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Umbilical Trochar Site is the Usual Suspect for Trocar Site Hernia After Laparoscopic Cholecystectomy: A Prospective Study

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ABSTRACT

Introduction: Trocar site hernia (TSH) is a rare but clinically significant complication of laparoscopic cholecystectomy (LC). This study aimed to evaluate the association between gallbladder retrieval site selection and postoperative TSH incidence.

Methods: In this prospective, randomized study, 110 patients undergoing LC were allocated to either the umbilical (n=55) or epigastric (n=55) gallbladder retrieval groups. Surgical techniques and postoperative management were standardized. Patients were followed for one year, with routine ultrasonography performed at 6 and 12 months regardless of symptoms. The primary outcome was the level of TSH. Secondary outcomes included postoperative pain and retrieval time.

Results: Fifty patients in each group were included in the final analysis. TSH occurred in 6 patients (12%) in the umbilical group and 5 patients (10%) in the epigastric group (p=1.00), with all hernias located at the umbilical site for both groups. Gallbladder retrieval time was significantly shorter in the epigastric group (p=0.013), whereas the umbilical retrieval was associated with significantly lower pain at 6 hours postoperatively (p=0.027). Multivariate analysis identified extraction site widening as the only independent risk factor for TSH (odds ratio =4.08, p=0.05).

Conclusion: The site of extraction did not significantly influence TSH rates, which consistently occurred at the umbilical site. Epigastric extraction shortened retrieval time but was associated with slightly higher early postoperative pain. Standardizing the technique and minimizing fascial dilation appear critical for reducing the risk of TSH. Future studies should explore the role of a 5-mm umbilical trocar to further mitigate hernia development.

Keywords: Trocar site hernia, incisional hernia, port site hernia, laparoscopic cholecystectomy

Introduction

Laparoscopic cholecystectomy (LC) is one of the most commonly performed surgeries worldwide and remains the most frequent laparoscopic procedure. It is primarily indicated for gallstones, gallstone pancreatitis, acute cholecystitis, and gallbladder polyps (1). Although LC is considered a minimally invasive technique, it is not without complications-some of which can be severe or even fatal (2).

Trocar site hernia (TSH), a herniation occurring at a trocar site after laparoscopic surgery, is a relatively rare but significant postoperative complication. Despite its low incidence, TSH can markedly increase patient morbidity by necessitating reoperation, increasing readmissions and costs, and ultimately diminishing the benefits of minimally invasive surgery. Reported TSH incidence rates vary widely, ranging from 1% to 25% (3-5). Clinically, TSH may present as a palpable lump, pain, skin discoloration, or thinning at the trocar site. In some cases, it may remain asymptomatic until complications such as incarceration occur (6).

To mitigate the risk of TSH, various preventive strategies have been proposed. Routine closure of fascial defects larger than 10 mm is a standard practice (7). Additionally, the use of bladeless trocars and smaller-diameter trocars (e.g., 5 mm) has been associated with a reduced TSH risk (8,9).

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Several risk factors for TSH have been well documented. Among them, the organ extraction phase of the surgery may exert additional mechanical stress on the trocar site, potentially enlarging fascial defects and increasing the likelihood of hernia formation (10).

Previous studies examining risk factors for TSH have largely been retrospective, with inconsistent follow-up and limited focus on the choice of extraction trocar site. In this study, we conducted a prospective cohort analysis to evaluate the association between TSH and the location of the organ extraction trocar. By controlling for known confounders, comparing umbilical and epigastric extraction sites, and incorporating extended follow-up, we aimed to provide more robust and clinically relevant evidence regarding this underexplored factor.

Methods

Study Ethics

The study was approved by the University of Health Sciences Türkiye, Ümraniye Training and Research Hospital, Clinical Research Ethics Committee (approval number: 106, date: 31.03.2022), and the study was registered with ClinicalTrials.gov (Study Id: NCT06953713). All procedures were conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all patients for participation in and publication of the study. This study was conducted and reported in accordance with the CONSORT guidelines.

