

# Entry techniques in gynecologic laparoscopy—a review

Johannes Ott · Agnes Jaeger-Lansky ·  
Gunda Poschalko · Regina Promberger ·  
Eleen Rothschedl · René Wenzl

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**Abstract** Laparoscopy is one of the most common surgical procedures in gynecologic medicine. Major complications associated with gynecologic laparoscopy are relatively rare, with up to 50% related to laparoscopic entry. Several entry techniques have been developed, all of which aim to provide a safe and easy entry to the abdominal cavity. In this article, we aim to review the available evidence on laparoscopic entry techniques in gynecologic surgery. We found no evidence that the Hasson (open) technique is superior to the Veress needle entry, the preferred method of most gynecologists all over the world. When entering the abdomen using the Veress needle, an intraperitoneal pressure <10 mmHg is a reliable predictor of correct intraperitoneal placement. Entry at Palmer's point (left upper quadrant laparoscopy) is recommended for patients with suspected or known periumbilical adhesions, or a history or presence of umbilical hernia, or after three failed insufflation attempts at the umbilicus. Recently published trials suggest that direct trocar entry, especially when using optical trocar systems, might be superior to both the Hasson open technique and the Veress needle entry to avoid extraperitoneal insufflation and failed entry. Moreover, blood loss can be reduced and the mean entry time shortened. Laparoscopic entry techniques are still a controversial topic in gynecologic surgery. Many studies are

underpowered in order to assess the risk for rare but life-threatening complications. In conclusion, there is no solid evidence proving the superiority of any method of laparoscopic entry.

**Keywords** Laparoscopy · Entry techniques · Gynecology · Complications · Veress needle · Hasson technique · Direct trocar entry

## Background

Laparoscopy is one of the most common surgical procedures in gynecologic medicine and has become the method of choice over the last few decades for treating benign diseases that require surgery [1, 2]. Major complications from gynecologic laparoscopy are relatively rare, occurring in three to six per 1,000 cases. However, complications related to access represent one third to one half of these adverse events [1, 3]. These complications include serious and potentially life-threatening adverse events in about 0.4 of 1,000 laparoscopic procedures, such as perforation of the bowel, major abdominal vessels, and vessels of the anterior abdominal wall. These factors make the access phase the most critical step of a laparoscopic procedure. Less serious complications include postoperative infection, extraperitoneal insufflations, and subcutaneous emphysema [4].

In a large survey of 506 patients with entry access injuries, gynecologic procedures accounted for 63% of claims outside the USA and for at least 47% of all cases. The structures injured most frequently during primary entry access were the small bowel, the iliac artery, and the colon, together accounting for more than 50% of injuries [5]. These data present a more severe spectrum of injuries than those described in procedure-

J. Ott · A. Jaeger-Lansky · G. Poschalko · E. Rothschedl ·  
R. Wenzl (✉)  
Department of Gynecology and Obstetrics,  
Medical University of Vienna,  
Waehringer Guertel 18-20,  
1090 Vienna, Austria  
e-mail: rene.wenzl@meduniwien.ac.at

R. Promberger  
Department of Surgery, Medical University of Vienna,  
Vienna, Austria

based studies and underline the severity and possible lethality of entry access injuries.

Several entry techniques exist [6–8]. However, there is no clear consensus on the optimal method of entry to the peritoneal cavity [8, 9]. Even a recent Cochrane database systematic review showed no evidence of benefit with regard to the safety of one technique over another [9]. We aimed to review the available evidence on laparoscopic entry techniques.

## Methods

A computerized search of the medical literature was conducted with the MedLine database. Articles published up until February 2011 were searched for the keywords laparoscopy, laparoscopic entry, Veress needle, Hasson technique, open trocar entry, complications, and adverse events. The selected articles' bibliographies were also manually examined for any articles not captured by the computerized search. Case reports, abstracts, and letters were excluded. Randomized, quasi-randomized, and non-randomized, or cohort, studies on human patients were included if they compared access methods and provided relevant information on safety and efficacy outcome that had to be defined a priori.

