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Comparison of Outcomes of Creating Pneumoperitoneum via Supraumbilical versus Infraumbilical Incisions in Laparoscopic Procedures

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ABSTRACT

Objective: To compare the outcomes of pneumoperitoneum establishment via supraumbilical and infraumbilical incisions in laparoscopic surgery with respect to time for creation of pneumoperitoneum, postoperative complications, surgical site infection, analgesic use, pain score and port-site healing. **Study Design:** Randomize controlled trial. **Place and Duration of the Study:** Department of General Surgery, Sheikh Zayed Hospital, Rahim Yar Khan, from February 2025 to June 2025. **Methodology:** Eighty patients undergoing laparoscopic cholecystectomy, appendectomy and diagnostic laparoscopy were randomized into two groups after consent: Group A (supraumbilical incision) and group B (infraumbilical incision). Open (Hasson) technique was used to create the pneumoperitoneum. Operative and postoperative outcomes per group were documented and analyzed for statistical significance via SPSS version 26.0 and p-value ≤0.05 considered significant. **Results:** Although both groups were similar at baseline (p>0.05), the time needed to create pneumoperitoneum turned out noticeably shorter with the infraumbilical entry, roughly 146 seconds on average, compared with about 153 seconds for the supraumbilical approach (p=0.027). Pain levels after surgery, the need for analgesics, and rates of surgical site infection didn't differ much between the two sets of patients (p>0.05). By the seventh postoperative day, wounds at the port sites looked better healed in the infraumbilical group (p=0.001). Complications overall were rare and roughly the same in both groups (p=0.688). **Conclusion:** Both supraumbilical and infraumbilical incisions are safe and effective for creating pneumoperitoneum. Although, the infraumbilical approach offers advantage relatively in that it took shorter time to access the abdomen and had superior port site healing, without increasing postoperative pain or complications

INTRODUCTION

Laparoscopic surgery is one of the key developments of modern surgical care because of its minimal access time, less postoperative pain, and quicker recovery than open surgery [1, 2]. One of the critical steps of laparoscopy is the creation of a safe and effective pneumoperitoneum, because significant number of major complications occurs during entrance into the abdominal cavity [3]. Major vascular injury is reported to occur at about 2 per 10,000 attempts, with an estimated mortality of 3 per 100,000 procedures [4, 5].

Traditionally, the umbilical region has been favored for primary trocar placement site due to favorable anatomy that is thinner abdominal wall with minimal vascularity [6]. However, there is an ongoing debate about the appropriate level of incision (supraumbilical versus infraumbilical) for creating pneumoperitoneum. Both supraumbilical and infraumbilical incisions have theoretical advantages and disadvantages, but again, the evidence comparing the two concepts is still inconclusive [7].

In the supraumbilical technique, the incision is made just above the umbilical margin, while in the infraumbilical approach, it lies below it. Both require careful dissection and trocar insertion under direct vision to establish insufflation [8]. Although the procedures appear largely similar, minor anatomical distinctions and technical adjustments can influence the ease of trocar insertion, the safety of peritoneal access, and subsequent postoperative outcomes [9].

In Pakistan, laparoscopic surgery is now part of everyday surgical practice, whether in public hospitals or private centers. Still, there is no agreed national guideline about where the first port should go. Most surgeons

choose the site based on how they were trained or what has worked best in their own hands. The decision between a supraumbilical and an infraumbilical entry is, in that sense, more a matter of habit than protocol. What we know from international studies is useful but the gap in locally relevant data makes it hard to say which approach is truly safer or technically easier for our population.

If we talk about existing studies, the literature comparing these two entry sites remains inconclusive. Some studies have reported that infraumbilical access facilitates a faster creation of pneumoperitoneum and may be associated with lower postoperative pain scores. Others have found no significant differences in operative duration, port-site infection or complication rates. While local evidence comparing operative ease, safety, postoperative pain, wound infection and scar outcomes is lacking. By systematically comparing these parameters, this study aims to provide evidence-based guidance for surgeons in selecting the most suitable port placement strategy for routine laparoscopic procedures in our setting. The objective of this study is to compare the outcomes of creating pneumoperitoneum via supraumbilical and infraumbilical incisions in laparoscopic procedures in terms of time required for pneumoperitoneum creation, postoperative complications, surgical site infection, analgesic requirement, pain score and port-site healing.