Study Design

One hundred and ten patients were enrolled in this two-arm study (n=55 per group). A power analysis was conducted to determine the required sample size for detecting a difference in incisional hernia rates between the two groups (umbilical vs. epigastric retrieval). Assuming a two-sided alpha level of 0.05 and a power of 80%, a minimum (min) of 47 patients per group was required to detect a statistically significant difference. To account for potential dropouts or loss to follow-up, we enrolled 55 patients in each group. The sample size calculation was performed using G*Power 3.1 software (Heinrich Heine University, Düsseldorf, Germany).

Patients were blinded to group allocation. Randomization was performed on the day of surgery by a surgical nurse using the Alea Randomisation mobile application (Alea Clinical Services, Abcoude, Netherlands). A sealed envelope containing the allocation (“U” or “E”) was delivered to the operating room and opened by the attending surgeon prior to specimen retrieval. Due to the nature of the intervention, the operating surgeon was not blinded; however, they were unaware of group assignment until the point of retrieval. All surgeries were performed by the same three experienced surgeons.

Routine antibiotic prophylaxis was administered with 2 g of intravenous cefazolin (Sefazol, Gensenta İlaç, İstanbul, Türkiye).

A standard four-trocar LC was performed using a 10-mm umbilical camera trocar, a 10-mm epigastric trocar, and two 5-mm subcostal trocars. The gallbladder was retrieved using a laparoscopic specimen bag through either.

Group U: gallbladder retrieved via the umbilical trocar, group E: gallbladder retrieved via the epigastric trocar.

After retrieval and hemostasis, the trocars were removed under direct laparoscopic vision. The umbilical fascia was closed using two interrupted polyglactin 910 sutures (Vicryl, Ethicon Inc., Edinburgh, Scotland); while the epigastric trocar fascia was left unsutured. Fascia closure practices were standardized and not related to group allocation. Total operation duration and gallbladder retrieval time were recorded.

All patients received paracetamol (Parol, Atabay İlaç, İstanbul, Türkiye) three times daily and tramadol (Contramal, Abdi İbrahim İlaç, İstanbul, Türkiye) twice daily for postoperative pain control. At 6 and 24 hours postoperatively, the Visual Analogue Scale (VAS) was used to assess pain in all patients with assistance from a ward nurse.

Follow-up

Patients without complications were discharged on postoperative day 1. Those who developed complications were discharged upon resolution of their condition. Patients were followed for one year postoperatively. Patients presenting with hernia-related symptoms (e.g., bulge or pain) underwent ultrasonography (USG) at the time of symptom onset, while asymptomatic patients received routine USG at the six-month and one-year follow-ups. Radiologists performing USGs were not part of the study and their procedures were not standardized.

Incisional hernia was defined as a pathological fascial defect at a postoperative trocar site causing the protrusion of intraabdominal contents. Both clinically and radiologically diagnosed hernias were considered incisional hernias.

Inclusion Criteria

- Age ≥18 years,
- Gallbladder stones,
- No known systemic comorbidities (e.g., cardiovascular, pulmonary, metabolic, or immunologic conditions).

Exclusion Criteria

- Age <18 years,
- Open cholecystectomy or conversion from laparoscopy to open surgery,
- Acute cholecystitis,
- Prior intervention involving the common bile duct,
- Presence of clinical or radiologic diastasis recti,
- Presence of clinical or radiologic umbilical hernia.

Primary and Secondary Outcomes

The primary outcome was an assessment of whether the site of gallbladder retrieval influenced the incidence of TSH following LC.

Secondary outcomes included assessing the relationship between retrieval site and postoperative pain (VAS scores) and identifying the risk factors associated with TSH.

