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Original Article

Surgery Section

# Direct Trocar Insertion versus Veress Needle Insertion Technique for Creating Pneumoperitoneum in Laparoscopic Surgeries: A Prospective Interventional Study

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## ABSTRACT

**Introduction:** The creation of pneumoperitoneum is an indispensable first step in laparoscopy, as it allows for the establishment of an operative field. There is ambiguity regarding the efficacy and complications of different techniques used for creating pneumoperitoneum.

**Aim:** To evaluate the safety and efficacy of creating pneumoperitoneum in laparoscopic surgeries with respect to direct safety trocar insertion and Veress needle insertion.

**Materials and Methods:** This prospective interventional study was conducted with 70 subjects undergoing laparoscopic surgeries at the Department of General Surgery, Shree Nijalingappa Medical College, and HSK Hospital and Research Centre, Bagalkot, Karnataka, India. Study subjects were allocated into two groups: direct trocar insertion group (Group A; n=35) and Veress needle insertion group (Group B; n=35). The variables measured included the number of attempts, time taken to create pneumoperitoneum, incidence of gas leakage, incidence of extraperitoneal insufflation, incidence of minor vessel injury, incidence of major vessel injury, incidence of bowel injury, and incidence of port site infection. An independent t-test was used to compare continuous variables between the study groups, while a Chi-square test was utilised to compare categorical variables.

**Results:** The mean time taken to create pneumoperitoneum (in seconds) was significantly less in the direct trocar insertion group (93.71±22.81 seconds) compared with the Veress needle insertion group (197.43±22.83 seconds). The mean number of attempts required to create pneumoperitoneum was similar, with one attempt in both groups. There was no significant difference in intraoperative complications such as gas leakage (p-value=1.000) and extraperitoneal insufflation (p-value=0.24) between the groups. Furthermore, there were no major or minor vessel injuries or bowel injuries observed in either group. Additionally, no significant port-site infections were noted in either of the groups.

**Conclusion:** Direct trocar insertion and Veress needle insertion techniques are equally effective and safe for creating pneumoperitoneum. However, the direct trocar insertion technique allows for quicker creation.


**Keywords:** Gas leakage, Laparoscopic complications, Minor vessel injury, Port-site infection

## INTRODUCTION

Laparoscopic surgeries have become the preferred method for performing abdominal surgeries due to their association with better cosmetic results and fewer complications in terms of patient morbidity and suffering [1]. Furthermore, laparoscopy has revolutionised surgery with its widespread acceptance as a predominantly minimally invasive approach to intra-abdominal surgical procedures [2]. From a gynaecological perspective, laparoscopic surgery is a recent diagnostic and therapeutic technique used to treat various gynaecological pathologies [3]. The first integral step of a successful laparoscopic procedure is the creation of pneumoperitoneum, as it enables the formation of a good operative field [4,5]. The majority of complications occur during the insertion of the primary trocar. Despite substantial progress in laparoscopic techniques and equipment, unintended and often preventable complications related to abdominal entry still occur. These complications can include severe issues such as damage to major and minor vessels, bowel injuries and extraperitoneal insufflation. Therefore, using the safest method for laparoscopic entry and pneumoperitoneum creation is essential [6,7]. Various techniques have been developed to address these complications and facilitate access to the abdominal cavity. The methods of choice for abdominal access include direct trocar insertion, Veress needle insertion, direct optical trocar entry and Hasson's technique. Veress needle insertion, Hasson's technique and direct safety trocar insertion are the most commonly used laparoscopic entry methods [8]. None of the access techniques currently in use is sufficient to entirely prevent these complications [9].

A drawback of laparoscopy is the risk associated with the initial entry of the primary trocar, which varies depending on the method used. Complications such as bowel injury and major and minor vessel injuries are encountered, although very rarely. Bowel perforation occurs in approximately 0.1 to 0.5% of cases, while vessel injury occurs in about 0.01 to 1% of cases [10-12]. With this in mind, the present study was conducted with the primary aim of comparing the safety and efficacy of creating pneumoperitoneum in laparoscopic surgeries, specifically with regards to direct safety trocar and Veress needle insertion techniques, as well as comparing intraoperative and postoperative complications associated with these methods.