METHODOLOGY

In this Randomize controlled trial, patients aged 16 to 50 years who were admitted to the Department of General Surgery, Sheikh Zayed Hospital Rahim Yar Khan, Pakistan for the purpose of undergoing laparoscopic cholecystectomy, appendectomy and diagnostic laparoscopy, from February 2025 to June 2025 were included. Patients scheduled for laparoscopic surgery were enrolled, but those on immunosuppressive therapy or classified as ASA grade IV-VI excluded.

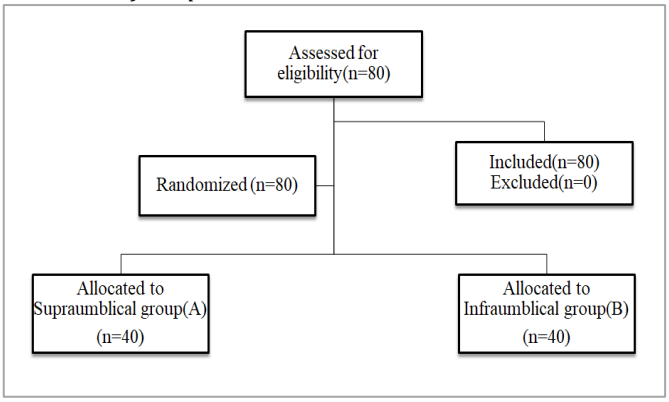
A sample size of 80 (40 in each group) was calculated by WHO calculator, taking an effect size of 0.5, $\alpha = 0.05$, and power = 80%. Patients were divided into two groups by a computer-generated random list. In group A, the pneumoperitoneum was made through a supraumbilical incision; in group B, it was created infraumbilically. Before inclusion, each patient was counseled about the procedure in simple terms and written consent was obtained. Ethical approval was secured from the Institutional Review Board (IRB).

Every patient had baseline tests, including chest x-rays, ultrasounds, serum urea and creatinine levels, complete blood counts and plain abdominal x-ray with electrocardiogram (ECG). Standard preoperative preparation was ensured by insertion of a nasogastric tube and Foley's catheter, along with intravenous fluid resuscitation during the initial hours of admission. Both procedures were standardized by performing them under general anesthesia. Furthermore, all patients in both groups received a prophylactic dose of 1 gram of Cefazolin one hour before surgery.

The open (Hasson) technique was used in all cases to create pneumoperitoneum. As described earlier by Kumar *et al.,* A small incision measuring about 1.5 to 2 cm was made at the predetermined site, either just above or below the umbilicus, according to the group assigned. [10]

Figure 1

Flowchart of the patient randomization



In patients of the supraumbilical group, the incision was placed just above the upper border of the umbilicus and carried carefully through the subcutaneous tissue until the anterior rectus sheath was exposed. The fascial layer was gently grasped and lifted, and the peritoneum was entered under direct vision. After confirming safe entry into the peritoneal cavity and ensuring that there were no adhesions or visceral injuries, a 10-mm trocar was introduced to establish the primary port. The trocar was secured in position with stay sutures placed at the fascial margins to maintain a tight seal and prevent gas leakage.

In patients of the infraumbilical group, a similar 1.5–2 cm incision was made just below the lower margin of the umbilicus. Dissection was carried down through the subcutaneous tissue until the linea alba was identified. The fascia was gently lifted with forceps, and the peritoneum was opened carefully under direct vision. Once the peritoneal cavity was entered and no adhesions were found, a 10-mm trocar was inserted to create pneumoperitoneum. The port was fixed with stay sutures to avoid gas leakage and keep it steady during the operation.

Postoperatively, all patients received the same pain control regimen. Intravenous paracetamol, 1 gram every six hours, was given routinely for the first day. If a patient still complained of pain, extra doses of intravenous toradol (50–100 mg) or an opioid were added according to the pain level on the Visual Analog Scale.

For each case, details such as age, sex, BMI, socioeconomic class and ASA score were recorded. The time taken to create pneumoperitoneum was measured in seconds. Pain in the recovery room was scored using VAS and the use of extra analgesia was noted. Any postoperative complication whether minor or major was also recorded. The wound was examined on day 3 and day 7 using the Vancouver Scar Scale to see healing and cosmetic results. Patients were followed daily until discharge, and wound infection was checked in both groups. Infection, when present, was graded as per the Surgical Site Assessment Criteria (SAC 2–4). All findings were entered into a predesigned proforma.

Data were analyzed using SPSS version 26 (IBM Corp., Armonk, NY, USA). Quantitative variables were described as mean ± SD or median (IQR), while qualitative variables

were given as frequencies and percentages. Chi-square test was applied for categorical variables and independent t-test for continuous data. A p-value < 0.05 was considered significant.