## Findings

### Challenges during laparoscopic entry

Adhesions at the umbilical area are a major concern with regard to the safety of laparoscopic entry. Rates of up to 21% and 28% have been reported for women with previous laparoscopy and previous laparotomy, respectively [10, 11]. Patients with prior midline incisions, in particular, are at high risk (up to 42%) [12]. Entry techniques other than the classic CO<sub>2</sub> insufflation using a subumbilical Veress needle might be useful in these patients.

In very thin patients, especially in those with an android pelvis or a prominent sacral promontory, the great vessels have been reported to lie about 1 to 2 cm underneath the umbilicus [13, 14]. In obese patients, the umbilicus is shifted caudally toward the aortic bifurcation [15]. These patients are believed to be at an increased risk for major vessel injury during the course of a closed laparoscopic entry [16].

### The Veress needle

Basic data on various entry techniques are provided in Table 1. The Veress needle technique is the preferred method of most gynecologists all over the world [17, 18]. The Veress needle is used to establish a pneumoperitoneum by blind insertion into the abdomen, which is then followed by trocar insertion. The classic insertion site in gynecologic laparoscopy is in the umbilical area in the midsagittal plane, used by 98% of gynecologists [9].

### Alternative Veress needle insertion sites

Alternative sites for Veress needle insertion have been reported: Insertion in the left upper quadrant (LUQ, Palmer's point) has been mentioned to be useful in obese and very thin patients, as well as in those with a history of previous open abdominal surgery. In the presence of a large uterine or pelvic mass, it may be also advantageous [19]. The Veress needle is inserted 3 cm below the left subcostal border in the midclavicular line [20]. The method should not be applied in patients with previous splenic or gastric surgery, portal hypertension, hepatosplenomegaly, and gastropancreatic masses [21]. Laparoscopic entry using Palmer's point has been reported to be safe and effective, with a low failure rate of about 1.5%. Complications, mainly puncture of the left lobe of the liver, have been found in about 1% of cases [19, 22, 23].

Insertion of the Veress needle directly through the ninth or tenth intercostal space, at the anterior axillary line along the superior surface of the lower rib, has also been reported to be safe. A retrospective analysis of more than 900 cases of

**Table 1** Overview of different entry techniques

Entry technique	First published in	Rates of major visceral injury (%)	Rates of major vascular injury (%)
Veress needle entry (classic)	<i>Gastroenterologia</i> , 1961 [89]	0.04–0.08	0.02–0.07
Optical Veress needle (minilaparoscopy)	<i>Endosc Surg Allied Technol</i> , 1995 [45]	1.1	Uncertain
Pressure sensor-equipped Veress needle	<i>J Am Assoc Gynecol Laparosc</i> , 1994 [47]	Uncertain	Uncertain
Hasson technique (open entry)	<i>Am J Obstet Gynecol</i> , 1971 [64]	0.05–0.1	0–0.005
Direct trocar entry	<i>Obstet Gynecol</i> , 1983 [90]	0	0

pneumoperitonization through the ninth intercostal space revealed only two major complications directly related to the laparoscopic entry [24]. The same indications apply to this method as to the entry at the Palmer's point [11].

Last but not the least, one might insufflate CO<sub>2</sub> through the posterior vaginal fornix (“trans cul-de-sac insufflation”) or transvaginally through the fundus of the uterus. Both methods are indicated in extremely obese women [25–32]. For the transuterine route, there was a lower ratio between punctures and establishment of a pneumoperitoneum, when prospectively compared to the classical intraumbilical approach in obese women with a BMI >25 kg/m<sup>2</sup> [30].