## MATERIALS AND METHODS

A prospective interventional study was conducted at the Department of General Surgery, Shree Nijalingappa Medical College and HSK Hospital and Research Centre, Bagalkot, Karnataka, India from August 2022 to December 2023. Approval from the ethical committee of the institute was obtained (SNMC/IECHSR/2021-22/A-53/1.1).

**Inclusion criteria:** Patients aged 18-60 years, undergoing laparoscopic surgeries and who consented were included in the study.

**Exclusion criteria:** Patients with previous midline incisions, patients with paramedian abdominal incisions, and patients with lower abdominal incisions were excluded from the study.

**Sample size estimation:** Sample size estimation was performed using Open Epi software version 2.3.1, with a 95% confidence level and 80% power of the study. The significance level (α) was set at 0.050 (two-tailed), and the type II error (β) was 0.200. The standard normal deviates were Zα=1.960 and Zβ=0.842. According to the study conducted by Mushtaq U et al., [2] the proportion of study subjects with intraoperative adverse events in the direct trocar group was 4.89% (p1), while the proportion in the Veress needle group was 30.9% (p2). The estimated sample size was 35 in each group, resulting in a total of 70 patients.

A total of 70 patients undergoing laparoscopic surgeries were selected for this study on a single-blinding basis and were allocated into two groups using a computerised method: the direct trocar insertion group (Group A; n=35) and the Veress needle insertion group (Group B; n=35).

## Study Procedure

**Direct safety trocar entry:** The anterior abdominal wall must be adequately lifted by hand, and the trocar is then inserted directly into the cavity, directed toward the pelvic cavity. After removing the sharp trocar, the laparoscope is inserted to verify the presence of omentum or bowel in the visual field.

**Veress needle insertion:** The needle was inserted through the skin and into the abdominal wall at a specific angle, usually 45° to the horizontal. After piercing the skin, the needle was advanced through the subcutaneous tissue and the fascia into the peritoneal cavity. Once proper needle placement was confirmed, $CO_2$ gas was introduced, and the pressure was monitored to ensure that the abdomen was distending and the gas was being introduced into the peritoneal cavity. After sufficient pneumoperitoneum was established, the Veress needle was withdrawn, and a trocar or cannula was inserted through the same incision to allow access to the laparoscope and other surgical instruments. In both techniques, the flow rate was set to 2 litres/min and intra-abdominal pressure was set to 12 mmHg.

## Assessment Parameters

The following parameters were examined in both groups: number of attempts, time taken to create pneumoperitoneum (from the time of skin incision to the insertion of the camera and confirming entry into the peritoneal cavity), intraoperative complications (gas leakage, incidences of extraperitoneal insufflation, minor and major vessel injuries, bowel injuries) and port-site infections.

# STATISTICAL ANALYSIS

Data were entered into Microsoft Excel 2019, and statistical analysis was conducted using IBM Statistical Package for the Social Sciences (SPSS) version 22.0. Categorical variables were represented in terms of percentages and frequencies. Continuous variables were presented as descriptive statistics (mean and standard deviation). An Independent t-test was used to compare continuous variables between the study groups, while the Chi-square test was employed to compare categorical variables. A p-value ≤0.05 was considered statistically significant.

# RESULTS

The mean age of the study subjects was found to be 41.51±11.29 years in group A and 37.69±12.99 years in group B, with no significant difference (p-value=0.199) in the mean age between the groups. In group A, a female predominance (51.40%) was observed compared to males (48.60%). In contrast, group B showed a male predominance (68.60%) compared to females (31.40%) [Table/Fig-1]. The majority of study subjects in group A (20.0%) were diagnosed with chronic calculus cholecystitis and acute calculus cholecystitis, followed by recurrent appendicitis (17.1%) [Table/Fig-2a]. In group B, the majority of study subjects (37.1%) were diagnosed with acute appendicitis, followed by acute calculus cholecystitis (22.8%) [Table/Fig-2b]. In group A, 14 out of 35 subjects underwent laparoscopic cholecystectomy (40.0%), followed by laparoscopic appendectomy (31.42%) [Table/Fig-3]. In group B, the majority of study subjects (42.85%) underwent laparoscopic appendectomy, followed by laparoscopic cholecystectomy (34.28%) [Table/Fig-4].

