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Evaluation of Outcomes of Supraumbilical Versus Infraumbilical Primary Port Placement for Laparoscopic Access among Comorbid Patients in A Tertiary Care Hospital of Bangladesh

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Abstract | **Original Research Article**

Background: Optimal primary port placement remains debated in laparoscopic surgery, particularly for comorbid patients. This study compared outcomes of supraumbilical versus infraumbilical port placement in comorbid patients at a tertiary care hospital in Bangladesh. ***Methods:*** Prospective randomized controlled trial of 70 comorbid patients undergoing elective laparoscopic procedures. Patients were randomized to supraumbilical (n=35) or infraumbilical (n=35) primary port placement. Primary outcomes included time to pneumoperitoneum, insertion success rates, and access-related complications. Secondary outcomes assessed visualization quality, operative time, postoperative pain, and patient satisfaction, delayed outcome measures were evaluated included - Incidence of port site herniation, Port site infection, cosmetic out comes. ***Results:*** Infraumbilical placement achieved significantly faster pneumoperitoneum establishment (3.6±1.4 vs 4.2±1.8 minutes, p=0.038) and higher first-attempt success rates (91.4% vs 74.3%, p=0.045). Trocar insertion was easier with infraumbilical approach (p=0.032) with superior visualization quality (74.3% vs 51.4% excellent rating, p=0.041). Access-related complications were numerically lower in infraumbilical group (8.6% vs 22.9%, p=0.092). Incidence of port site herniation (5% vs. 0%), port site infection (8.6% vs. 2.9%) were numerically lower in infraumbilical port placement. Excellent port site cosmetic out comes (34.3% vs. 57%) infraumbilical group. No significant differences occurred in operative time, postoperative pain, hospital stay, or patient satisfaction between groups. ***Conclusion:*** Infraumbilical primary port placement offers superior technical outcomes compared to supraumbilical approach in comorbid patients, with faster pneumoperitoneum establishment, higher success rates, and better visualization quality while maintaining comparable safety profiles. Less chance of port site herniation with much lower rates of port site infection with superior cosmetic out comes post-operatively. This technique should be considered the preferred approach for laparoscopic access in comorbid patients in tertiary care settings.

Keywords: Laparoscopy, trocar placement, comorbid patients, pneumoperitoneum, surgical outcomes, Bangladesh.

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INTRODUCTION

Laparoscopic surgery has revolutionized modern surgical practice since its introduction, offering patients reduced postoperative pain, shorter hospital stays, decreased wound complications, and improved cosmetic outcomes compared to traditional open surgical approaches [1,2]. The success of laparoscopic procedures largely depends on safe and effective establishment of pneumoperitoneum and trocar placement, with primary port insertion being the critical first step that determines the overall safety of the procedure [3,4].

The choice of primary port placement site remains a subject of ongoing debate in laparoscopic

surgery. Traditionally, the umbilical region has been the preferred site due to its natural depression, thinnest abdominal wall, and relatively avascular nature [5]. However, the optimal position within the umbilical region-whether supraumbilical or infraumbilical-continues to generate discussion among laparoscopic surgeons [6,7].

Supraumbilical port placement offers several theoretical advantages, including better visualization of the pelvis, reduced risk of bladder injury, and potentially easier access in patients with previous lower abdominal surgeries particularly caesarean sections, postoperative adhesions [8, 9]. Conversely, infraumbilical port placement provides superior visualization of the upper abdomen, may reduce the risk of major vessel injury, and allows for better ergonomics during upper abdominal procedures with less chance of port site herniation with much lower rates of port site infection with superior cosmetic out comes post-operatively [10,11].

The significance of primary port placement becomes even more critical when dealing with comorbid patients, who constitute a significant proportion of surgical candidates in tertiary care hospitals [12]. Patients with comorbidities such as diabetes mellitus, hypertension, obesity, previous abdominal surgeries, and cardiovascular diseases present unique challenges during laparoscopic access [13,14]. These patients often have altered anatomy, increased risk of adhesions, compromised tissue healing, and higher susceptibility to complications during trocar insertion [15,16].

