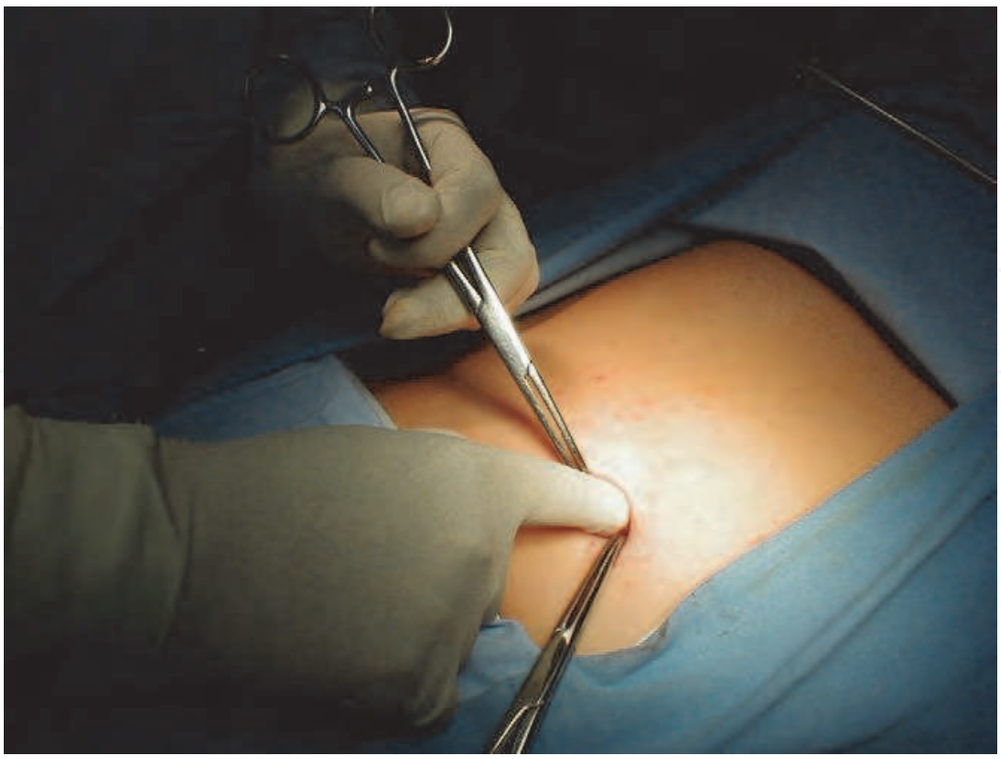

Fig. 12. Finger control of the place for trocar insertion inside the abdominal cavity.

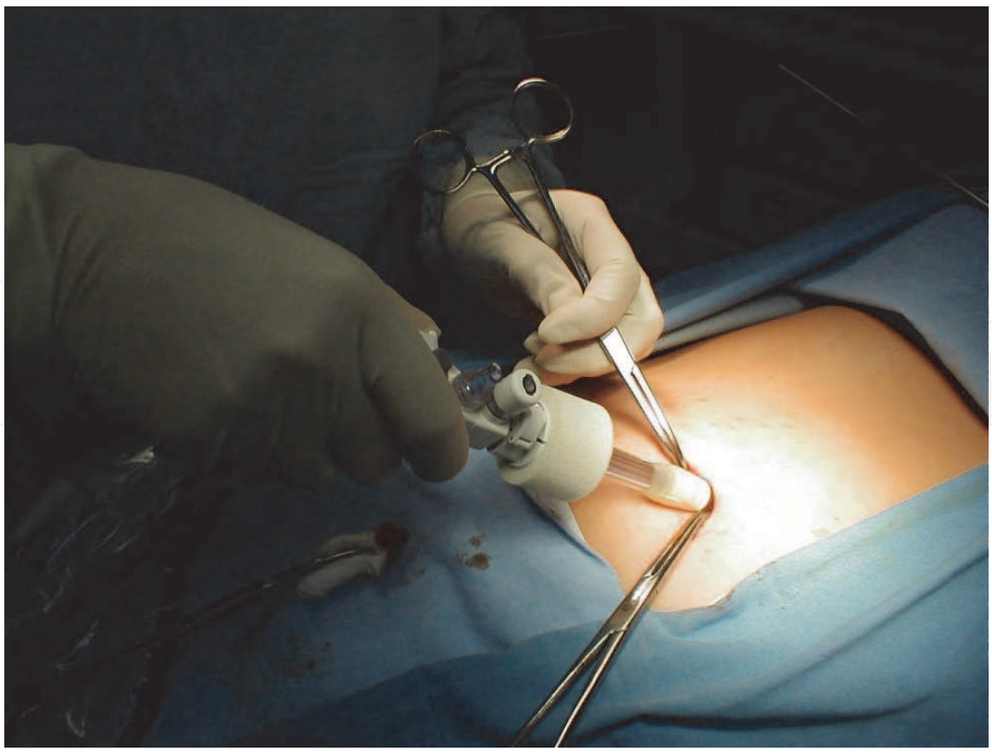

Fig. 13. Hasson-like trocar insertion.

