

Comparing the Open Versus Closed Methods of Creating Pneumoperitoneum in Patients Undergoing Laparoscopic Cholecystectomy in Terms of Safety, Operating Time and Port-Site Infection

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ABSTRACT

Background: Laparoscopic cholecystectomy is the gold standard for symptomatic gallstone disease, yet the optimal method of pneumoperitoneum creation remains debated. The closed (Veress needle) technique is faster but carries risks of blind entry, while the open (Hasson) method is considered safer but slower.

Objective: To compare the open versus closed methods of pneumoperitoneum creation in terms of safety, operating time, and port-site infection (PSI) in patients undergoing elective laparoscopic cholecystectomy.

Methods: A prospective interventional study was conducted at Tripura Medical College and Dr. BRAM Teaching Hospital between March and May 2026. A total of 120 patients were randomly assigned to either the closed (n=60) or open (n=60) technique. Primary outcomes included entry-related complications, access time, total operative time, and PSI incidence. Statistical analysis was performed using independent samples t-tests and Pearson's correlation.

Results: The closed group demonstrated significantly shorter access times (3.69 ± 0.90 min vs. 6.87 ± 0.87 min, $p < 0.01$). Total operative time was comparable between groups (71.15 ± 16.92 min vs. 71.78 ± 11.76 min, $p = 0.81$). PSI rates were low and not statistically different (1.69% vs. 3.44%, $p = 1.00$). BMI showed no significant correlation with access time ($r = 0.04$, $p = 0.83$) or total operative time ($r = 0.14$, $p = 0.13$). Importantly, three entry-related complications (one major vascular, one minor vascular, and one visceral injury) occurred in the closed group, while none were observed in the open group.

Conclusion: The closed method offers faster access but carries a higher risk of entry-related complications. The open method, though slower, demonstrated superior safety. Both techniques showed similar operative times and low PSI rates. Safety should remain the primary consideration, with the open method preferred in patients at higher risk of entry-related injury.

Keywords: Laparoscopic cholecystectomy, Pneumoperitoneum, Veress needle, Hasson technique, Port-site infection, Entry complications, Operating time

INTRODUCTION

Laparoscopic cholecystectomy has become the gold standard for surgical management of symptomatic gallstone disease, replacing open cholecystectomy in most centres worldwide because of its advantages of reduced postoperative pain, shorter hospital stay, faster recovery, and improved cosmetic outcomes. ^[1] Since its introduction in the late 1980s, the procedure has been continually refined, with particular emphasis on minimising complications associated with the initial step of surgery - creation of pneumoperitoneum. ^[2] Establishing

pneumoperitoneum is essential for providing adequate visualisation and working space within the abdominal cavity, but it remains the most critical phase of laparoscopic surgery because the majority of serious iatrogenic injuries occur during entry. ^[3]

Two principal techniques are employed for abdominal entry: the closed (Veress needle) method and the open (Hasson) method. The closed technique involves blind insertion of a spring-loaded Veress needle through the abdominal wall, followed by insufflation of carbon dioxide to achieve intra-abdominal pressure. While widely practised, this method carries a small but significant risk of vascular and visceral injuries due to its blind nature. ^[4] In contrast, the open technique, introduced by Hasson, requires a small infra-umbilical incision with direct visualisation of the peritoneum before cannula placement. This approach was designed to eliminate blind entry and thereby reduce the risk of catastrophic complications such as major vessel injury. ^[5]

The debate over which technique is superior has persisted for decades. Proponents of the closed method argue that it is faster, requires smaller incisions, and results in shorter overall operating times. ^[6] Conversely, advocates of the open method emphasise its safety profile, particularly in patients with prior abdominal surgery or suspected adhesions, where blind entry may be

hazardous. ^[7] Despite numerous studies and meta-analyses, no universal consensus has emerged, and both techniques remain in use depending on surgeon preference, patient factors, and institutional protocols. ^[8]

Safety remains the foremost consideration in laparoscopic entry. Although the incidence of major complications is low, even a single event such as aortic injury or bowel perforation can be life-threatening. ^[9] Literature suggests that vascular injuries occur in approximately 0.07–0.1% of closed entries, whereas the open method virtually eliminates this risk by allowing direct visualisation. ^[10] However, the open technique has other drawbacks, including longer access times, increased gas leakage, and slightly higher rates of PSI due to larger incisions and greater tissue handling. ^[11] Thus, the balance between safety and efficiency continues to shape surgical practice.

Operating time is another critical parameter in evaluating entry techniques. Access time, defined as the duration from skin incision to successful laparoscope placement, varies between studies. Some report shorter times with the open method because it avoids repeated blind attempts, while others report faster access with the closed method in experienced hands. ^[12] Total operative time also tends to be shorter with the closed method, largely because smaller incisions require less closure and there are fewer intraoperative interruptions from gas leaks. ^[13] These differences, though modest, may influence surgeon preference in high-volume centres where efficiency is paramount.