Statistical Analysis

Statistical analyses were conducted using SPSS version 26.0 (IBM Corp., Armonk, NY), and data visualizations were generated in RStudio version 4.2.0. Normality of continuous variables was assessed using the Shapiro-Wilk test. Categorical variables were presented as frequencies and percentages, while continuous variables were reported as mean ± standard deviation for normally distributed data or as median with min and maximum values for non-normally distributed data. Categorical data were analyzed using Fisher's exact or chi-square tests, and continuous variables were compared using Student's t-test or Mann-Whitney U test, depending on the distribution. Potential risk factors for incisional hernia were first evaluated using univariate logistic regression analyses. Variables with statistical significance ($p<0.05$) or clinical relevance were subsequently included in a multivariate logistic regression model to identify independent predictors of incisional hernia.

Results

Patient Characteristics

A total of 110 patients were enrolled, with 55 randomized to each group. Two patients in group U and one in group E required conversion to open surgery. Additionally, three patients in group U and four in group E were lost to follow-up. These 10 patients were excluded from the final analysis. The study flowchart summarizing patient enrollment, randomization, and outcomes is presented in Figure 1.

Baseline characteristics including age, gender distribution, previous abdominal surgery, chronic cough, and urgency of surgery were comparable between groups. The mean age was slightly higher in the umbilical group (51.68±15.66 years), compared to the epigastric group (46.50±12.20 years), though this difference did not reach statistical significance (p=0.068). Body mass index (BMI) and abdominal circumference were similar between groups (p=0.381 and p=0.475, respectively) (Table 1).

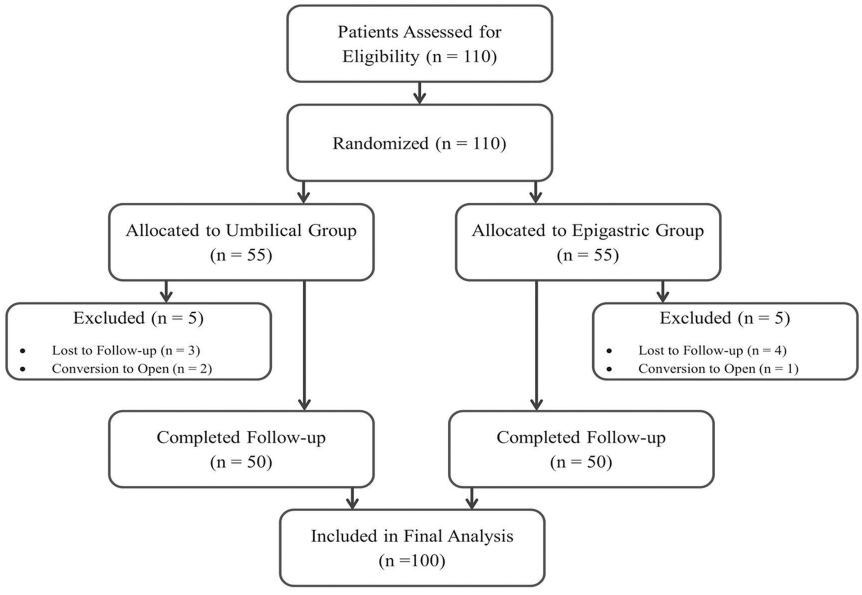

Figure 1. Flowchart of the study

Table 1. Patient demographics

Variable	Category	Umbilical (n=50)	Epigastric (n=50)	p-value
Gender	Male	15	9	0.241[α]
	Female	35	41	
Previous surgery	None	32	29	0.682[α]
	Lower abdomen	18	20	
	Upper abdomen	0	1	
Chronic cough	No (0)	46	49	0.362[α]
	Yes (1)	4	1	
		Mean ± SD	**Mean ± SD**	
Age (years)		51.68±15.66	46.50±12.20	0.068[β]
Body mass index (kg/m^2)		28.50±4.73	29.36±5.01	0.381[β]
Abdomen circumference (cm)		98.70±14.60	96.44±16.85	0.475[β]