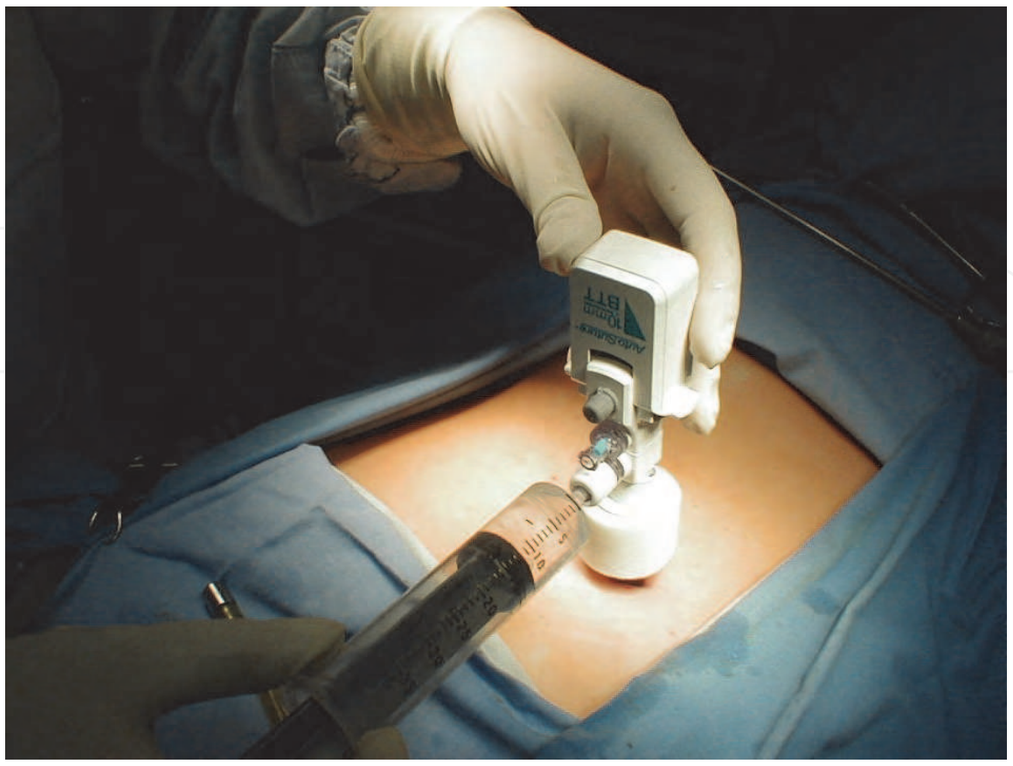

Fig. 14. Trocar cuff insufflation.

Fig. 15. Trocar in its place.

2.4 Indirect laparoscopic access (optic trocar technique)

The intermediate method between the open and the closed laparoscopic access, which allows to avoid the need of the blind Veres needle and trocar traversion, and at the same time does not require an anterior abdominal wall dissection. However, it must be mentioned, that in this case a sophisticated instrumentarium (an optical trocar) is needed.

2.4.1 Instrumentarium

There are many various optical access trocar systems available nowadays. The complete system consists most often of three main parts: standard 10 mm port, blunt trocar with optical lens, and the standard optic with 0° angle. The most popular systems are Optiview, Johnson&Johnson, Ethicon Endo-Surgery, and Visiport, Autosuture. The first one is equipped with a conical clear tip which allows for a traversion through abdominal wall by dilating, the second with a cutting blade is able to penetrate through the layers for the same reason. In both cases the whole procedure is controlled on the screen of the camera. Previously other solutions were also proposed, the example would be the Trocarless Rotational Access Cannula (TRAC). It consisted also of a trocarless canula in 5 or 10 mm diameter, where also a standard 0° optic may be inserted. The canula had the screw-like threads for its whole length, therefore can be countersinked through the abdominal cavity wall also under the vision control.

2.4.2 Key steps

In the first step, a standard (up to 2 cm) incision is made, usually under the umbilicus, and the optical trocar is advanced into a wound. All of the traversed layers are seen on the screen, subsequently these are: skin and subcutaneous tissue, anterior and posterior fascia of the abdominal rectus muscle (also seen), transversalis fascia, and at last peritoneum. Insufflation is started only when the peritoneum is punctured. The other steps follows as in the open and closed laparoscopic entries.