RESULTS

Total 80 patients were included in this trial with 40 in both groups. The baseline characteristics were comparable between the groups (Table I). In supraumbilical group, mean age was 34.90 ± 8.04 years and 34.83 ± 7.32 years in the infraumbilical group (p = 0.29). Gender distribution was identical, comprising 35% males and 65% females in both groups (p = 0.59). The mean body mass index (BMI) and socioeconomic scores also showed no significant difference (p = 0.56 and p = 0.32, respectively). Most patients in both groups were classified as ASA class II. The distribution of surgical procedures—including appendectomy, cholecystectomy, and diagnostic laparoscopy—did not differ significantly between the groups (p = 0.50).

During intraoperative assessment, the mean time required to establish pneumoperitoneum was significantly shorter in the infraumbilical group (145.80 ± 12.72 seconds) than in the supraumbilical group (152.63 ± 14.37 seconds) (p = 0.02), suggesting that infraumbilical entry provided slightly quicker access to the peritoneal cavity (Table II).

The postoperative pain scores were similar in the two groups (median = 4, p = 0.89). There was no significant difference between the number of analgesic doses required in the first 24 hours (p = 0.21). The scar evaluation by the Vancouver Scar Scale (VSS) revealed that the baseline and day 3 scores were similar in both the groups. However, the infraumbilical group had a better scar look on day 7, with the mean VSS score being lower (5.22 ± 1.19) as compared to the supraumbilical group (6.15 ± 1.10) (p = 0.01).

The prevalence of surgical-site infection (SAC 2-4) was similar between the two cohorts (p = 0.74). The majority of the patients had minor postoperative complications and there was no statistically significant difference in the occurrence of complications between them.

In general, the use of the infraumbilical route was linked with more rapid pneumoperitoneum creation and better early scar healing, while postoperative pain, infection and complication rates were similar in both groups.

Table I

Baseline Characteristics of the Patients

Variable	Group A (Supraumbilical) (Mean ± SD / n %)	Group B (Infraumbilical) (Mean ± SD / n %)	p-value
Age (years)	34.90 ± 8.044	34.83 ± 7.317	0.965[a]
Gender (Male/Female)	14 (35.0%) / 26 (65.0%)	14 (35.0%) / 26 (65.0%)	0.593[b]
BMI (kg/m^2)	28.067 ± 2.635	27.629 ± 3.896	0.558[a]
Socioeconomic Score	17.84 ± 2.183	18.33 ± 2.225	0.317[a]
ASA II/III	28 (70.0%) / 12 (30.0 %)	29 (72.5%)/ 11(27.5%)	0.500[b]
Procedure			
Appendectomy	12(15%)	12(15%)	
Cholecystectomy	19(23.8%)	21(26.3%)	0.839[c]
Diagnostic lap	9(11.3%)	7(8.8 %)	

[a] The data are presented as Mean ± SD. p: Independent t-test. A p-value ≤0.05 was considered statistically significant.
[b] Data are presented as frequency (%). p: Fisher's exact test. A p-value ≤ 0.05 was considered statistically significant
[c] Data are presented as frequency (%). p: Chi square test. A p-value ≤ 0.05 was considered statistically significant. ASA score= American Society of Anesthesiologists risk score

Table II

Intraoperative and Postoperative Findings

Variable	Group A (Supraumbilical)	Group B (Infraumbilical)	p-value
Time for creation of pneumoperitoneum (sec)	152.63 ± 14.37	145.800 ± 12.72	0.027[d]
Analgesic doses (24 h)	2.00(1)	2.00(2)	0.206[e]
Pain score (0–10)	4.00(2)	4.00(4)	0.387[e]
Vancouver Scar Scale – Baseline	2.00(1)	2.00(0)	0.106[e]
Vancouver Scar Scale – Day 3	6.00(2)	6.00(2)	0.393[e]
Vancouver Scar Scale – Day 7	6.00(2)	5.00(2)	0.001[e]
Surgical-site infection (SAC2–4)			
SAC2	5(6.3%)	4(5.0%)	0.848[f]
SAC3	9(11.3%)	11(13.8%)	
SAC4	26(32.5%)	25(31.3%)	
Post-operative complications (Minor/Major)			
Major	2(2.5%)	1(1.3%)	0.688[f]
Minor	4(5.0%)	6(7.5%)	
None	34 (42.5%)	33(41.3%)	

[d] The data are presented as Mean ± SD. p: Independent t-test. A p-value ≤ 0.05 was considered statistically significant.
[e] The data are presented as Median (IQR). p: Mann–Whitney U test. A p-value ≤ 0.05 was considered statistically significant.
[f] Data are presented as frequency (%). p: Chi square test. A p-value ≤ 0.05 was considered statistically significant.

