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Closed access techniques for initial peritoneal entry in laparoscopic surgery: Veress needle versus direct trocar access.

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Abstract

Background and Aims: In laparoscopic surgery, initial peritoneal access is a blind procedure & can lead to many complications. In this study, initial peritoneal access by the veress needle technique has been compared with direct trocar access technique in terms of complications & efficiency.

Material and Methods: 2400 laparoscopic operations performed by the closed technique of access in the peritoneal cavity over a period of 10 years between April 2011 and May, 2021 were evaluated in this study. Two groups of the patients were made (A & B). Group A consisting of 1200 patients in whom initial peritoneal access was made by the veress needle & Group B consisting of 1200 patients in whom initial peritoneal access was made by direct trocar.

Results: At an average, peritoneal access took 25 seconds in Group A & 15 seconds in Group B. In Group A, 7 (0.58%) patients developed major complications in the form of bowel & major vascular injuries, whereas in Group B, small gut injury occurred in 3 patients & there was no major vessel injury. In group A, mortality rate was 0.25%, whereas in group B, mortality was 0%.

Conclusion: Many techniques have been introduced to eliminate laparoscopic access complications. There is not a single technique without complications, still the most common technique used for laparoscopic access is the veress needle, though access by direct trocar is quick, safe & efficient.

Keywords: Closed technique; Direct trocar access; Laparoscopy; Pneumoperitoneum; Port; Umbilicus; Veress needle.

Introduction

One of the most anxious moments in laparoscopic surgery is the initial access to the peritoneal cavity as 20% of the complications of laparoscopy take place during initial access.^[1,2] The most common cause of stressful laparoscopic surgery is the vascular & bowel injuries that may take place during first trocar insertion & these can be dreadful complications.^[3,4] To prevent the complications associated with the initial access to peritoneal cavity is the main concern for laparoscopic surgeons. There are two common methods of insertion of the first trocar to create carbon dioxide pneumoperitoneum in laparoscopic surgery.^[5] These include the closed technique of inserting the veress needle in the peritoneal cavity followed by blind introduction of the first trocar^[6] and the open technique described by Hasson^[7] in which all layers of abdominal wall are incised at umbilicus followed by the insertion of first trocar under direct vision and then carbon dioxide insufflation is created.^[8]

In a review of 51 publications which include 21,547 open technique, 16,739 direct trocar access technique & 134,917 veress needle technique in the United States, entry related rates of vascular injury were 0.01% (open), 0% (direct trocar) & 0.04% (veress/trocar) and rates of bowel injury were 0.11%, 0.05% & 0.04%, respectively.^[9] Table 1 shows the rates of major complications reported in a review of selected studies of the various techniques of abdominal entry.^[10] According to this data, the difference in rates of complications observed in the various techniques adopted for abdominal entry is not significant & the results have

remained the same during the past three decades.

Table 1: Complication rates of different techniques of abdominal entry.

Abdominal Entry Technique	Complication Rate per 1000
Direct trocar access	0.6-1.1
Veress needle access	0.3-2.7
Open laparoscopy	0.6-12

There is increased risk of complications while entering the abdominal cavity in patients of previous abdominal operations with vertical midline scars.^[11] Despite the associated risks, the closed technique is one of the most popular methods of initial peritoneal access because more time is required to perform open technique & risk of leakage of gas through incision is very high. Moreover, the incidence of complications is same as with the closed method of insertion. Authors also prefer the closed technique of primary access to the peritoneal cavity, either by the veress needle or by direct trocar.

Janos Veres was the physician who invented veress needle in 1932. He had introduced this tool basically for the aspiration of fluid in patients of pleural effusion. Later, this needle was used for creating pneumoperitoneum in laparoscopy. In 1978, Dingfelder first introduced direct trocar access technique in which the peritoneal cavity access is made directly with a trocar & there is no need of prior pneumo-insufflation by the veress needle insertion.^[12] This method has advantages to avoid complications caused by the veress needle such as failed pneumo-peritoneum, gas insufflation into preperitoneal space, bowel insufflation or carbon dioxide (CO₂) embolism. There is only one blind step in direct trocar access method for laparoscopic entry (i.e., the trocar). On the other hand, there are three steps in the veress needle access technique, (i.e., first veress needle, second gas insufflation & third trocar insertion). Moreover, direct trocar access method is fastest method of entry in laparoscopic surgery.

