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# Comparison of Ergonomics of Epigastric Port Placement in Relation to the Falciform Ligament in Laparoscopic Cholecystectomy

Running Title: Epigastric Port Ergonomics in Laparoscopic Cholecystectomy

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**Abstract:** ***Background: Epigastric port placement during laparoscopic cholecystectomy affects instrument triangulation and working ergonomics. The optimal position in relation to the falciform ligament remains variable. Aim: To compare ergonomic measurements and selected perioperative outcomes between epigastric port placement to the left and right of the falciform ligament. Methods: This comparative study included 40 adults undergoing standard four-port laparoscopic cholecystectomy at Government Medical College and Associated Group of Hospitals, Kota, Rajasthan, between October 2023 and December 2024. Twenty patients underwent left-of-falciform placement and 20 underwent right-of-falciform placement. Outcomes included manipulation and azimuth angles, port-to-port and port-to-target distances, port insertion time, operative time and hospital stay. Results: Mean manipulation angle was 60.0° (SD 0) in the left-sided group and 105.5° (SD 6.05) in the right-sided group (reported p<0.001). Mean azimuth angle 1 was 30.0° (SD 0) versus 80.25° (SD 7.34; p<0.001); azimuth angle 2 was 30.0° versus 32.0° (p=0.095). Mean epigastric port insertion time was 33.5 versus 37.5 seconds (p=0.023). Operative time (92.5 versus 100.5 minutes; p=0.219) and hospital stay (3.65 versus 3.85 days; p=0.651) did not differ significantly. Conclusion: Left-of-falciform placement was associated with a manipulation angle of 60°, more symmetrical reported azimuth angles and shorter port insertion time. No statistically significant differences were observed in operative time or hospital stay. The findings should be interpreted cautiously pending verification against the original dataset.***

**Keywords:** Laparoscopic cholecystectomy; epigastric port; falciform ligament; ergonomics; manipulation angle; azimuth angle.

## 1. Introduction

Laparoscopic cholecystectomy is an established procedure for symptomatic gallstone disease. Instrument movement in minimally invasive surgery is constrained by fixed fulcrums, limited tactile feedback and a restricted range of motion. Port position therefore influences triangulation, instrument collision, posture and perceived effort. The epigastric working port is particularly important during dissection of the hepatocystic triangle and gallbladder bed [1, 2, 10].

Conventional epigastric port placement is commonly performed to the right of the falciform ligament, although left-sided placement has been proposed as an alternative that may improve instrument geometry [5]. The "baseball diamond" concept emphasizes a manipulation angle of approximately 60° and balanced azimuth angles around the camera port. Previous ergonomic studies have evaluated manipulation angles, port locations and instrument geometry [7–9,12,13]. This study compares reported ergonomic measurements and selected perioperative outcomes between left- and right-of-falciform epigastric port placement.

## 2. Aim and Objectives

The aim was to compare left- and right-of-falciform epigastric port placement during laparoscopic cholecystectomy. The stated objectives were to compare subjective ease of dissection; manipulation and azimuth angles; distances between ports and the target; epigastric port insertion time; operative duration; hospital stay; and reported complications.

## 3. Materials and Methods

### Study Design and Setting

The supplied study record describes a comparative case-control study conducted in the Department of General Surgery, Government Medical College and Associated Group of Hospitals, Kota, Rajasthan, India, from October 2023 to December 2024 (14 months). Forty participants were included, with 20 patients in each group. The source document states that ethics committee clearance was obtained; the committee name, approval number and approval date were not provided in the manuscript source and must be inserted after verification.

### Participants

Inclusion criteria were age above 18 years and chronic calculous cholecystitis. Exclusion criteria were acute cholecystitis, uncontrolled diabetes mellitus, uncontrolled hypertension, deranged coagulation profile, age below 18 years, suspected malignancy, previous abdominal surgery and pregnancy.