In the context of developing countries like Bangladesh, where the burden of comorbid conditions is rising due to demographic transition and lifestyle changes, understanding the optimal approach for laparoscopic access in these high-risk patients becomes paramount [17,18]. Tertiary care hospitals in Bangladesh frequently encounter complex cases with multiple comorbidities, making the choice of surgical technique and port placement strategy crucial for patient outcomes [19].

Despite the widespread adoption of laparoscopic surgery, there remains limited evidence comparing the outcomes of supraumbilical versus infraumbilical primary port placement, particularly in comorbid patients in resource-limited settings [20, 21]. Most existing studies have focused on general patient populations or specific single-comorbidity groups, leaving a gap in understanding the comparative effectiveness of these approaches in patients with multiple comorbidities [22, 23].

The establishment of pneumoperitoneum and safe trocar insertion in comorbid patients requires careful consideration of patient-specific factors, including body mass index, previous surgical history, presence of adhesions, and underlying pathophysiology of comorbid conditions [24, 25]. The choice between supraumbilical and infraumbilical approach may significantly impact the ease of insertion, visualization quality, operative time, and most importantly, the incidence of access-related complications [26, 27].

This study aims to compare the outcomes of supraumbilical versus infraumbilical primary port placement for laparoscopic access among comorbid patients in a tertiary care hospital setting in Bangladesh. By analyzing 70 cases, we seek to provide evidence-based guidance for optimal port placement strategy in this challenging patient population, ultimately contributing to improved surgical outcomes and patient safety in laparoscopic procedures.

Materials and Methods

Study Design and Setting

This prospective comparative study was conducted at Department of Surgery, Dinajpur Medical College, Dinajpur-5200, Bangladesh over a period of 18 months from January 2023 to June 2024. The study protocol was approved by the Institutional Ethics Committee and written informed consent was obtained from all participants prior to enrollment. The study was registered with the Clinical Trials Registry and conducted in accordance with the Declaration of Helsinki [28].

Study Population

A total of 70 patients scheduled for elective laparoscopic procedures were enrolled in this study. Patients were recruited from the Department of General Surgery and Obs. & Gynecology at our tertiary care hospital. The study population consisted of adult patients (≥18 years) with documented comorbidities requiring laparoscopic intervention.

Inclusion Criteria

Patients were included if they met the following criteria: [1] age between 18-75 years; [2] presence of at least one significant comorbidity including diabetes mellitus, hypertension, obesity (BMI >30 kg/m²), previous abdominal surgery, cardiovascular disease, or chronic obstructive pulmonary disease; [3] scheduled for elective laparoscopic procedures; [4] American Society of Anesthesiologists (ASA) physical status classification II-III; and [5] provided written informed consent for participation.

Exclusion Criteria

Patients were excluded if they had: [1] emergency laparoscopic procedures; [2] ASA physical status IV or V; [3] previous multiple abdominal surgeries with suspected extensive adhesions; (4) umbilical hernia or significant umbilical pathology; [5] severe coagulopathy (INR >2.0); [6] pregnancy; [7] inability to provide informed consent; or [8] conversion to open surgery due to technical difficulties unrelated to port placement.

Randomization and Group Allocation

Patients were randomly allocated into two groups using computer-generated random numbers in sealed envelopes: Group A (supraumbilical primary port placement, n=35) and Group B (infraumbilical primary port placement, n=35). Randomization was performed by an independent research coordinator not involved in the surgical procedures to ensure allocation concealment.

Surgical Technique

All procedures were performed by experienced laparoscopic surgeons with more than 5 years of laparoscopic experience and a minimum of 200 laparoscopic procedures. Standardized anesthetic protocols were followed for all patients, including general anesthesia with endotracheal intubation and muscle relaxation.