Aims and Objectives.

In this study, initial peritoneal access by the veress needle technique during laparoscopic surgery has been compared with direct trocar access technique in terms of complications & efficiency.

Material and Methods

Retrospective analysis of 2400 patients of laparoscopic surgery over a period of 10 years from April, 2011 to May, 2021 by the closed entry techniques of initial peritoneal access was done in this study. The cases were divided into two groups (A & B). Group A consisting of 1200 patients in whom veress needle access technique was used & Group B consisting of 1200 patients in whom direct trocar access was done. Various parameters like patient demographics, the type of laparoscopic operation, time to access the peritoneal cavity, intra-operative & post-operative complications in the two groups were analysed & compared.

Inclusion criteria. 589(24.54%) acute cases and 1811(75.45%) chronic cases were included in the study.

Exclusion criteria were the patients of previous vertical midline laparotomy incision and patients with history of severe adhesions due to previous operative reports, peritonitis, bowel resection, oncological procedures with omentectomy or abdominoplasty.

Veress needle access technique

Description. It is a spring-loaded tool available in different sizes: 8 cm, 10 cm, 12 cm & 20 cm. The 8 cm veress needle is used for the paediatric patients, 10 or 12 cm for adults and 20 cm is used for obese patients and in bariatric surgery. The veress needle has two parts, outer sheath/cannula and the inner stylet. The outer cannula has external diameter of 2 mm & has a bevelled/sharp lower end to cut through the tissues of the abdominal wall. There is an eye along the side of the stylet near its lower end. The diameter of the eye is 0.4 mm so that the maximum flow of carbon dioxide which is possible is 2.5 L/min even if high flow rate is set. There is on/off tap (valve) at the upper end of the needle which opens if it is parallel to the shaft of the needle & closes if it is at right angle to the shaft. In the upper part of the needle just below the valve is a spring mechanism the purpose of which is just to keep the blunt tip of stylet ahead to protect bowel or blood vessels from injury by the sharp outer cannula. Direct pressure on the tip pushes the blunt stylet into the shaft of the outer cannula. When the tip of the needle enters a space such as the peritoneal cavity, the inner stylet again springs forward (Figure 1). This system provides safety in making the puncture of peritoneal cavity & makes the veress needle access an easy, fast & effective technique.



Fig. 1: Veress Needle

Veress needles can be both disposable and non-disposable (reusable). The disposable veress needle is a one-piece made up of plastic that can't be opened, cleaned or sterilised & should be thrown away after one use, whereas the latter is made up of metal & can be disassembled, cleaned & sterilised. The disposable veress needle has a red indicator near its upper end which indicates the position of the needle while making peritoneal access in laparoscopic surgery.

Always check the veress needle for its spring action & patency by flushing saline through it before use. Push the blunt tip of the veress needle against a solid surface like the handle of a knife to make sure that the blunt tip will retract easily & will spring forward rapidly & smoothly. We shouldn't hold the needle from the top, but the veress needle should be held from the shaft like a dart to guard it so that the full length of the needle does not go in. Lifting the abdominal wall is important by holding the skin of abdomen halfway between the umbilicus & pubic symphysis. Flanks can also be used from both the sides to lift the abdominal wall. In morbidly obese patients, it is not possible to lift the abdominal wall & the veress needle should be inserted trans-umbilically at right angle to the abdominal wall without lifting. There should be 45 degrees