#### *Additional considerations with the Veress needle entry*

The following tests that attempt to determine the correct intra-abdominal placement of the Veress needle have been described: the double click sound of the Veress needle; the Palmer's test (aspiration test); the hanging drop of saline test [33]; the “hiss” sound test [34]; the syringe test [35–38]; and the pressure profile test, of which the first five pressures registered by the gas insufflator are recorded at 5-s intervals and pressures less than 10 mmHg are assumed to indicate correct intraperitoneal placement [17, 39]. A prospective analysis demonstrated that the double click, aspiration, and hanging drop tests provided very little useful information about the placement of the Veress needle [40]. These findings are supported by the fact that, despite the implementing of these tools in the clinical routine, serious complications occur. Especially in women with previous open abdominal surgery, the pressure profile test is more specific and sensitive than the Palmer's test [39]. However, performing the Palmer's test is still recommended because of its value in warning the surgeon if any blood or feces is aspirated.

Many gynecologists elevate the anterior lower abdominal wall at the time of the Veress needle insertion either by hand or with the use of towel clips [11]. However, only with the use of towel clips a sufficient elevation of about 7 cm above the level of the viscera can be achieved [41]. Moreover, by lifting the abdominal wall by hand, one might also elevate the omentum in rare cases, causing omental perforations [42]. However, in a recent Cochrane database analysis, the authors concluded that lifting the abdominal wall resulted in an increased rate of entry failure (odds ratio 5.17) without an increase in the complication rate [9].

The literature reports successful Veress needle entry into the abdominal cavity on the first attempt in about 85% of cases. This is of particular importance since higher numbers of attempts are associated with increased complication rates including extraperitoneal insufflation, omental injuries, bowel injuries, and failed laparoscopy [41, 43].

#### *The optical Veress needle*

Entry using the optical Veress needle is also called “minilaparoscopy.” A modified Veress needle of 2.1 mm diameter and a 10.5-cm-long cannula are used, allowing insertion of a thin, zero-degree, semirigid, fiberoptic minilaparoscope. During insertion of the Veress cannula with the telescope, one observes a cascade of color sequences on the monitor that represent the different abdominal wall layers. No randomized trials have been published as yet. Therefore, the relative risks of this procedure remain unclear [44]. However, in a prospective study of 184 cases, two bowel perforations occurred (Table 1) [45].

As another modification of the classical Veress needle, a pressure sensor-equipped Veress needle has been described [46]. However, no further studies evaluating the risk profile of this method have been published to date. It would be reasonable to conclude that these Veress needle modifications have not proven themselves in practice.

#### *Insertion of the camera trocar after establishment of the pneumoperitoneum*

Pneumoperitonization using the Veress needle is followed by trocar insertion. The force applied to the anterior abdominal wall during this procedure might put the viscera at risk for damage.

An adequate pneumoperitoneum is considered useful to prevent visceral damage during trocar insertion. Traditionally, the pneumoperitoneum has been defined as sufficient after insufflation of 1 to 4 L of CO<sub>2</sub> or the establishment of an intraperitoneal pressure of 10 to 15 mmHg [43]. It has been demonstrated that the use of the “pressure technique,” using a median pressure of 14 mmHg, leads to a reduction in the complication rate of 50% when compared to the “volume technique” [43].

Based on these considerations, one might consider the pressure-controlled “high-pressure entry” (HIP entry) technique of benefit in order to decrease the complication rate. Three prospective studies on the safety of HIP entry using median intra-abdominal pressure values of 25–30 mmHg included nearly 9,000 female subjects. Only four bowel injuries (0.04%) and one major vessel injury (0.01%) were reported. Although the method leads to a significant decline in pulmonary compliance of about 20%, the maximum respiratory effects at 25 to 30 mmHg did not differ from the effect of the Trendelenburg position with intra-abdominal pressures of 15 mmHg [2, 44, 47, 48].

In order to minimize the risk for entry-associated complications following Veress needle insufflation, disposable shielded trocars and optical access trocars have been developed. Disposable shielded trocars are designed with a

shield that partially retracts, exposing the sharp tip as it encounters resistance through the abdominal wall. After the shield enters the abdominal cavity, it springs forward and covers the sharp tip of the trocar [44]. The rationale for this method is to avoid intra-abdominal injuries. However, evidence proves that major complications, including death from trocar entry, cannot be avoided by using disposable shielded trocars [49, 50]. There is a lack of evidence in the literature about the safety of these instruments when used after establishment of the pneumoperitoneum.