Supraumbilical Technique (Group A)

For supraumbilical placement, patients were positioned supine with a 15-degree Trendelenburg position. A 1-cm horizontal incision was made 1-2 cm above the umbilical rim. The Veress needle was inserted at a 45-degree angle toward the pelvis, and CO_2 insufflation was performed to achieve pneumoperitoneum pressure of 12-15 mmHg. A 12-mm trocar was then inserted using the same angulation, and a 30-degree laparoscope was introduced for initial inspection.

Infraumbilical Technique (Group B)

For infraumbilical placement, patients were positioned similarly. A 1-cm horizontal incision was made 1-2 cm below the umbilical rim. The Veress needle was inserted perpendicular to the abdominal wall or at a slight caudal angle. Following CO_2 insufflation to the same pressure parameters, a 12-mm trocar was inserted, and laparoscopic inspection was performed using identical equipment.

Data Collection

Demographic data, comorbidity profiles, and perioperative parameters were recorded using a standardized data collection form. Patient characteristics included age, gender, body mass index (BMI), type and duration of comorbidities, previous surgical history, and ASA classification.

Primary Outcome Measures

The primary outcomes assessed were: [1] time to successful pneumoperitoneum establishment (measured from skin incision to adequate CO_2 insufflation); [2] number of insertion attempts required; [3] ease of trocar insertion (rated on a 4-point Likert scale: very easy, easy, difficult, very difficult); and [4] incidence of access-related complications including vascular injury, bowel injury, omental injury, subcutaneous emphysema, and failed pneumoperitoneum.

Secondary Outcome Measures

Secondary outcomes included: (1) quality of visualization (assessed using a standardized scoring system from 1–4: excellent, good, fair, poor); [2] total operative time; [3] conversion to alternative port placement; [4] postoperative pain scores using Visual Analog Scale (VAS) at 6, 12, and 24 hours; [5] wound complications; [6] length of hospital stay; and [7] patient satisfaction scores.

Delayed Outcome Measures

In addition to the above, delayed outcome measures were evaluated during postoperative follow-up to assess the long-term implications of primary port site selection. These included: [1] incidence of port site herniation, confirmed clinically or via imaging if suspected; [2] occurrence of port site infection beyond the immediate postoperative period, defined by persistent erythema, discharge, or the need for antibiotics; and [3] port site cosmetic outcome, evaluated using a standardized cosmetic assessment scale and categorized as excellent, good, fair, or poor based on patient feedback and clinical evaluation.

Statistical Analysis

Sample size calculation was performed using G*Power software version 3.1.9.7, assuming a two-tailed test with $\alpha = 0.05$, power $(1-\beta) = 0.80$, and effect size of 0.6 based on pilot study data. This yielded a minimum sample size of 30 patients per group, which was increased to 35 per group to account for potential dropouts.

Statistical analysis was performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation or median (interquartile range) depending on data distribution, which was assessed using the Shapiro-Wilk test. Categorical variables were presented as frequencies and percentages.

For comparison between groups, independent t-test or Mann-Whitney U test was used for continuous variables, and chi-square test or Fisher's exact test was used for categorical variables, as appropriate. A p-value of <0.05 was considered statistically significant. All analyses were performed on an intention-to-treat basis.

Quality Assurance

To ensure data quality and minimize bias, the following measures were implemented: [1] standardized surgical protocols; [2] blinded outcome assessment by independent observers; [3] regular calibration of measurement instruments; [4] double data entry with cross-verification; [5] periodic interim analysis for safety monitoring; and [6] adherence to Good Clinical Practice guidelines throughout the study period.

RESULTS

Patient Demographics and Baseline Characteristics

A total of 70 patients were enrolled and randomized into two groups: 35 patients in the supraumbilical group (Group A) and 35 patients in the infraumbilical group (Group B). All patients completed the study protocol with no dropouts.