Statistical significance at $p<0.05$. SD: Standard deviation, [α]: Fischer's exact chi-square test, [β]: Student's t-test

Perioperative Outcomes

Median calculus diameter, operative duration, and extubation time did not differ significantly between the two groups. However, gallbladder retrieval time was significantly longer in the umbilical group compared to the epigastric group (p=0.013). Postoperative pain, assessed using VAS, was significantly lower at 6 hours in the umbilical group (p=0.027), while 24-hour scores were similar (p=0.285) (Table 2). Figure 2 presents raincloud plots illustrating the distribution of perioperative outcomes across the study groups.

Incisional Hernia Rates

TSH occurred in 6 patients (12%) in the umbilical group and 5 patients (10%) in the epigastric group, with no statistically significant difference between groups (p=0.749; p=1.00 with Yates' correction). All hernias

Table 2. Perioperative comparisons

	Median (min.-max.)	Median (min.-max.)	Rank (umbilical vs. epigastric)	p-value
Calculus diameter (mm)	11 (1-30)	13 (1-35)	47.04 vs. 53.96	0.231
Operation time (minutes)	60 (19-110)	55 (25-120)	54.87 vs. 46.13	0.131
Gallbladder retrieval time (minutes)	3 (1-6)	3 (1-5)	57.41 vs. 43.59	**0.013**
6-hour VAS	4 (2-7)	4 (2-7)	44.45 vs. 56.55	**0.027**
24-hour VAS	3 (1-6)	3 (1-6)	47.51 vs. 53.49	0.285
Externation time (hour)	23 (14-96)	23 (16-47)	49.32 vs. 51.62	0.635

Mann-Whitney U test. Statistical significance at p<0.05. Min.: Minimum, Max.: Maximum, VAS: Visual Analogue Scale