### Port Placement and Operative Approach

All patients underwent standard four-port laparoscopic cholecystectomy. The epigastric port site was planned by

measuring the xiphoid-to-umbilicus distance, marking two-thirds of that distance, and then marking a point 4–5 cm lateral to the midline. In the study group, a 10-mm epigastric port was placed to the left of the falciform ligament; in the control group, it was placed to the right.

**Outcomes and Statistical Analysis**

Recorded outcomes included age, hospital stay, epigastric port insertion time, manipulation angle, azimuth angles 1 and 2, optical-to-epigastric port distance, target-to-epigastric port distance and operative duration. The source document reports use of independent-samples t-tests in SPSS. Values originally printed as p=0.000 are conventionally presented as p<0.001. The version supplied did not specify the SPSS version, the precise method used to measure angles, assessor blinding, allocation sequence or handling of missing data; these details should be confirmed from the study protocol and original records.

## 4. Results

Forty patients were included: 20 in the left-of-falciform group and 20 in the right-of-falciform group. Mean age was 38.35 years (SD 12.76) in the left-sided group and 40.00 years (SD 13.63) in the right-sided group. The reported outcome summaries are shown in Table 1.

**Table 1:** Summary statistics transcribed from the supplied study document. *The source reports p=0.000; values are conventionally presented as p<0.001

| Outcome | Left of ligament (n=20), mean ± SD | Right of ligament (n=20), mean ± SD | p value |
|---|---|---|---|
| Hospital stay (days) | 3.65 ± 1.42 | 3.85 ± 1.35 | 0.651 |
| Epigastric port insertion time (s) | 33.5 ± 5.16 | 37.5 ± 5.50 | 0.023 |
| Manipulation angle (°) | 60.0 ± 0.00 | 105.5 ± 6.05 | <0.001* |
| Azimuth angle 1 (°) | 30.0 ± 0.00 | 80.25 ± 7.34 | <0.001* |
| Azimuth angle 2 (°) | 30.0 ± 0.00 | 32.0 ± 5.23 | 0.095 |
| Optical–epigastric port distance (cm) | 6.375 ± 0.76 | 15.35 ± 0.75 | <0.001* |
| Target–epigastric port distance (cm) | 13.4 ± 1.23 | 6.85 ± 0.78 | <0.001* |
| Operative time (min) | 92.5 ± 18.46 | 100.5 ± 21.88 | 0.219 |

The optical-to-epigastric port distance was reported as 5.0–7.5 cm and the target-to-epigastric port distance as 11–15 cm in the left-sided group. Corresponding distances in the right-sided group were 14–17 cm and 5.5–8 cm, respectively.