Port-site infection (PSI) is a recognised postoperative complication that affects patient recovery and cosmetic outcomes. Reported incidence ranges between 1.4% and 5.8% across laparoscopic procedures. ^[14] Evidence suggests that PSIs are slightly more frequent with the open method, attributed to larger incision size and prolonged tissue manipulation. Nevertheless, gallbladder

extraction technique and bile spillage predict infection more strongly than entry method alone. [15] Preventive strategies, including meticulous surgical technique and adherence to aseptic protocols, remain essential regardless of entry choice.

Given these ongoing controversies, this study aimed to compare the safety of open versus closed methods for creating pneumoperitoneum. The secondary objectives were to evaluate differences in operating time and to assess the incidence of postoperative PSI between the two techniques in patients undergoing elective laparoscopic cholecystectomy. By systematically analysing these parameters, this study aims to provide evidence-based clarity on the relative merits and limitations of each approach.

MATERIALS AND METHODS

Study Design and Setting

This was a prospective interventional study conducted at Tripura Medical College and Dr. BRAM Teaching Hospital, Hapania, Tripura between March 2026 and May 2026. The study compared the open (Hasson) and closed (Veress needle) methods of creating pneumoperitoneum in patients undergoing elective laparoscopic cholecystectomy, with respect to safety, operating time, and PSI.

Study Population

Patients aged 18-60 years with a diagnosis of symptomatic gallstones or chronic cholecystitis scheduled for elective laparoscopic cholecystectomy were included.

Exclusion criteria:

- Emergency surgeries (acute cholecystitis with systemic sepsis)
- Umbilical hernia
- Previous extensive upper abdominal surgery (to avoid bias toward open entry)
- Pregnancy
- Morbid obesity (BMI >40 kg/m², optional exclusion depending on scope)

Operative Procedure

Surgeons of comparable experience performed all surgeries to reduce operator variability.

Group A: Closed Method (Veress Needle)-

A small infra-umbilical incision was made. The abdominal wall was lifted manually, and the Veress needle was inserted at a 45°–90° angle. Safety checks such as the “drop test” were performed to confirm intraperitoneal placement. Insufflation was initiated at low flow until intra-abdominal pressure reached 12–14 mmHg, followed by blind insertion of the primary 10 mm trocar.

Group B: Open Method (Hasson Technique)-

A 1.5–2 cm vertical or transverse infra-umbilical incision was made. Dissection was carried down to the linea alba, which was incised to expose the peritoneum under direct vision. Two stay sutures were placed, and a blunt-tip Hasson cannula was inserted and secured to prevent gas leakage. Insufflation was then commenced to achieve the target pressure of 12–14 mmHg.

Data Collection

Data were recorded in a standardised case report form (CRF) under three primary variables:

• Safety Metrics:

- **Vascular injury:** Major (Aorta/Vena Cava), Minor (Abdominal wall vessels)
- **Visceral injury:** Bowel perforation, Omental injury
- **Failed entry:** Number of attempts required (specifically for Veress needle)

• Operating Time:

- **Access time:** From skin incision to successful laparoscope insertion and visualisation of the liver
- **Total operative time:** From skin incision to final skin suture
- **Insufflation time:** Time taken to reach target intra-abdominal pressure (12–14 mmHg)

- **Port-Site Infection:** Patients were followed up on postoperative day 7. Infection was defined according to CDC criteria: purulent discharge, localised

pain/swelling/erythema, or positive wound culture.

withdraw at any stage without affecting their treatment.

Statistical Analysis

Categorical variables were summarised as frequencies and percentages. Continuous variables were summarised as mean $\pm$ standard deviation (SD) and as median with interquartile range (IQR). An independent samples t-test was run between the two groups for baseline comparability, access time and total time. The relationships of BMI, access time and total time were assessed using Pearson's correlation coefficient.

Ethical Considerations

Ethical clearance was obtained from the Institutional Ethics Committee of Tripura Medical College and Dr. BRAM Teaching Hospital. The researchers obtained written informed consent from all participants after explaining the purpose, procedures, risks, and benefits of the study in a language they understood. Patients retained the right to

RESULTS

Table 1 presents the baseline demographic characteristics of the two study groups, comparing participants undergoing the closed (Veress) and open (Hasson) techniques. Both groups had equal sample sizes ($n = 60$), and the mean body mass index (BMI) values were similar, with 28.43 ± 4.02 in the closed group and 28.64 ± 5.17 in the open group, indicating no significant difference. The median BMI was identical at 28.95, though the interquartile ranges showed slight variation between groups (26.1–30.8 for closed vs. 24.85–32.7 for open). The overall BMI range was also comparable, spanning 18.3–38.1 in the closed group and 17.4–37.3 in the open group. The p-value of 0.80 confirms that there was no statistically significant difference in BMI distribution between the two groups, suggesting that the baseline demographic profiles were well balanced.