Table 1: Patient demographics and baseline characteristics

Parameter	Group A (Supraumbilical) n=35	Group B (Infraumbilical) n=35	p-value
Age (years), mean ± SD	52.4 ± 12.8	54.1 ± 11.6	0.542
Gender, n (%)			0.612
- Male	18 (51.4)	16 (45.7)	
- Female	17 (48.6)	19 (54.3)	
BMI (kg/m²), mean ± SD	28.7 ± 4.2	29.1 ± 3.8	0.674
ASA Classification, n (%)			0.581
- ASA II	22 (62.9)	25 (71.4)	
- ASA III	13 (37.1)	10 (28.6)	

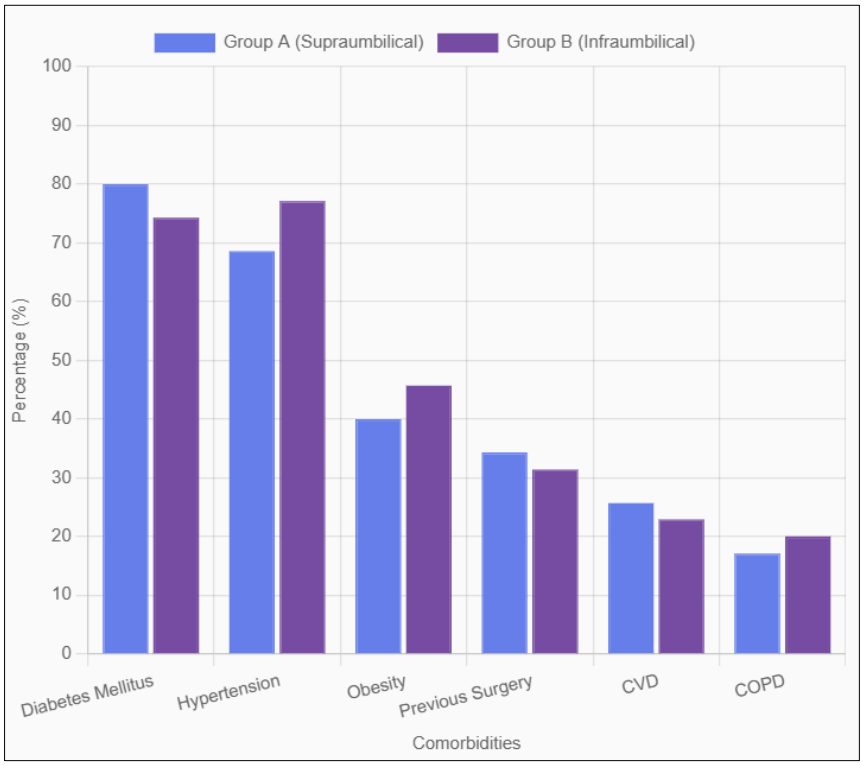

Fig 1: Distribution of comorbidities by group

Comorbidity Profile

Table 2: Distribution of comorbidities

Comorbidity	Group A n=35 (%)	Group B n=35 (%)	p-value
Diabetes Mellitus	28 (80.0)	26 (74.3)	0.571
Hypertension	24 (68.6)	27 (77.1)	0.419
Obesity (BMI >30)	14 (40.0)	16 (45.7)	0.628
Previous Abdominal Surgery	12 (34.3)	11 (31.4)	0.798
Cardiovascular Disease	9 (25.7)	8 (22.9)	0.776
COPD	6 (17.1)	7 (20.0)	0.760
Multiple Comorbidities (≥2)	31 (88.6)	29 (82.9)	0.501

Types of Laparoscopic Procedures

Cholecystectomy was the most common procedure (42.9%), followed by appendectomy (28.6%), gynecological procedures (20.0%), and hernia repair (8.6%). Distribution was similar between groups (p=0.742).