2.5 Direct trocar insertion

Direct trocar insertion seemed to be far more dangerous than other methods of a laparoscopic entry, but in reality it is considered as a relatively safe alternative for a closed laparoscopic access, when performed properly. The procedure also starts with a skin incision, most often below the umbilicus, the abdominal wall is lifted with a hand of an operator, or with Backhaus clamps, and the trocar is inserted in a pelvic direction. The crucial point of this method is the sharpness quality of a trocar, therefore mainly good quality disposable trocars are in use. In the last step, the blade of a trocar is removed, and the optics of the camera is passed through to assess the localization of introduced canulas. This method allows to avoid most of the complications related to the insuflation procedure like a pneumoembolism, more common in Veress needle insertion, being much faster method at once.

2.6 Low pressure pneumoperitoneum

It is controversial to define the concept of a low pressure pneumoperitoneum. It may be described as the pressure of the gas insufflated lower than used usually. The conception is to decrease the risk of complications of the pneumoperitoneum, when a higher pressure is not necessary due to the anatomical conditions. Obviously, rather smaller procedures can be performed in these circumstances, for example jejunostomy, sigmoideostomy, and peritoneal dialysis catethers manoeuvres.

Fig. 16. Direct trocar insertion.

2.7 Pneumoperitoneum techniques summary

It is absolutely not possible to point out the best method of the laparoscopic entry. Hasson's technique, developed to avoid major complications, helped indeed to lower the risk of major vessels injuries, however did not alter (or even increased) the incidence of intestine perforations. The reason could be that it is more often used in patients after prior surgery with peritoneal adhesions. Additionally, closed laparoscopic entry is arguably most often used among the surgeons, especially gynaecologists, who point at its superiority as a faster technique. This also cannot be advocated, because with the correct technique used, open access is comparable, or even faster then the one with use of Veres needle. The open technique is also recommended for pregnant women from third semester. Unsurprisingly, also the optical trocar system is not a complications free method, as the major complications were also described. Despite this, the costs of these more sophisticated techniques can be an essential barrier, therefore these devices are often used as second-line techniques for the creation of the pneumoperitoneum.

3. Non pneumoperitoneum (low pressure pneumoperitoneum) techniques

Laparoscopic pneumoperitoneum techniques appear as minimally invasive with relatively low risk of complications, however there are still various clinical situations, when these become too great danger for the patients. Primarily it concerns older ones with significant cardiopulmonary dysfunctions, when the pneumoperitoneum characteristic with its physiological consequences may cause a life threatening risk for the patients. That has resulted in developing techniques of the laparoscopic entry without the necessity for the pneumoperitoneum creation.

3.1 Techniques used

Following techniques may be performed with an initial low pressure pneumoperitoneum in the first step, or without the need of the pneumoperitoneum creation at all. Despite of the

method used, the next steps of the laparoscopic procedure are performed without the need of an insuflation, or only with a low pressure gas flow. These also appear to be useful in extremely obese patients, to limit the utilization of gases for pneumoperitoneum, however in all of the cases the proper relaxation is necessary. The following suspension techniques are described mainly for use in a hepatobiliary laparoscopic surgery.

3.1.2 Cutaneous suture suspension

In the first step of this technique the low pressure pneumoperitoneum is performed (however it is not obligatory), then the strong sutures are placed in a right subcostal region in midclavicular and middle line of the patient's body, through all the layers of the abdominal cavity wall. This step is performed under the eye-control, through the introduced previously optics. The sutures are fastened to the frame of the operation table. In the other type of the cutaneus sutrure suspension, the first suture is placed, after a minilaparotomy (like in an open access laparoscopy) most often under the umbilicus. Often additional sutures are placed in the right subcostal region, like in the first type of this method, enabling easier maneuveration. The sutures are subsequently attached to the operation table frame. These methods of laparoscopic entry enable the operation with an use of a low pressure pneumoperitoneum, or without it.

3.1.3 Kirschner wire suspension

This method is analogical to other suspension methods described above, however instead of the sutures, Kirschner wire is in use. In the first step low pressure pneumoperitoneum is achieved and the bent wire is inserted subfascially in the right subcostal region also between right midclavicular and midline. Afterwards, the wire is attached to the table frame. Then the operation without the pnuemoperitoneum, or with low pressure insufflations may be performed.