| Variables | Group A | Group B |
|---|---|---|
| **Age (years)** | | |
| 11-20 | - | 2 (5.7) |
| 21-30 | 7 (20.0) | 12 (34.3) |
| 31-40 | 11 (31.4) | 7 (20.0) |
| 41-50 | 9 (25.7) | 9 (25.7) |
| 51-60 | 8 (22.9) | 5 (14.3) |
| Mean±SD | 41.51±11.29 | 37.69±12.99 |
| p-value | 0.1990 | |
| **Gender** | | |
| Male | 17 (48.6) | 24 (68.6) |
| Female | 18 (51.4) | 11 (31.4) |

**[Table/Fig-1]:** Demographic characteristics.
T-test for mean age; Chi-square test for gender; Values were expressed as n (%) unless otherwise stated

| Diagnosis | Group A n (%) |
|---|---|
| Acute calculus cholecystitis | 7 (20) |
| Chronic calculus cholecystitis | 7 (20) |
| Acute appendicitis | 5 (14.3) |
| Recurrent appendicitis | 6 (17.1) |
| Ovarian cyst | 2 (5.7) |
| Tubectomy | 4 (11.4) |
| Abnormal uterine bleed | 3 (8.6) |
| Torsion ovary + Haematosalpinx | 1 (2.9) |
| Total | 35 (100) |

**[Table/Fig-2a]:** Distribution of study subjects based on diagnosis in Group A.

| Diagnosis | Group B n (%) |
|---|---|
| Acute appendicitis | 13 (37.1) |
| Recurrent appendicitis | 3 (8.6) |
| Acute calculus cholecystitis | 8 (22.8) |
| Cholelithiasis | 3 (8.6) |
| Recurrent appendicitis + Cholelithiasis | 1 (2.9) |
| Rectal prolapse | 1 (2.9) |
| B/L indirect inguinal hernia | 1 (2.9) |
| Hiatus hernia | 3 (8.6) |
| Umbilical hernia | 1 (2.9) |
| Gall bladder polyp | 1 (2.9) |
| Total | 35 (100) |

**[Table/Fig-2b]:** Distribution of study subjects based on diagnosis in Group B.

The mean time taken to create pneumoperitoneum (in seconds) was significantly greater (p-value<0.001) in Group B (197.43±23.83) compared to Group A (93.71±22.81). However, the mean number of attempts required to create pneumoperitoneum was similar between Group A and Group B, with an average of 1.06±0.23 attempts [Table/Fig-5].

| Procedure | Group A n (%) |
|---|---|
| Laparoscopic cholecystectomy | 14 (40) |
| Laparoscopic appendectomy | 11 (31.42) |
| Laparoscopic ovarian cystectomy | 2 (5.72) |
| Laparoscopic tubectomy | 4 (11.43) |
| Laparoscopic hysterectomy | 4 (11.43) |
| Total | 35 (100) |

**[Table/Fig-3]:** Distribution of study subjects based on procedure performed in Group A.

| Procedure | Group B n (%) |
|---|---|
| Laparoscopic cholecystectomy | 12 (34.28) |
| Laparoscopic appendectomy | 15 (42.85) |
| Laparoscopic fundoplication | 3 (8.57) |
| Diagnostic laparoscopy+open appendectomy | 2 (5.7) |
| Transabdominal preperitoneal repair | 1 (2.9) |
| Intraperitoneal only mesh repair | 1 (2.9) |
| Laparoscopic appendectomy +cholecystectomy | 1 (2.9) |
| Total | 35 (100) |

**[Table/Fig-4]:** Distribution of study subjects based on procedure performed in Group B.

| Variables | Group A | Group B | p-value |
|---|---|---|---|
| Number of attempts | 1.06±0.23 | 1.06±0.23 | 1.000 |
| Time taken to create pneumoperitoneum (seconds) | 93.71±22.81 | 197.43±23.83 | <0.001 |