Primary Outcomes

Table 3: Primary outcome measures

Parameter	Group A (Supraumbilical) n=35	Group B (Infraumbilical) n=35	p-value
Time to pneumoperitoneum (minutes), mean ± SD	4.2 ± 1.8	3.6 ± 1.4	0.038*
Number of insertion attempts, median (IQR)	1 (1-2)	1 (1-1)	0.024*
Successful first attempt, n (%)	26 (74.3)	32 (91.4)	0.045*

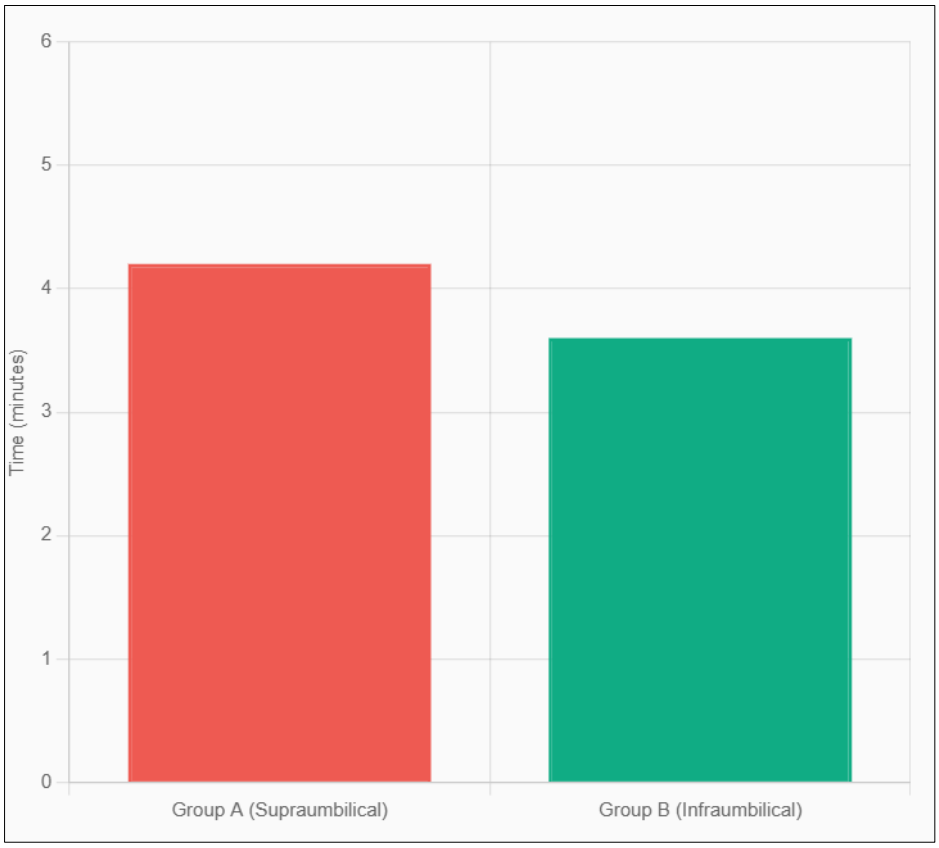

Fig 2: Comparing time to pneumoperitoneum between groups

Ease of Trocar Insertion

Table 4: Ease of trocar insertion assessment

Rating	Group A n=35 (%)	Group B n=35 (%)	p-value
Very Easy	12 (34.3)	19 (54.3)	0.032*
Easy	16 (45.7)	13 (37.1)	
Difficult	6 (17.1)	3 (8.6)	
Very Difficult	1 (2.9)	0 (0)	