There are two available disposable visual entry systems: the Endopath Optiview optical trocar (Ethicon Endo-Surgery, Inc., Cincinnati, OH) and the Visiport optical trocar (Tyco-United States Surgical, Norwalk, CT). Both are inserted through a 5-mm incision in the anterior rectus fascia after having withdrawn the Veress needle and dissected off the fatty tissue. However, with regard to trocar entry after pneumoperitonization by the Veress needle, most reports did not show superiority of visual entry trocars over other trocars, based on entry-associated complications, since these trocars cannot avoid vascular or visceral injury [44, 51–53]. Only in one retrospective study, the rate of major complications during insertion of the primary trocar in the blind insertion group was five of 1,000 (0.5%), whereas there were no major complications in the optical-guided insertion group (0.0%) [54].

Another visual entry system is the EndoTIP visual cannula (ENDOTIP; Karl Storz, Tuttlingen, Germany). The cannula has no cutting or sharp end. Thus, tissue layers are not transected [55]. However, there are no randomized trials that compare this entry method to any other method.

#### Radially expanding access system

The radially expanding access system (Step; InnerDyne, Sunnyvale, CA) consists of a 1.9-mm Veress surrounded by an expanding polymeric sleeve. The abdomen can be insufflated prior to removal of the Veress needle and subsequent dilatation of the sleeve by inserting a blunt obturator with a twisting motion [56–58]. The advantages of this system arise from the elimination of sharp trocars [44, 56]. In a number of case series and randomized trials, there were no major vessel injuries and no procedure-related deaths [56]. Randomized controlled trials have demonstrated less postoperative pain and more patient satisfaction with the radially expanding device than with the conventional trocar entry techniques [59–62].

#### Hasson technique (open laparoscopic entry)

Hasson first described his technique of open access to the peritoneal cavity in 1971 (Table 1) [63]. He suggested that

the method might result in less adverse events, such as gas embolism, preperitoneal insufflation, visceral and major vascular injury, and that it thus might be superior to the blinded entry. Thus, it has been recommended for patients with previous abdominal surgery, especially for those with longitudinal abdominal wall incisions.

In their large 2002 meta-analysis on laparoscopic entry techniques, Molloy et al. reported a rate of 0.1% bowel injuries and 0.005% major vascular injuries for the Hasson technique out of a total of 21,547 procedures, with the vast majority of reviewed studies providing only level III evidence [64]. However, several case reports of vascular injuries with the open technique have been published [5, 65, 66].

#### The Veress needle vs. the Hasson open technique

Many studies have been conducted comparing the safety of the Hasson technique vs. entry using the Veress needle. Hasson himself conducted a review that included 17 publications of open laparoscopy (20,691 patients), comparing them to studies of closed laparoscopy (669,662 patients). This detailed analysis revealed an interesting result: General surgeons had experienced higher complication rates than gynecologists with the closed technique, whereas gynecologists had reported similar complication rates with both techniques [67].

Several other reviews of studies comparing open and closed entry techniques have been published.

Bonjer et al. reviewed 12 trials on laparoscopy in general surgery (6 about the closed and 6 about the open technique, including 489,335 and 12,444 patients, respectively). The rates of visceral and vascular injury were, respectively, 0.08% and 0.07% after closed laparoscopy, and 0.05% and 0% after open laparoscopy ( $p=0.002$ ). Mortality rates did not differ significantly [68]. Similar findings in general surgery were reported by Sigman et al. [69] and Zaraca et al. [70].

However, other studies did not report any significant differences, in terms of major complication rates, between the Veress needle entry and the Hasson technique. The Swiss Association for Laparoscopic and Thoracoscopic Surgery prospectively collected data on 14,243 low-risk patients undergoing standard laparoscopy between 1995 and 1997. Only eight visceral injuries (0.06%) after primary port insertion were found (six after blind insertion vs. two after a Hasson entry; not significant) [71]. However, in a meta-analysis of a mixed study population including gynecologic and general surgical trials, the risk of bowel injury was higher with open access compared to needle/trocar access (relative risk=2.17). However, the authors noted that selection bias may have influenced the results: open procedures may be more likely chosen for patients with previous abdominal surgery. On the other side, in nonobese patients, a 57% reduced risk of minor complications was seen with open access (relative risk=0.43).