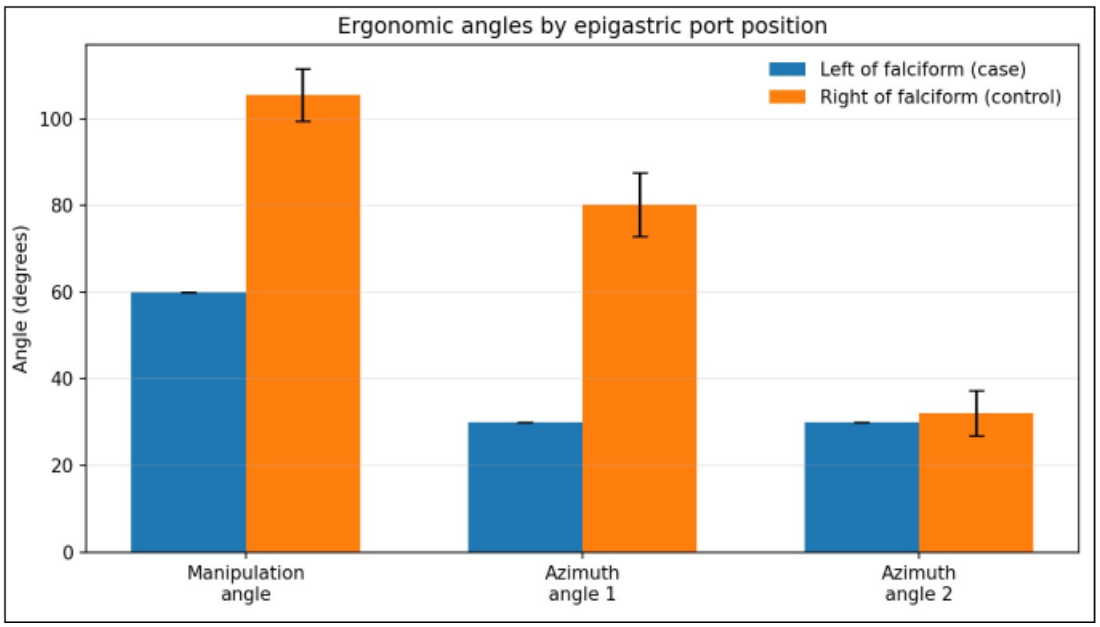



**Figure 1:** Reported mean manipulation and azimuth angles; error bars represent reported standard deviations

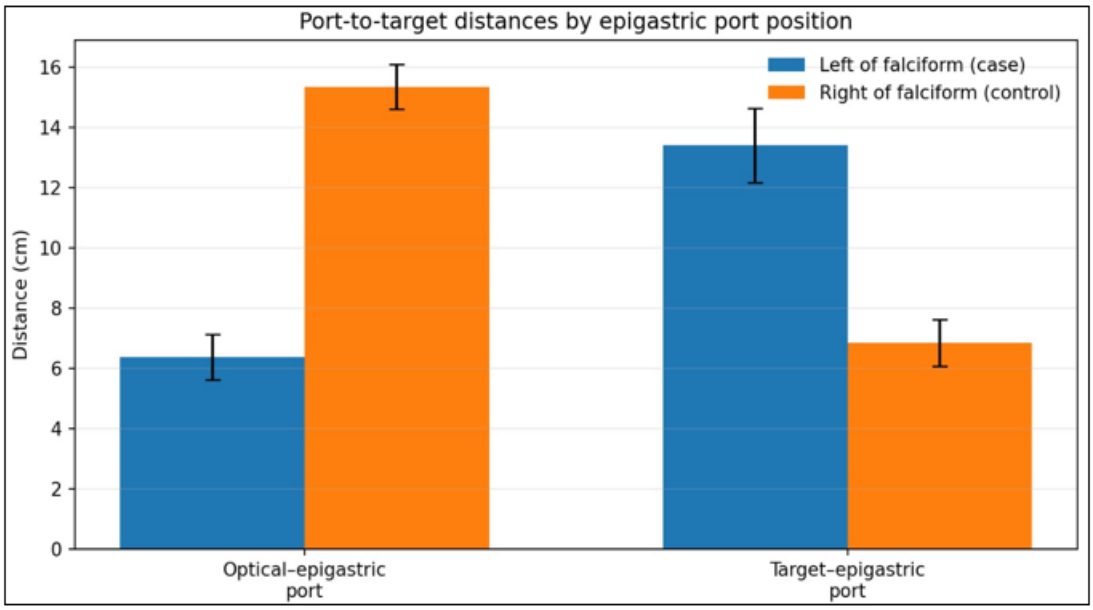



**Figure 2:** Reported mean distances between optical port, epigastric port and target; error bars represent reported standard deviations