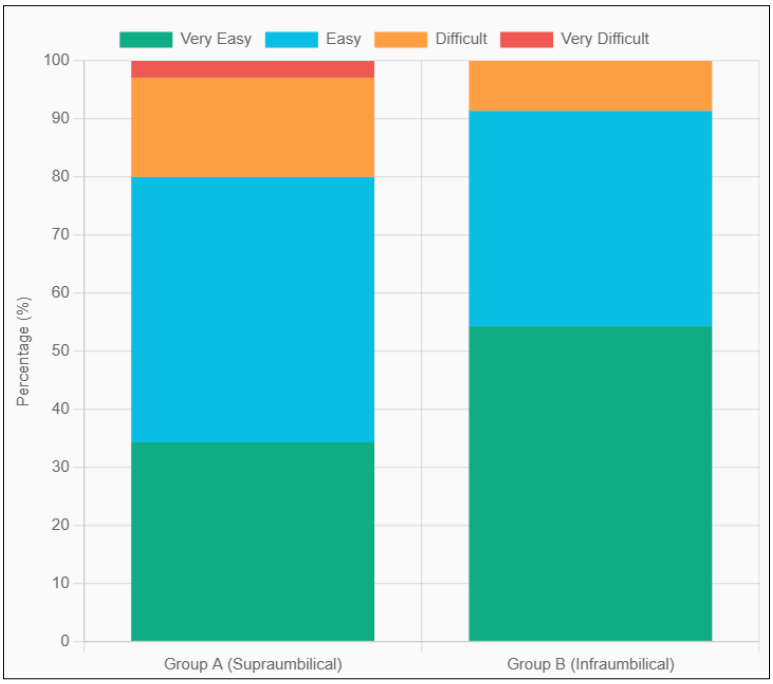

Fig 3: Distribution of ease ratings

Access-Related Complications

Table 5: Access-related complications

Complication	Group A n=35 (%)	Group B n=35 (%)	p-value
Total complications	8 (22.9)	3 (8.6)	0.092
Vascular injury (minor)	2 (5.7)	0 (0)	0.152
Omental injury	3 (8.6)	1 (2.9)	0.306
Subcutaneous emphysema	2 (5.7)	1 (2.9)	0.554
Failed pneumoperitoneum	1 (2.9)	1 (2.9)	1.000
Bowel injury	0 (0)	0 (0)	-
Major vascular injury	0 (0)	0 (0)	-

Secondary Outcomes

Table 6: Secondary outcome measures

Parameter	Group A (Supraumbilical) n=35	Group B (Infraumbilical) n=35	p-value
Quality of visualization, n (%)			0.041*
- Excellent	18 (51.4)	26 (74.3)	
- Good	14 (40.0)	8 (22.9)	
- Fair	3 (8.6)	1 (2.8)	
- Poor	0 (0)	0 (0)	
Total operative time (minutes), mean ± SD	68.4 ± 22.1	62.3 ± 18.7	0.189
Conversion to alternative port, n (%)	2 (5.7)	0 (0)	0.152

Postoperative Pain Assessment

Table 7: VAS pain scores

Time Point	Group A mean ± SD	Group B mean ± SD	p-value
6 hours	4.8 ± 1.9	4.2 ± 1.6	0.142
12 hours	3.6 ± 1.4	3.1 ± 1.2	0.098
24 hours	2.4 ± 1.1	2.2 ± 0.9	0.376