DISCUSSION

This randomized controlled trial evaluated the differences between creating pneumoperitoneum via supraumbilical and infraumbilical incisions during laparoscopic surgeries. Results have demonstrated that the time taken for the establishment of the pneumoperitoneum was shorter when access was achieved through the infraumbilical area and also the early scar appearance was better, while postoperative pain, infection and complication rates did not show any significant differences between the two methods.

The two groups were also similar in terms of demographics and clinical parameters at baseline without any significant differences in age, gender distribution, body mass index, socioeconomic status or ASA grade. These similar baseline characteristics bolster the internal validity of the findings by reducing potential confounding variables.

The reason why the access time was shorter for the infraumbilical incision could be due to the anatomy of the area where a thinner fascial layer and the central depression of the umbilicus can help peritoneal opening. Several recent studies concluded the same. In their research, Mansouri et al. (2024) stated that an infraumbilical entry provided a more uniform tissue plane

and thus led to a shorter time of the insertion as compared to other levels of the umbilicus [11], whereas Barman et al. (2025) reported a lower number of unsuccessful attempts and a more rapid access through the same path [12]. However, Sentürk et al. (2018) found no significant difference in access time, suggesting that operator experience and patient habitus may influence these outcomes [13].

In the present study, postoperative pain and analgesic requirements showed no statistically significant difference between the two techniques. These results correspond with prior trials by Hiremath (2022) and Elmeligy (2020), which demonstrated that postoperative discomfort is mainly affected by the number and size of ports rather than the incision level used for entry [8, 14].

Early assessment of wound healing using the Vancouver Scar Scale revealed better scar appearance in the infraumbilical group at day 7. In contrast, Sentürk et al. (2018) observed no long-term cosmetic difference among infra-, supra-, and transumbilical techniques [13], whereas Kim et al. (2009) reported that supraumbilical incisions produced nearly invisible scars and higher satisfaction, especially among female patients [15]. These varying results probably indicate changes in the follow-up duration, patient factors and ways of evaluation. The initial appearance improvement in this study might be due to less tension and the infraumbilical wound being naturally hidden within the umbilical contour; nevertheless, a longer follow-up is necessary to find out whether this benefit stays.

In our study, surgical-site infection rates were comparable between supraumbilical and infraumbilical entries. This finding agrees with recent clinical studies indicating that, when aseptic precautions and secure fascial closure are ensured, the level of umbilical entry has minimal effect on postoperative infection [16,17]. Barman et al. (2025) reported similar results, emphasizing that wound infection is more closely related to patient factors and operative sterility than to incision level [12]. Some authors, however, have noted slightly lower infection rates with supraumbilical access, attributing this to reduced skin-fold contamination and better exposure [19].

Overall port-site complications in our series were low and comparable between both approaches, consistent with previously reported rates of 1–3% [18]. Most complications described in the literature, such as minor infections or hematomas, resolve conservatively and rarely correlate with entry site [17]. Ogaick and Martel (2014) also emphasized that the main factors leading to safety are the adherence to standard access protocols and the surgical skill, rather than the position of the incision [6]. All these results lead to the conclusion that the most important things for lessening the risk of access-related injuries are still careful entry under direct vision and thorough closure.

This trial's strengths lie in its randomized design, uniform operative protocol, and the utilization of a validated instrument for the objective evaluation of the scar. Additionally, the equal baseline characteristics of the two groups increase the reliability of the obtained results. Nevertheless, a few limitations of the study deserve consideration. The number of participants was sufficient only for detecting differences in access time and early scar appearance and could not be enough for identifying rare events such as trocar-site hernia. The follow-up time was just one week, so we could not evaluate the cosmetic results over a longer period. Besides, because of the single-center design, the results may not be typical of other surgical environments. There is a requirement for a future multi-center study with a larger number of patients and a longer follow-up time to confirm these findings.

CONCLUSION

The infraumbilical approach offers a quicker and simpler method to gain access to the peritoneal cavity without the patient experiencing more pain after surgery or the complication rates being elevated. Therefore, it might be the first choice for a laparoscopic procedure in cholecystectomy, appendectomy, and diagnostic laparoscopy.

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