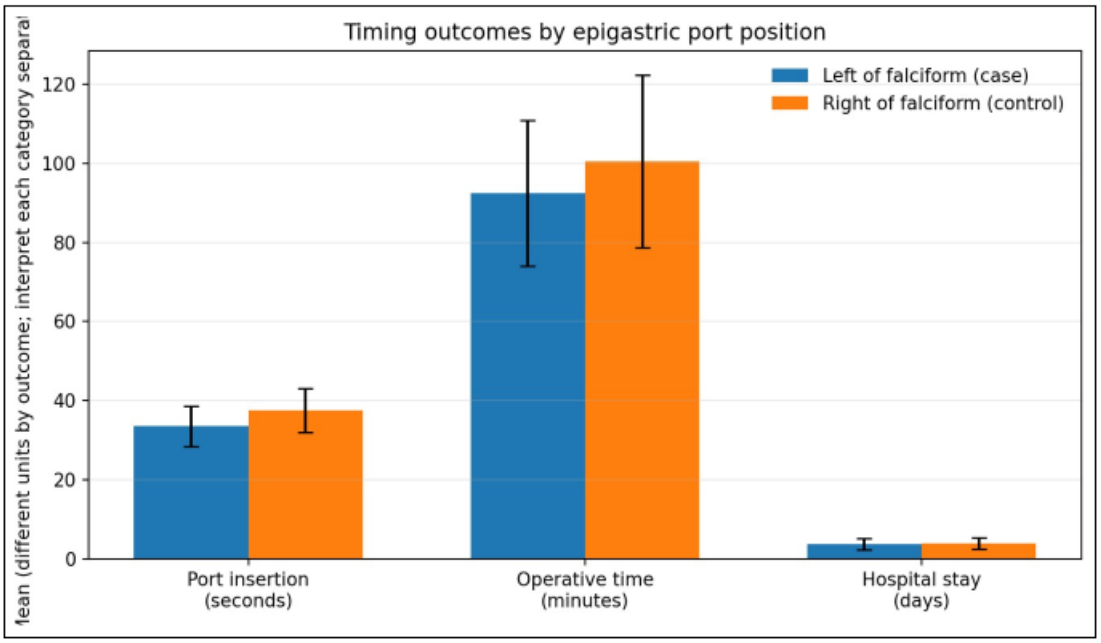



**Figure 3:** Timing and hospital-stay outcomes. Units differ between categories; comparisons should be made within each category

## 5. Discussion

In the reported results, left-of-falciform placement was associated with a mean manipulation angle of 60°, compared with 105.5° for right-sided placement. The left-sided group had azimuth angles of 30° and 30°, while the right-sided group had means of 80.25° and 32°. These measurements are consistent with the ergonomic rationale that a manipulation angle near 60° and more balanced azimuth angles may facilitate instrument movement during laparoscopic tasks [5,7–9,12,13].

Epigastric port insertion was faster in the left-sided group (33.5 versus 37.5 seconds; p=0.023). However, the difference in operative duration (92.5 versus 100.5 minutes; p=0.219) and hospital stay (3.65 versus 3.85 days; p=0.651) was not statistically significant. Thus, the reported findings demonstrate differences in geometric measurements and port insertion time, but do not establish an improvement in overall operative efficiency or postoperative recovery.

Potential disadvantages described in the source include concern about gallbladder or stone spillage if a retrieval bag is not used, the need to close the epigastric port separately if conversion to open surgery is required, and unfamiliarity among surgeons accustomed to a different port site. These considerations should be balanced against any ergonomic benefit. Safe dissection, adequate exposure and achievement of the critical view of safety remain the priorities.

## 6. Limitations

The sample was small, with 20 patients per group. The allocation method is not described in sufficient detail, and

subjective ease of dissection and complications are not quantified in the reported results. The source document also contains internal inconsistencies: its sex-distribution table totals 21 participants in the case group despite a stated group size of 20, and one discussion passage refers to NSCB Medical College, Jabalpur although the methods identify Government Medical College, Kota. In addition, zero standard deviations for some angle measurements suggest that these values may have been fixed by the port-placement method rather than independently observed. The master chart, case records and statistical output must be audited before submission.

## 7. Conclusion

In this 40-patient comparative study, left-of-falciform epigastric port placement was associated with a manipulation angle of 60° and equal azimuth angles of 30°, compared with a mean manipulation angle of 105.5° and azimuth angle 1 of 80.25° with right-sided placement. Port insertion time was shorter in the left-sided group, whereas operative duration and hospital stay did not differ significantly. Larger, methodologically rigorous studies using clearly defined and validated ergonomic outcomes and audited data are required before these findings can be generalized.

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