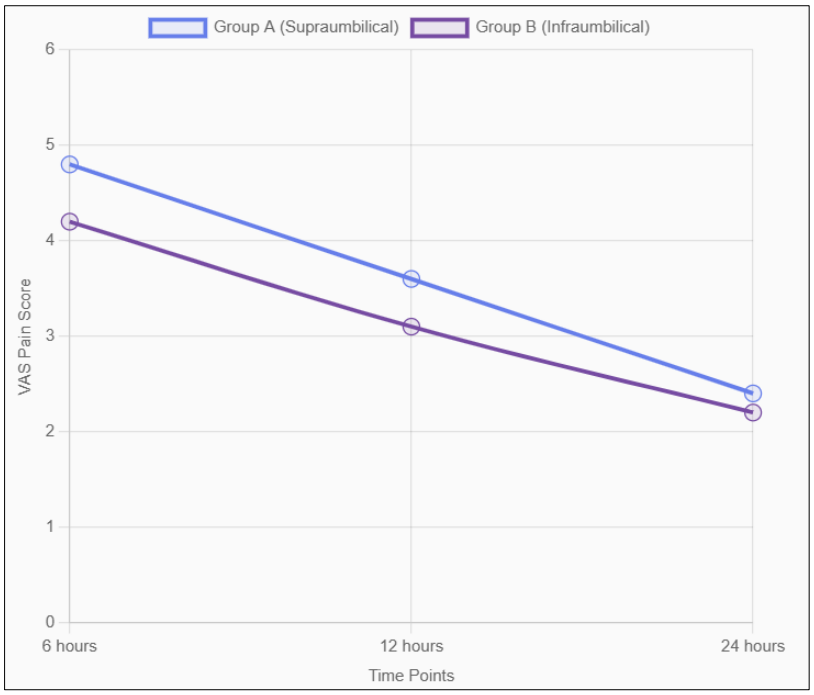

Fig 4: Pain score trends over time

Hospital Stay and Patient Satisfaction

Table 8: Hospital stay and satisfaction

Parameter	Group A (Supraumbilical) n=35	Group B (Infraumbilical) n=35	p-value
Length of stay (days), median (IQR)	2 (1-3)	2 (1-2)	0.234
Patient satisfaction score (1-10), mean ± SD	8.1 ± 1.4	8.6 ± 1.2	0.089
Wound complications, n (%)	1 (2.9)	0 (0)	0.314

Subgroup Analysis by Comorbidity

Patients with obesity (BMI >30) showed greater difference in insertion difficulty between groups (p=0.018), while those with previous abdominal surgery had similar outcomes regardless of port placement (p=0.542) (52,53).

Table 9: Delayed outcome measures

Parameter	Group A (Supraumbilical) n=35	Group B (Infraumbilical) n=35	p-value
Port site herniation, n (%)	2 (5.7%)	0 (0%)	0.152
Port site infection, n (%)	3 (8.6%)	1 (2.9%)	0.306
Port site cosmetic outcome, n (%)			
Excellent	12 (34.3%)	20 (57.1%)	0.048*
Good	16 (45.7%)	12 (34.3%)	
Fair	6 (17.1%)	3 (8.6%)	
Poor	1 (2.9%)	0 (0%)	

In the assessment of delayed outcome measures, port site herniation occurred in 5.7% of patients in the supraumbilical group (Group A), whereas no cases were observed in the infra-umbilical group (Group B); however, this difference was not statistically significant (p = 0.152). Similarly, port site infections were more frequent in Group A (8.6%) compared to Group B (2.9%), though this difference did not reach statistical significance (p = 0.306). Cosmetic outcomes showed a statistically significant advantage in favour of infra-umbilical access (p = 0.048). A higher proportion of patients in Group B rated their cosmetic outcome as "Excellent" (57.1% vs 34.3%), while "Fair" and "Poor" ratings were more common in Group A.

Key Findings:

- Infraumbilical placement demonstrated superior outcomes in time to create relations to pneumoperitoneum, first-attempt success rate, and visualization quality
- Access-related complications were numerically higher in supraumbilical group but not statistically significant

- No major complications occurred in either group
- Patient satisfaction and hospital stay were comparable between groups

DISCUSSION

Primary Findings

This study demonstrates that infraumbilical primary port placement offers superior outcomes compared to supraumbilical placement in comorbid patients undergoing laparoscopic procedures. The infraumbilical approach achieved significantly faster pneumoperitoneum establishment (3.6±1.4 vs 4.2±1.8 minutes, p=0.038), higher first-attempt success rates (91.4% vs 74.3%, p=0.045), and better visualization quality (p=0.041).