3.1.4 Laparolift technique

Laparolift (Autosuture) device consists of a hydropneumatic elevator, and specific interchangeable body hooks in V or C shape. It enables to achieve laparoscopic entry completely without the creation of a pneumoperitoneum, with relatively low invasiveness (however incomparably greater than in other methods of laparoscopic entry described above). The hooks are introduced to the abdominal cavity through the minilaparotomy folded, and subsequently assembled inside, then the anterior abdominal wall is being elevated, and the hook is attached to the hydropneumatic elevator. The similar method to the one described above is the one with an use of the tire shape balloon instead of laparolift hooks (device like Origin Airlift), it is arguably considered as the safer method. These two methods may be used in the most of the laparoscopic operations.

3.2 Non –pneumoperitoneum (low pressure pneumoperitoneum) techniques summary

The methods of non-pneumoperitoneum techniques are certainly less popular than the open and closed laparoscopic entries. Most of the problems related to the creation of the pneumoperitoneum may be omitted by discerning anaesthesiology, what with limited equipment, makes suspension methods useful only in a very selected group of patients.

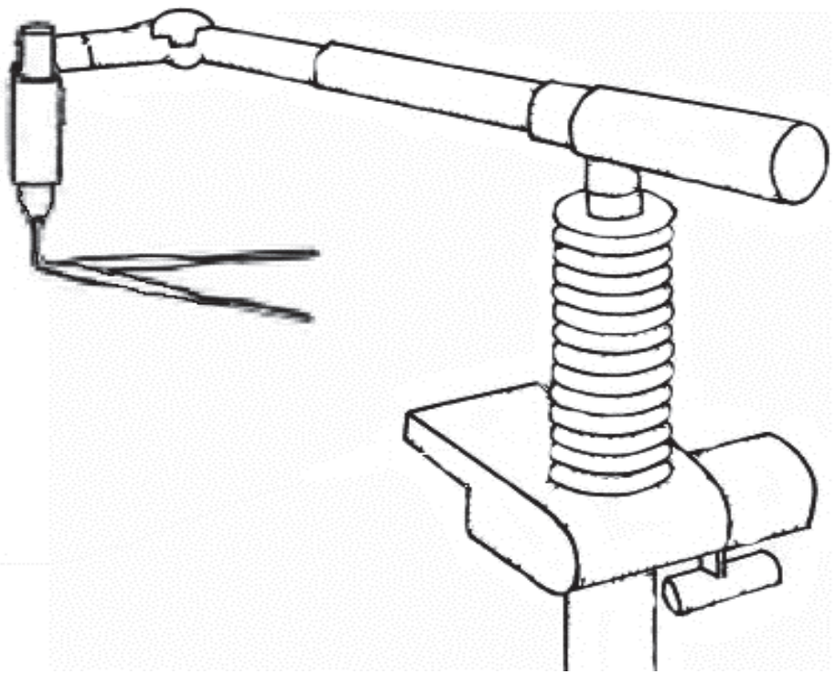

Fig. 17. Laparolift device.

4. The wind of change. Single port and NOTES laparoscopy

It appears obvious, that the future belongs to these even less invasive procedures. Both NOTES and single port laparoscopy, without exception also demand the laparoscopic entry. These are mainly based on the access methods with use of a pneumoperitoneum, like in the single port laparoscopic surgery, where the paraumbilical minilaparotomy is performed, to insert larger port. Also in NOTES, the need for creation of a pneumoperitoneum is achieved through the closed entry like access, with an use of a needle introduced to the abdominal cavity through the vaginal fornix. It must be however said that there are also some other methods assigned to the NOTES surgery, with the use of other access procedures, like the flexible endoscope introduced to the abdominal cavity through a cut in a stomach wall, and the pneumoperitoneum achieved this way.

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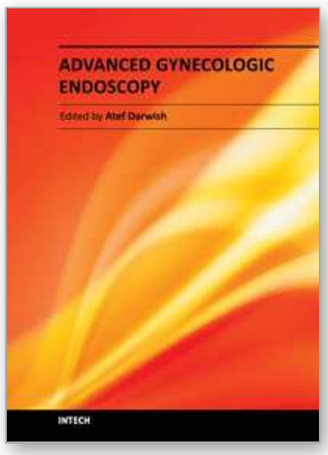

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The main purpose of this book is to address some important issues related to gynecologic laparoscopy. Since the early breakthroughs by its pioneers, laparoscopic gynecologic surgery has gained popularity due to developments in illumination and instrumentation that led to the emergence of laparoscopy in the late 1980's as a credible diagnostic as well as therapeutic intervention. This book is unique in that it will review common, useful information about certain laparoscopic procedures, including technique and instruments, and then discuss common difficulties faced during each operation. We also discuss the uncommon and occasionally even anecdotal cases and the safest ways to deal with them. We are honored to have had a group of world experts in laparoscopic gynecologic surgery valuably contribute to our book.

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