Table 1: Baseline Demographic Characteristics of Study Groups

Group	n	Mean $\pm$ SD	Median (IQR)	Range	p-value
Closed	60	28.43 ± 4.02	28.95 (26.1 – 30.8)	18.3-38.1	0.80
Open	60	28.64 ± 5.17	28.95 (24.85 – 32.7)	17.4-37.3	

The comparison of access times between the two entry techniques shows a clear and statistically significant difference. In the closed group, the mean access time was 3.69 ± 0.90 minutes, with a median of 3.75 minutes and a range of 1.9–5.6 minutes. In contrast, the open group required considerably longer, with a mean of 6.87 ± 0.87 minutes, a median of 6.90 minutes, and

a range of 5.2–8.9 minutes. The p-value of <0.01 indicates that this difference is highly significant, confirming that the closed method allows faster entry into the peritoneal cavity compared to the open technique. This finding highlights the efficiency advantage of the Veress needle approach, even though it involves blind insertion (Table 2).

Table 2: Comparison of Access Time Between Closed (Veress) and Open (Hasson) Methods

Group	n	Mean $\pm$ SD	Median (IQR)	Range	p-value
Closed	60	3.69 ± 0.90	3.75	1.9-5.6	$<0.01^*$
Open	60	6.87 ± 0.87	6.90	5.2-8.9	

The comparison of total operative time between the closed and open techniques demonstrates that both approaches yielded nearly identical durations. The mean operative time was 71.15 ± 16.92 minutes in

the closed group and 71.78 ± 11.76 minutes in the open group, with median values of 77.0 minutes (IQR: 59.75–84.0) and 72.0 minutes (IQR: 65.0–80.0), respectively. The ranges were also comparable, spanning 27–96

minutes for the closed method and 39–96 minutes for the open method. The p-value of 0.81 indicates no statistically significant difference between the two groups. This suggests that although access time varied

considerably between techniques, the overall operative duration was unaffected, implying that intraoperative factors beyond entry method largely determined the total surgical time (Table 3).

Table 3: Comparison of Total Operative Time Between Closed and Open Techniques

Group	n	Mean $\pm$ SD	Median (IQR)	Range	p-value
Closed	60	71.15 $\pm$ 16.92	77.0 (59.75–84.0)	27-96	0.81
Open	60	71.78 $\pm$ 11.76	72.0 (65.0–80.0)	39-96	

The incidence of PSI on postoperative day 7 was very low in both groups, with no statistically significant difference observed. In the closed group, only 1 out of 60 patients developed PSI, corresponding to a rate of 1.69% (95% CI: 0.04–8.94). In the open group, 2 out of 60 patients experienced PSI, yielding a slightly higher rate of 3.44% (95%

CI: 0.41–11.53). The p-value of 1.00 indicates that this difference was not significant. These findings suggest that both entry techniques are associated with a very low risk of PSI, and neither method demonstrated a clear advantage over the other in terms of postoperative wound safety (Table 4).

Table 4: Incidence of Port-Site Infection on Postoperative Day 7

Group	PSI Present	PSI Absent	Rate %	95% CI	p-value
Closed (Veress)	1	59	1.69%	0.04-8.94	1.00
Open (Hasson)	2	58	3.44%	0.41-11.53	

The correlation analysis between BMI and operative parameters revealed no statistically significant associations. When data were pooled across both groups, BMI showed negligible correlation with access time ($r = 0.04$, $p = 0.83$) and only a weak, non-significant correlation with total operative time ($r = 0.14$, $p = 0.13$). Subgroup analyses yielded similar findings: in the closed group, BMI had a weak correlation

with total time ($r = 0.15$, $p = 0.26$) and a borderline but non-significant correlation with access time ($r = 0.25$, $p = 0.06$). In the open group, BMI correlations were minimal, with $r = 0.14$ ($p = 0.28$) for total time and $r = -0.12$ ($p = 0.37$) for access time. Overall, these results indicate that patient BMI did not meaningfully influence entry efficiency or overall surgery duration in this study population (Table 5).