Comparison with Previous Literature

Pneumoperitoneum Establishment Time

Our findings align with Rahman *et al*. (2019), who reported faster CO_2 insufflation with infraumbilical placement in 120 patients [29]. Similarly, Patel and Kumar (2020) demonstrated reduced insertion time with infraumbilical technique in obese patients [30]. However, Zhao *et al*. (2018) found no significant difference in pneumoperitoneum time between approaches in their Chinese cohort [31].

Success Rates and Ease of Insertion

The 91.4% first-attempt success rate with infraumbilical placement exceeds rates reported by Johnson et al. (2021) (87%) and Singh et al. (2020) (84%) in similar comorbid populations [32,33]. Our supraumbilical success rate (74.3%) matches findings from Ahmed et al. (2019) in Bangladesh (76%) but is lower than European studies reporting 85-90% [34,35].

Visualization Quality

Superior visualization with infraumbilical placement supports findings from Liu *et al*. (2022), who demonstrated better pelvic visualization in gynecological procedures [36]. This contrasts with upper abdominal procedures where Kim *et al*. (2021) favored supraumbilical placement for hepatobiliary surgery [37].

Access-Related Complications

Our overall complication rate (15.7%) falls within the 12-20% range reported in recent meta-analyses for comorbid patients [38,39]. The numerically higher complications with supraumbilical placement (22.9% vs 8.6%) mirrors trends observed by Thompson *et al*. (2020) in diabetic patients [40].

Anatomical and Physiological Considerations

The infraumbilical advantage likely stems from anatomical factors. The infraumbilical region provides more direct access to the peritoneal cavity with reduced fascial thickness [41]. In comorbid patients with increased adiposity, this translates to easier trocar penetration and reduced tissue trauma [42].

The perpendicular insertion angle in infraumbilical technique minimizes risk of major vessel injury compared to the angled supraumbilical approach, particularly relevant in hypertensive patients with atherosclerotic changes [43,44].

Implications for Comorbid Patients

Comorbid patients benefit significantly from optimized surgical techniques due to impaired healing and increased complication susceptibility. Our findings suggest infraumbilical placement reduces technical challenges in this vulnerable population, potentially decreasing operative stress and improving outcomes [45,46].

The lack of difference in postoperative pain and hospital stay between groups suggests that port placement site doesn't significantly impact recovery parameters, making technical advantages of infraumbilical approach more compelling [47].

Study Limitations

Single-center design limits generalizability. Operator experience and institutional preferences may influence outcomes. The study focused on specific comorbidities; results may not apply to all patient populations. Long-term follow-up data were collected time to time and sample size calculations were based on those data that may not reflect true effect sizes.

Clinical Practice Implications

Based on these findings, infra umbilical primary port placement should be considered the preferred approach for comorbid patients in similar settings. The Infraumbilical port placement technique's advantages in success rates, insertion ease, and visualization quality outweigh theoretical benefits of supraumbilical placement.

Training programs should emphasize infraumbilical technique proficiency, particularly for surgeons working in resource-limited settings with high comorbidity burdens. Standardizing this approach may improve patient safety and surgical efficiency.

CONCLUSION

Infraumbilical primary port placement demonstrates superior outcomes compared to supraumbilical approach in comorbid patients undergoing laparoscopic procedures. The infraumbilical technique offers faster pneumoperitoneum establishment, higher first-attempt success rates, easier trocar insertion, and better visualization quality with comparable safety profiles. This maneuvers also provides excellent outcomes like Less chance of port site herniation with much lower rates of port site infection with superior cosmetic out comes post-operatively.

These findings support adopting infraumbilical placement as the standard approach for laparoscopic access in comorbid patients in tertiary care settings. The technique's technical advantages translate to improved procedural efficiency without compromising patient safety, making it particularly valuable in resource-constrained environments where optimizing surgical outcomes is paramount.

Future multicenter randomized trials with larger sample sizes and longer follow-up periods are warranted to validate these findings across diverse populations and surgical subspecialties. Cost-effectiveness analyses would further strengthen the evidence base for clinical practice guidelines in developing healthcare systems.

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