of elevation angle while inserting the veress needle. Elevation angle is angle between the instrument & body of the patient, whereas angle between the veress needle & the abdominal wall should be 90 degrees which can be made possible by proper lifting of the abdominal wall if the patient has good muscle relaxation. Needle should point towards the anus except in cases of midline lower abdominal incision as there may be adhesions present & one can puncture the bowel. To find appropriate length of insertion of the veress needle add 4 to the thickness of the abdominal wall lifted. More insertion of the needle than the required length should be avoided to prevent the risk of vascular injury. Less insertion of the needle leads to pre-peritoneal insufflation, resulting in inappropriate distension of the anterior wall of abdomen & operative difficulty. Umbilicus is the most common site of insertion of the veress needle because it is the thinnest part of the abdominal wall & has no fat or muscle & there are insignificant blood vessels. In patients with a previous vertical midline laparotomy scar, the best site of the veress needle insertion is left upper quadrant (LUQ) or Palmer's point.^[13] This site is located 3 cm below the left subcostal margin in the midclavicular line & is usually not affected by the adhesions, but is contraindicated in patients with hepatosplenomegaly, portal hypertension, previous gastric or splenic surgery & gastro-pancreatic masses.^[14] Different safety tests like irrigation & aspiration test & hanging drop test are performed before carbon dioxide gas insufflation to verify whether the veress needle is positioned correctly in the peritoneum & is not in a viscera.

Direct trocar access technique

In this technique, the patient is first positioned supine. As a routine, umbilicus is cleaned thoroughly with 10% Povidone iodine lotion before incision. The operating table is tilted 15-20 degrees head low Trendelenburg position & the skin at umbilicus is elevated with a skin hook & 1 cm intra-umbilical incision is made with a sharp No.11 blade. By applying two towel clips or Allis forceps 3 cm on either side of the umbilicus, the anterior abdominal wall is then pulled & elevated. The surgeon holds a 10 mm safety trocar in such a way that his index finger is positioned along the

shaft of the trocar 3 cm away from the tip to guard against sudden uncontrolled entry in the peritoneal cavity & top of the trocar is pressed against the thenar eminence of his hand. The trocar is then inserted at an angle of 90 degrees & advanced with a twisting semi-circular motion in the peritoneal cavity in a controlled fashion (Figure 2). Then, the telescope is introduced and intra-peritoneal placement of the trocar is ascertained & pneumo-peritoneum created with high-flow carbon dioxide insufflation. Always inspect the underlying structures carefully for any injury before performing the laparoscopic procedure. At the end of the procedure, the surgical wound is irrigated with the saline solution & the fascia is exposed with small rectangular skin retractors & is closed with interrupted sutures using 00 vicryl.



Fig. 2: Demonstrating direct trocar access technique.

Results

2400 patients of laparoscopic surgery with the closed technique of initial access in the peritoneal cavity performed by a single surgeon, Dr Rajive Gupta, the corresponding author over a period of 10 years between April, 2011 & May, 2021 at different private hospitals in Jammu (J & K), India (Table 2) were included in the study. Table 3 shows the various observations.

Table 2: Hospital wise distribution of cases in the two groups.

Name of the hospital	Number of cases (%)	Group A	Group B
Maxxlyfe Hospital, Bathindi	900(37.5%)	300	600
Kalindi Nursing Home, Subash Nagar	456(19%)	274	182
Care & Cure Hospital, Trikuta Nagar	414(17.25%)	250	164
Ganeshdaya Nursing home, Talab Tillo	250(10.41%)	150	100
Lochan Nursing Home, Trikuta Nagar	180(7.5%)	100	80
Goel Hospital, Canal Road	70(2.91%)	40	30
AV Nursing Home, Channi Himmat	60(2.5%)	36	24
Vini Hospital, Janipur	42(1.75%)	30	12
Mediaids Nursing Home, Channi Himmat	28(1.16%)	20	8
Total	2400	1200	1200

Table 3: Comparing the study variables in the two groups.