Considering serious adverse events secondary to gas insufflation, open laparoscopy seems superior to the closed entry. The rate of carbon dioxide embolism was 0.001% in a review of 489,335 closed laparoscopies [69]. Several case reports have reported coronary, cerebral, or other gas embolism with fatal or near fatal outcomes [67, 72]. Such complications have not been reported at open laparoscopy.

The evidence does not provide a definitive answer to the question of whether the open technique is superior or inferior to the Veress needle entry. One might also consider other Veress needle insertion sites, such as the Palmer's point, more appropriate than the Hasson entry in high-risk patients with obesity or previous abdominal surgery.

#### Laparoendoscopic single-site surgery/single-incision laparoscopic surgery

Laparoendoscopic single-site surgery (LESS) is a novel and rapidly advancing minimally invasive technique, developed to result in improved cosmesis for patients and even decreased postoperative analgesia requirements when compared to conventional laparoscopy [73]. The access point for these surgeries is typically the umbilicus [73]. There are various multiaccess single-port systems provided by various manufacturers. The open Hasson entry is used to install these subumbilical access systems. Comparisons between the single-incision approach and conventional multipuncture procedures have demonstrated similar complication rates. However, the sample sizes were too small to draw valid conclusions about the safety profile of LESS in gynecologic studies.

#### Direct trocar entry

This technique was developed to reduce or avoid various complications related to the Veress needle use, such as a failed pneumoperitoneum, preperitoneal insufflation, intestinal insufflation, or the more serious CO<sub>2</sub> embolism [44]. Moreover, it is faster than any other method of laparoscopic entry [74, 75]. Recently, a large prospective study that included 17,350 patients undergoing gynecologic laparoscopy in China using the "Yan's open technique" was published. Laparoscopic entry was performed by making an umbilical incision with a scalpel followed by direct entry of a 10-mm trocar into the abdominal cavity through direct trocar puncture or insertion of the cannula sheath via the opened umbilicus. As a control group, 4,570 patients were enrolled, who were undergoing the traditional Veress needle entry. The use of the Veress needle was associated with a significantly higher complication rate (0.09% vs. 0.01%) [76].

Several randomized controlled trials, comparing direct trocar access to the Veress needle, have been published, most of them demonstrating lower minor complication rates

and/or a shorter entry time. The largest trial ( $n=1,000$ ) was published by Zakherah, which showed a significantly lower minor complication rate for the direct trocar access (0.4% vs. 14%,  $p<0.0001$ ) [77]. Agresta et al. compared direct trocar insertion to the Veress needle access in nearly 600 patients. Obesity, major abdominal distension, and two or more previous abdominal operations were the exclusion criteria. There were no minor complications in the direct access group, in contrast to a rate of 5.9% in the Veress needle group ( $p<0.01$ ) [7]. Similar results concerning the rate of minor complications were reported by Nezhat et al., who excluded past abdominal surgery but took into account BMI, and by Byron et al. [74, 78]. A study by Altun et al. showed higher rates for both major and minor complications in the Veress needle group, which, however, were not significant due to the small sample size [79].

Direct access can also be performed using optical access trocars to achieve visual guidance during direct entry. Only a few randomized trials prospectively evaluated the risk profile of direct optical access and compared it to other entry techniques.

Two trials compared the direct optical access to the Veress needle technique [80, 81]. The first study was performed in postmenopausal women. Estrogen loss at menopause is known to have a profound influence on skin, with postmenopausal atrophy and loss of tone and elasticity. The study demonstrated significantly lower entry time ( $65.7\pm 11.9$  vs.  $192.8\pm 5.6$  s) and lower overall blood loss in the direct optical access group ( $9.6\pm 8.1$  vs.  $19.2\pm 7.3$  ml) [80]. Similar results were found, in premenopausal women, by the same group of investigators. Direct optical access led to a shorter entry time [81]. When comparing the direct optical access to the Hasson technique, there was lower blood loss ( $9.6\pm 8.1$  vs.  $19.2\pm 7.3$  ml) and a shorter mean entry time ( $61.8\pm 10.4$  vs.  $163.1\pm 9.2$  s) [82]. Based on these results, the direct optical access can be considered a feasible and safe alternative for first laparoscopic entry in both pre- and postmenopausal women.