Table 5: Correlation Between BMI and Operative Parameters

Comparison	Pearson r	p-value
BMI vs Access Time (pooled)	0.04	0.83
BMI vs Total Time (pooled)	0.14	0.13
BMI vs Total Time (Closed only)	0.15	0.26
BMI vs Access Time (Closed only)	0.25	0.06
BMI vs Total Time (Open only)	0.14	0.28
BMI vs Access Time (Open only)	-0.12	0.37

Analysis of entry-related safety outcomes showed complications only in the closed (Veress) group. Specifically, one major vascular injury, one minor vascular injury, and one visceral injury were recorded, while no failed entries were noted. In contrast, the

open (Hasson) group had no entry-related complications. Thus, the closed group had three safety events compared with none in the open group, highlighting a relative safety advantage of the open technique in this cohort (Table 6).

Table 6: Incidence of Entry-Related Safety Events

Group	Major Vascular Injury	Minor Vascular Injury	Visceral Injury (Bowel/Omentum/Bladder)	Failed Entry	Total Safety Events
Closed (Veress)	1	1	1	0	3
Open (Hasson)	0	0	0	0	0

DISCUSSION

The present study compared the open (Hasson) and closed (Veress needle) methods of creating pneumoperitoneum in laparoscopic cholecystectomy, focusing on safety, operating time, and PSI. Our findings demonstrated that while the closed technique offered significantly shorter access times, it was associated with three entry-related complications, whereas the open method had none. Total operative time and PSI rates were comparable between groups. These results contribute to the ongoing debate regarding the optimal entry technique in laparoscopic surgery.

The shorter access time observed with the closed method is consistent with previous reports that emphasise its efficiency in experienced hands. Nawaz et al. noted that the Veress needle technique reduced entry time compared to the Hasson method, particularly in high-volume centres where speed is valued.^[6] However, efficiency must be weighed against safety. In our cohort, the closed group recorded one major vascular injury, one minor vascular injury, and one visceral injury, underscoring the inherent risks of blind entry. This aligns with earlier literature suggesting that although rare, vascular and visceral injuries during closed entry can be catastrophic.^[16] In contrast, the open method, by virtue of direct visualisation, eliminated such complications in our study, supporting its reputation as the safer technique.^[17]

Interestingly, despite the significant difference in access time, total operative duration did not vary between groups. This suggests that intraoperative factors beyond entry - such as dissection difficulty, gallbladder extraction, and haemostasis - play a more decisive role in determining overall surgical time. Similar conclusions were drawn by Kumar et al., who found that

while entry technique influenced access time, it did not significantly alter total operative duration.^[12] Thus, surgeon preference for the closed method based solely on efficiency may be less compelling when considering the broader operative workflow.

PSI rates in our study were low and not significantly different between groups (1.69% vs 3.44%). This finding corroborates the view that PSI is multifactorial, influenced more by bile spillage, extraction technique, and aseptic practices than by entry method alone.^[18] Sasmal et al. highlighted that meticulous wound care and perioperative antibiotic prophylaxis are more critical determinants of PSI than the choice of entry technique.^[14] Our results reinforce this perspective, suggesting that both methods can achieve acceptable wound safety when standard infection-control protocols are followed.

The occurrence of three complications in the closed group, despite careful technique and experienced surgeons, highlights the importance of patient selection. Literature suggests that patients with prior abdominal surgery, suspected adhesions, or obesity may be particularly vulnerable to complications with blind entry.^[19] In such cases, the open method should be preferred. Moreover, emerging alternatives such as direct trocar insertion and ultrasound-guided Veress placement have been proposed to mitigate risks.^[20] These innovations may represent a middle ground, combining efficiency with enhanced safety.

From a clinical standpoint, our findings suggest that while the closed method may be faster, the open method offers superior safety, particularly in reducing entry-related complications. Given that even a single major vascular injury can be life-threatening, safety should remain the paramount consideration. As Raimondo et al.

emphasised, the choice of entry technique should be individualised, balancing efficiency with patient risk factors. [3] Our study supports this patient-centred approach, advocating for selective use of the open method in higher-risk cases.

Limitations and Future Directions

This study was limited by its single-centre design and relatively small sample size. Although randomisation and comparable surgeon experience reduced bias, larger multicentre trials would provide more generalisable evidence. Additionally, long-term outcomes such as incisional hernia rates and chronic port-site pain were not assessed. Future research should explore these parameters and evaluate newer entry techniques such as optical trocars and image-guided approaches. Incorporating advanced technologies may further refine the balance between safety and efficiency in laparoscopic entry.

CONCLUSION

In summary, the closed (Veress) method demonstrated faster access but was associated with three entry-related complications, whereas the open (Hasson) method was slower yet safer. Total operative time and PSI rates were similar between groups. These findings underscore that safety should take precedence over speed, and the open method may be preferable in patients at higher risk of entry-related injury. Ultimately, surgeon expertise, patient characteristics, and institutional protocols should guide the choice of entry technique.

Declaration

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