Parameter	Group A	Group B	(P value)
Mean Age in years	36	32	NS
Sex ratio (F:M)	1.42:1	1.26:1	NS
Average time to access peritoneum	25 seconds	15 seconds	S*
Conversion rate	7 (0.58%)	3 (0.25%)	S*
Operative complications	43 (3.58%)	20 (1.66%)	S*
Mortality	3 (0.25%)	Nil (0.0%)	S*

P value <0.05 (significant)*, S: Significant, NS: Non-significant.

The abdominal disease & the type of laparoscopic surgery performed are shown in Table 4.

Table 4: Abdominal disease & the type of laparoscopic surgery.

Abdominal disease	Type of laparoscopic surgery	Group A	Group B
Cholelithiasis	Laparoscopic Cholecystectomy	740	724
Acute cholecystitis	Laparoscopic Cholecystectomy	180	210
Ovarian Cyst	Laparoscopic cystectomy	96	90
Acute appendicitis	Laparoscopic Appendectomy	92	107
Elective appendicitis	Laparoscopic Appendectomy	40	30
Incisional hernia	Laparoscopic Hernioplasty	26	16
Non-functioning kidney	Transabdominal Nephrectomy	10	9
Unexplained pain abdomen	Diagnostic Laparoscopy	9	8
Inguinal Hernia	Trans abdominal preperitoneal repair	7	6
Total	2400	1200	1200

As shown in Table 5, the overall complication rate was higher in Group A as compared to complications in Group B and this difference was statistically significant ($p < 0.05$). In Group A, most of the complications (36) were minor & only 7 (0.48%) were major complications in the form of bowel injury (5 patients) & major vascular injury (2 patients), whereas in Group B, only 3 (0.25%) patients had major complications in the form of bowel injury. In the present study, small bowel injury while entry occurred in 8 patients (5 in Group A and 3 in Group B) and injury was detected on operation table in 6 patients & they were immediately converted to open surgery and the injured bowel segment was identified & repaired with interrupted sutures using 000 vicryl & after irrigating the peritoneal

cavity with normal saline and betadine, laparotomy wound was closed by placing an intraperitoneal tube drain. All the 6 patients recovered and discharged after 9 days stay in the hospital. In 2 cases, small bowel injury went undetected & patients developed septicaemia & were referred to higher centres for further management, though one out of two died. Two major blood vessel injuries occurred in Group A, one was IVC injury & other was injury to distal Aorta near its bifurcation. Both the patients were male & immediately converted to open laparotomy, but they went to irreversible haemorrhagic shock & could not be saved due to delay in arranging blood, though the vascular surgeon was also called for help in both the cases.

Table 5: Complications in two Groups of the primary peritoneal access technique.

Complication	Group A Number of patients (%)	Group B Number of patients (%)
Port Site infection	9 (0.75%)	8 (0.66%)
Pneumo-omentum	7 (0.58%)	Nil
Surgical emphysema	5 (0.41%)	Nil
Subcutaneous hematoma/Ecchymosis	6 (0.50%)	4 (0.33%)
Bowel injury	5 (0.41%)	3 (0.25%)
Mesenteric perforation	3 (0.25%)	2 (0.16%)
Bleeding of omentum	2 (0.16%)	1 (0.08%)
Port Site Hernia	3 (0.25%)	2 (0.16%)
Major Vessel Injury	2 (0.16%)	Nil
Loss of outer sheath of the veress needle	1 (0.08%)	----
Total	43 (3.58%)	20 (1.66%)

17 patients (9 in Group A & 8 in Group B) in whom umbilical port infection occurred got recovered in a period of 2 weeks by local wound dressings. 5 patients (3 in Group A & 2 in Group B) who developed umbilical port hernia were taken up for mesh hernioplasty after 12 weeks of laparoscopic surgery & recovered.

We failed to enter the peritoneal cavity by the veress needle in 10 cases and we failed to enter the peritoneal cavity by

direct trocar in 30 cases and in these 40 cases, we used open Hasson technique to enter the peritoneal cavity. In 10 patients (7 in Group A & 3 in Group B) who sustained iatrogenic small gut injury & major vascular injuries while creating pneumoperitoneum, conversion to open conventional surgery was done & as shown in Table 6, the difference was statistically significant ($p \text{ value} < 0.05$).