One recent prospective study evaluated direct primary visual entry using the EndoTIP visual cannula (ENDOTIP; Karl Storz) in 165 urologic patients [83]. Access to the peritoneum with the EndoTIP was successful in all consecutive transperitoneal cases. No complications were registered. The method seems feasible and safe in a gynecologic patient collective. Direct optical access has also been mentioned as a possible future entry technique at Palmer's point when adhesions are suspected [84].

#### Study weaknesses

Several study weaknesses have to be considered when drawing conclusions from the reported results. First and foremost, surgeons might be experienced in either one of



the techniques—this issue has not been properly assessed in most of the studies. Thus, learning curves must be taken into account when surgeons are recommended to start using a technique that has been considered superior in studies. The existence of learning curves for laparoscopic entry techniques has already been proven, and the incidence of related complications is higher among inexperienced surgeons. Surgeons might experience fewer adverse events if they use the technique with which they are most familiar [85–87]. This might also be considered when recommending alternative Veress needle entry sites in obese patients or women with previous abdominal surgery. The use of alternative Veress insertion sites by gynecologists is limited as is the literature on this issue.

Furthermore, only very few studies have evaluated the safety profile of alternative entry techniques including the optical Veress needle and the radially expanding access system. Thus, the incidences of rare but possibly life-threatening complications can hardly be assessed for these procedures. The same is true for direct trocar access. However, more prospective randomized studies will hopefully be published in the near future providing a reliable overview on the technique's safety profile. Whether LESS procedures might be widely accepted will depend on other outcome parameters than just an improved cosmesis: reduced pain, perioperative morbidity, and convalescence could justify both the increased technical demands and the increased costs [85].

Literature on cosmetic considerations is also scarce. To the best of our knowledge, only one study has directly addressed this issue. This trial dealt with the general population's view on the aesthetic importance of the umbilicus with regard to single-incision techniques [88]. From that point of view, one might consider direct trocar entry using 5-mm trocars superior to the Hasson technique. Keeping in mind that most of the entry techniques are similar in terms of major complication rates, future research might also want to focus on the cosmetic aspects of these techniques.

## Conclusions

All in all, there is no solid evidence proving the superiority of any method of laparoscopic entry. In general, the guidelines set forth by the Society of Obstetricians and Gynecologists of Canada in 2007 [44] remain valid. Among other recommendations, we chose to underline the following: in gynecologic procedures, there is no evidence that the Hasson technique is superior to the Veress needle entry. When entering the abdomen using the Veress needle, an intraperitoneal pressure <10 mmHg is a reliable predictor of correct intraperitoneal placement. Entry at the Palmer's

point (LUQ laparoscopy) is recommended in patients with suspected or known periumbilical adhesions or a history or presence of umbilical hernia, or after three failed insufflation attempts at the umbilicus.

However, recently published trials suggest that direct trocar entry, especially when using optical trocar systems, might be superior to both the Hasson open technique and the Veress needle entry in terms of avoiding extraperitoneal insufflation and failed entry. Moreover, blood loss can be reduced and the mean entry time shortened.

Much work has been done in order to make laparoscopy a safe procedure. However, further investigation is needed in order to shed some new light into the "hot topics" of laparoscopic entry. Will there be hard evidence for a certain technique on how to deal with obese patients or suspected anterior wall adhesions? Will any new strategies be developed in order to avoid major complications, such as major vessel or bowel injury? Hopefully, researchers will be able to clarify these and other concerns in the future. Notably, cosmetic results have not been considered in the literature as yet and might also be a focus of interest in the near future for the older Veress needle and the Hasson entry techniques.

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