**[Table/Fig-5]:** Comparison of the number of attempts and time taken to create pneumoperitoneum.
t-test; Values were expressed as mean±standard deviation (sd); n=35

There was no significant difference in gas leakage (p-value=1.000) and extraperitoneal insufflation (p-value=0.24) regarding complications observed between the groups. However, there were no major or minor vessel injuries or bowel injuries observed in either group [Table/Fig-6]. There was no significant difference in port-site infection on day 3 and day 10 (p-value=0.24). Moreover, no port-site infections were observed on day 30 in both groups [Table/Fig-7].

| Intraoperative complications | Group A | Group B | p-value |
|---|---|---|---|
| Gas leakage | 1 (2.9) | 1 (2.9) | 1.000 |
| Major vessel injury | 0 | 0 | NA |
| Minor vessel injury | 0 | 0 | NA |
| Bowel injury | 0 | 0 | NA |
| Extraperitoneal insufflation | 2 (5.7) | 2 (5.7) | 0.24 |

**[Table/Fig-6]:** Intraoperative complications comparisons.
Chi-square test; Values were expressed as n (%); NA, not applicable

| Port-site infection | Group A | Group B | p-value |
|---|---|---|---|
| Port-site infection on day 3 | 1 (2.9) | 2 (5.7) | 0.24 |
| Port-site infection on day 10 | 1 (2.9) | 2 (5.7) | 0.24 |
| Port-site infection on day 30 | Nil | Nil | NA |

**[Table/Fig-7]:** Port-site infection.
Chi-square test; Values were expressed as n (%); NA: Not applicable

## DISCUSSION

Morbidity and mortality among surgical patients have been documented to increase with age. When limited to laparoscopic procedures, outcomes in elderly patients are often superior. López C et al., documented the superiority of laparoscopic surgery, with morbidity and mortality rates of 10.8% and 3.4%, respectively, among patients older than 70 years of age [13]. Briet JM et al., also reported significant improvements in quality of life, in terms of physical and social functioning, even in elderly patients (>65 years old) following laparoscopic surgeries [14].

The mean age of the study subjects enrolled in present study was found to be 41.51 years in the direct trocar insertion group and 37.69 years in the Veress needle insertion group. These findings were comparable to the findings of studies reported in the literature by various other researchers. The mean age of patients who underwent laparoscopic surgeries using either technique in the study by Mushtaq U et al., was 47.54 years, which was similar to the age found in the present study [2]. The mean age of 150 patients who underwent laparoscopic cholecystectomy in a study by Abdullah AA et al., was 41 years, slightly lower than that in the present study [15]. The mean age of patients in a study by Ganesh MK et al., was 40 years [16]. The age difference observed between the present study and those reported in the literature may be attributed to variations in inclusion criteria.

In present study, the direct trocar insertion group exhibited female predominance (51.4%) compared to males (48.6%), whereas in the Veress needle insertion group, male predominance (68.6%) was observed in comparison to females (31.4%). These findings were consistent with those reported in the literature by various other researchers. Abdullah AA et al., reported that the maximum number of patients who underwent laparoscopic cholecystectomy were females [15]. Mushtaq U et al., also documented female predominance with a male-to-female ratio of 1:1.56 [2]. Ganesh MK et al., reported a male (86%) predominance in their study [16]. Chauhan S et al., documented that older age and male gender were associated with a higher conversion rate of laparoscopic surgery to open surgery [17].

In the direct trocar insertion group, the majority of the study subjects (20.0%) were diagnosed with chronic calculus cholecystitis and acute calculus cholecystitis. The procedure performed for the treatment of these conditions was primarily laparoscopic cholecystectomy. In the Veress needle insertion group, the majority of the study subjects were diagnosed with acute appendicitis (37.1%). The procedures performed to treat this condition were predominantly laparoscopic appendectomy.

In line with the results of present study regarding procedures performed in laparoscopic surgeries, laparoscopic cholecystectomy was the most common surgical procedure performed, accounting for 52.08% of patients, followed by laparoscopic appendectomy (13.02%) in a study by Mushtaq U et al., [2]. In a study by Sreejith V et al., the majority of patients also underwent laparoscopic cholecystectomy, followed by laparoscopic ovarian cyst excision and laparoscopic appendectomy [18].