Table 6: Conversion to open surgery in two Groups.

Cause of conversion	Group A Number of cases (%)	Group B Number of cases (%)	(p value)
Bowel injury	5 (0.41%)	3(0.25%)	S*
Major vessel injury	2 (0.16%)	Nil	S*
Total	7 (0.58%)	3 (0.25%)	S*

Average hospital stay after laparoscopic surgery was 12-24 hours in both the groups, though in cases of iatrogenic small bowel injury, stay was extended to 9 days in the

hospital. In our study, overall mortality was 0.25% in Group A & 0% in Group B. This includes 2 (0.16%) patients of major vascular injury who died on table & 1

(0.08%) patient who got bowel injury. The difference in mortality in the two groups was statistically significant (p value <0.05).

Discussion

In laparoscopic operations, the making of the pneumoperitoneum constitutes the first step & a variety of techniques can be used. The veress needle, direct trocar access & open entry methods are commonly used techniques for establishing pneumoperitoneum in laparoscopic surgery. It is still controversial which technique is better. We prefer closed access technique by veress needle & direct trocar access rather than the open method.

Chapron et al.^[15] have reported comparison of open versus closed laparoscopic entry in a nonrandomized study practised by university affiliated hospital teams. The rate of bowel injury was 0.04% & major vessel injury was 0.01% in the closed technique & in the open technique, it was 0.19% & 0%, respectively and they concluded that open laparoscopy does not reduce the risk of major complications during laparoscopic access. In 2012, Bozkurt^[16] & colleagues in Turkey conducted a prospective study comparing the efficiency, complication & post-operative pain between the direct trocar access method & open entry method & concluded that both techniques have advantages as well as disadvantages & stated that the surgeons should prefer the technique that they are accustomed to & have experience in. Altun^[17] & colleagues from Turkey in 2010 investigated the reliability of the direct trocar access method on laparoscopy; the direct trocar entry method may cause minor complications, but was considered a safe & fast method. In 2007, Corcione et. al.^[18] from Italy emphasized from their study that the open entry technique is safer for patients having past history of surgery & they said there is no technique that doesn't come without risk. In our study, we converted to open Hasson technique in 10 patients in Group A where veress needle insertion failed & 30 patients in Group B where direct trocar access failed. In 2006, Cakir^[19] from Turkey emphasized from his study that the veress needle has not been identified as a component of the organ injury & that the veress needle method is safe. In 2006, Chávez^[20] from Mexico reviewed the use of the veress needle & direct trocar access techniques in laparoscopic cholecystectomy; it was seen that the veress needle method had a higher complication rate & took longer time than the direct trocar access method & similar findings were observed in our study. In our study, the incidence of bowel injury by the veress needle access was 0.41% & the incidence of major vascular injury was 0.16%, whereas the incidence of bowel injury by the direct trocar access was only 0.25% and our results are comparable to the complications in other studies.

Retroperitoneal major vascular injury (MVI) during laparoscopic surgery is the most serious potential complication & can be life threatening & is reported to the frequency of 0.01–0.39%.^[21] As reported in the literature, usually the midline punctures in the umbilical region by the veress needle resulted injuries to the great vessels.^[22] Even in the hands of experienced surgeons, major vascular injuries can be caused by the insertion of the veress needle into the abdominal midline. In analysis of 26 major vascular injuries, it is reported by Schäfer et al.^[23] that inexperienced surgeons have caused only 15% (4 injuries)

& experienced surgeons or very experienced surgeons have caused rest 85% (22 injuries). We experienced retroperitoneal MVI in 2 (0.08%) patients with the veress needle access & this is within the reported range, but we lost both the patients.

In a laparoscopic procedure, unlike major vascular injuries where the risk & presentation are immediate, many bowel injuries go unrecognised at the time of the procedure.^[24] This delay has been a significant cause of morbidity & mortality in case of bowel injuries. After the introduction of the telescope, the bowel should be inspected for any injury & abdomen visualised for the presence of adherent bowel around the umbilicus. Unilateral distension means bowel is involved as bowel takes very less gas. Patients with past history of abdominal surgery are more prone to bowel injury by the closed access techniques because of peritoneal adhesions. In a study of 360 women undergoing operative laparoscopy after a previous laparotomy, Brill et al.^[25] found that the patients with prior midline incisions had significantly more adhesions (58 of 102) than those with Pfannenstiel incisions (70 of 258) & 28% (21 patients) suffered direct injury to the adherent omentum & bowel during the laparoscopic entry procedure. In cases of suspected peri-umbilical adhesions & in obese patients, Palmer's point pneumoperitoneum should be considered for safe entry. According to Azevedo et al.,^[26] Palmer's point insertion of the veress needle has been reported to be safe & effective. In a systematic review by Merlin et al.,^[27] the most common major complication of the initial access was bowel injury & the risk was higher with the open technique than with closed technique. In our study, 5 (0.41%) patients got bowel injury while peritoneal access with the veress needle & 3 (0.25%) patients got bowel injury with direct trocar access & all were converted to open surgery.

Roy et al.^[28] in their study used a method that involves grasping & elevating the umbilical ring and reported that the mean maximum distance from the abdominal wall to the intra-abdominal organs, particularly the colon, was 6.8 cm when this method of insertion of trocar was used, meaning that this amount of empty space must be created between the bowel and the abdominal wall simply to perform a puncture.

Teoh et al.^[29] evaluated the tests used to ascertain the veress needle placement in closed laparoscopy & said that the most valuable test is to observe the actual insufflation pressure to be 10 mm or less & that the gas is flowing freely. Prospective studies have concluded that initial intra-abdominal pressures of 10 mm Hg or below indicate the correct placement of the veress needle, regardless of the woman's body habitus, parity or age.^[30] Pneumoperitoneum prior to insertion of the primary trocar is said to be adequate or sufficient if there is an arbitrary volume of 1–4 L of CO₂ depending on BMI & parity of the patient or an arbitrary intra-peritoneal pressure of 10–15 mm Hg.^[31] In a prospective study by Richardson and Sutton^[32] on 836 patients undergoing laparoscopy, the complications associated with the first entry were determined by using the volume technique ($n = 291$) & the pressure technique ($n = 335$, median pressure 14 mmHg) as the end points. The average volume of CO₂ used in the pressure technique group was significantly greater than with the volume technique, but the complication rate in the pressure technique group was lower than in the volume technique group. Thus, it was suggested by the authors that

the pressure technique should be universally adopted.

On keeping high intraperitoneal pressure (HIP) ranging from 20-25 mm Hg at entry, the gas bubble increases & produces greater splinting of the anterior abdominal wall and a distance of at least four centimetres from the abdominal contents is maintained.^[33] HIP entry thus allows easy entry of the primary trocar and reduces the risk of vascular injury. No clinical adverse effect on the cardiopulmonary function in healthy women have been observed by the transitory elevation of intraperitoneal pressure.^[34] In obese patients, pneumoperitoneum should be raised to 18 mm Hg at the time of inserting the primary trocar & once the insertion of the trocar is done, reduce the distension pressure to 12-14 mm Hg to avoid cardiopulmonary complications and gas embolism.

Even though we came across different outcomes from the literature we examined, many studies show that there were no serious complications with the direct trocar access method.^[35] Another advantage of the direct trocar access technique is the reduced number of blind insertions to gain peritoneal access.

Conclusion

Many techniques have been introduced to eliminate laparoscopic access complications. There is not a single technique of access in the peritoneal cavity free of complications. It is important that these complications are recognised promptly & addressed immediately. Despite associated risks, the veress needle access technique of initial peritoneal entry is still the most common method used in laparoscopy, though access by direct trocar method is quick, safe, simple & efficient with minimal morbidity & no mortality.

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