The direct trocar insertion technique has been described as a rapid, feasible and safe method for creating pneumoperitoneum in laparoscopic surgeries [19]. In present study, there were no significant differences observed in the mean number of attempts required to create pneumoperitoneum, which was similar between the direct trocar insertion and Veress needle insertion groups, averaging 1.06±0.23 attempts. These results were consistent with a study by Garrido M et al., which found that 12.3% of cases in the Veress needle group required two or more attempts, compared to 7.8% in the direct trocar insertion group. However, the difference between the two groups was not statistically significant (p-value>0.05) [20]. In contrast to the present study, Sinha S and Malik S, reported a significantly higher number of attempts in the Veress needle group compared to the direct trocar insertion group [21]. Chávez E et al., also reported a significantly higher number of failed attempts in the Veress needle group compared to the direct trocar insertion group; the probable reasons may include the use of disposable or reusable

materials, the presence of obese patients, or differences in surgical expertise [22].

On the other hand, the mean time taken to create pneumoperitoneum (in seconds) was significantly greater (p-value<0.001) in the Veress needle insertion group (197.43 seconds) compared to the direct trocar insertion group (93.71 seconds). The mean time taken to create pneumoperitoneum in present study was comparable to literature reports. Shatta AF and Girbash EF, documented 100.6 seconds as the mean time to induce pneumoperitoneum using direct trocar insertion [23]. In a study by Abdullah AA et al., the mean time for induction of pneumoperitoneum with the direct trocar insertion technique was 2.3 minutes compared to 5 minutes for Veress needle insertion [15]. Both techniques are safe and feasible for the creation of pneumoperitoneum during laparoscopic procedures. However, the time required to create pneumoperitoneum was significantly less in the direct trocar insertion group compared to the Veress needle insertion group [19].

Laparoscopic surgeries may be associated with various complications. Literature reports indicate that the incidence of visceral and vascular injuries is much lower with direct trocar insertion and Veress needle techniques compared to the classical open method [24,25]. In present study, there were no major or minor vessel injuries that occurred during the creation of pneumoperitoneum with either the direct trocar insertion or Veress needle insertion techniques. In line with present study findings, Datey A et al., reported no vascular or visceral injuries during the creation of pneumoperitoneum with either technique [19]. Furthermore, the findings of our study were supported by findings from Imran M et al., which documented no vascular or visceral injuries in either group [26]. Abdullah AA et al., also reported no incidence of vascular or visceral injuries in patients from both groups, namely direct trocar insertion and Veress needle insertion [15]. According to Ahmad A and Kaur A, since the direct trocar insertion technique does not involve the use of any needle, it is a quick method and is associated with fewer complications [27].

Other intraoperative complications observed in present study included gas leakage, with one subject from both Group A and Group B (2.9%), and extraperitoneal insufflation observed in 2 out of 35 (5.7%) subjects in Group A and Group B. However, the difference in these complications between the two techniques was not statistically significant.

The results regarding port-site infections in present study revealed no significant differences in port-site infections observed on day 3 and day 10 between the two groups. However, no port-site infections were recorded on day 30 in either group. These findings align with those of Godara R et al., who also reported no significant difference in complications between the two groups, i.e., direct trocar insertion and Veress needle insertion. They documented port-site bleeding in 4% and 2% of cases in the Veress needle and direct trocar insertion groups, respectively [28]. Abdullah AA et al., reported port-site infections in two cases of the direct trocar insertion and one case of the Veress needle insertion technique, respectively [15]. In contrast, present study observed one case of port-site infection with direct trocar insertion and two cases with Veress needle techniques. Based on the surgeon's expertise, preference and availability of resources, different techniques can be used to create pneumoperitoneum in laparoscopic surgeries.

### Limitation(s)

The limitations of the study include its being a single-centre study and the varied levels of surgical expertise.

## CONCLUSION(S)

Both the direct trocar insertion and Veress needle insertion techniques are equally effective and safe for creating pneumoperitoneum. However, with the direct trocar insertion technique, pneumoperitoneum creation during the laparoscopic procedure could be achieved in less time.

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