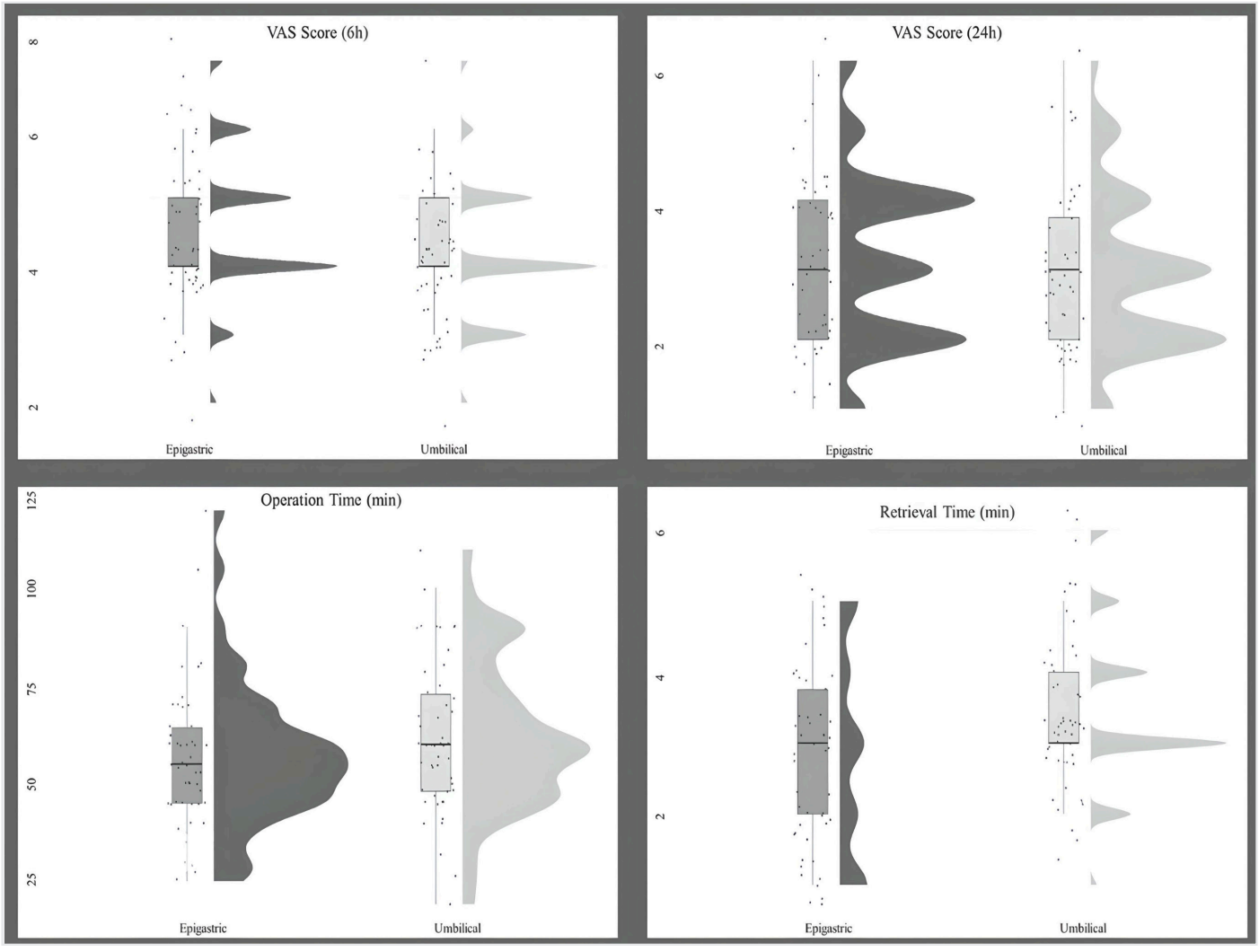

Figure 2. Top row: Visual Analogue Scale (VAS) scores at 6 hours and 24 hours postoperatively. Bottom row: total operation time and gallbladder retrieval time. Each plot displays individual data points, boxplots, and density distributions
Min: Minutes

were located at the umbilical trocar site, irrespective of the retrieval route (Table 3).

Risk Factor Analysis

Univariate logistic regression identified two significant predictors of incisional hernia. Longer gallbladder retrieval time was associated with a lower risk of hernia [odds ratio (OR) =0.636, 95% confidence interval (CI): 0.445-0.909, p=0.013], while extraction site widening showed a trend toward increased hernia risk (OR =2.698, p=0.130), though this did not reach statistical significance. Age demonstrated a borderline association with decreased hernia risk (p=0.071). Other factors such as BMI, abdominal circumference, previous surgery, chronic cough, and operation duration were not significantly associated with hernia development.

In the multivariate model, which included variables with clinical relevance or statistical significance, extraction site widening was identified as an independent risk factor for incisional hernia (OR=4.080, 95% CI: 1.001-16.640, p=0.050). Gallbladder retrieval time was no longer statistically significant (p=0.069), and neither age nor operation time showed any meaningful association. Figure 3 displays a dot and whisker plot representing the univariate analysis of all evaluated risk factors for incisional hernia. Univariate and multivariate analysis results are summarized in Table 4.

Given that all incisional hernias in our cohort occurred at the umbilical trocar site, a subgroup analysis was performed to evaluate the effect of extraction site widening specifically in patients who underwent umbilical gallbladder retrieval. Logistic regression analysis demonstrated that extraction site widening was significantly associated with an increased risk of TSH in this group (p=0.014). The odds of developing a hernia were approximately 10.6 times higher (OR=10.571, 95% CI: 1.613-69.267) in patients with widened extraction sites compared to those without.

Table 3. Incisional hernias

		Incisional hernia		Incisional hernia location		p-value
		No	Yes	Umbilical	Epigastric	
Extraction site	Umblical	44	6	6	0	p=1.00
	Epigastric	45	5	5	0	

Fishers Exact test. Statistical significance at p<0.05

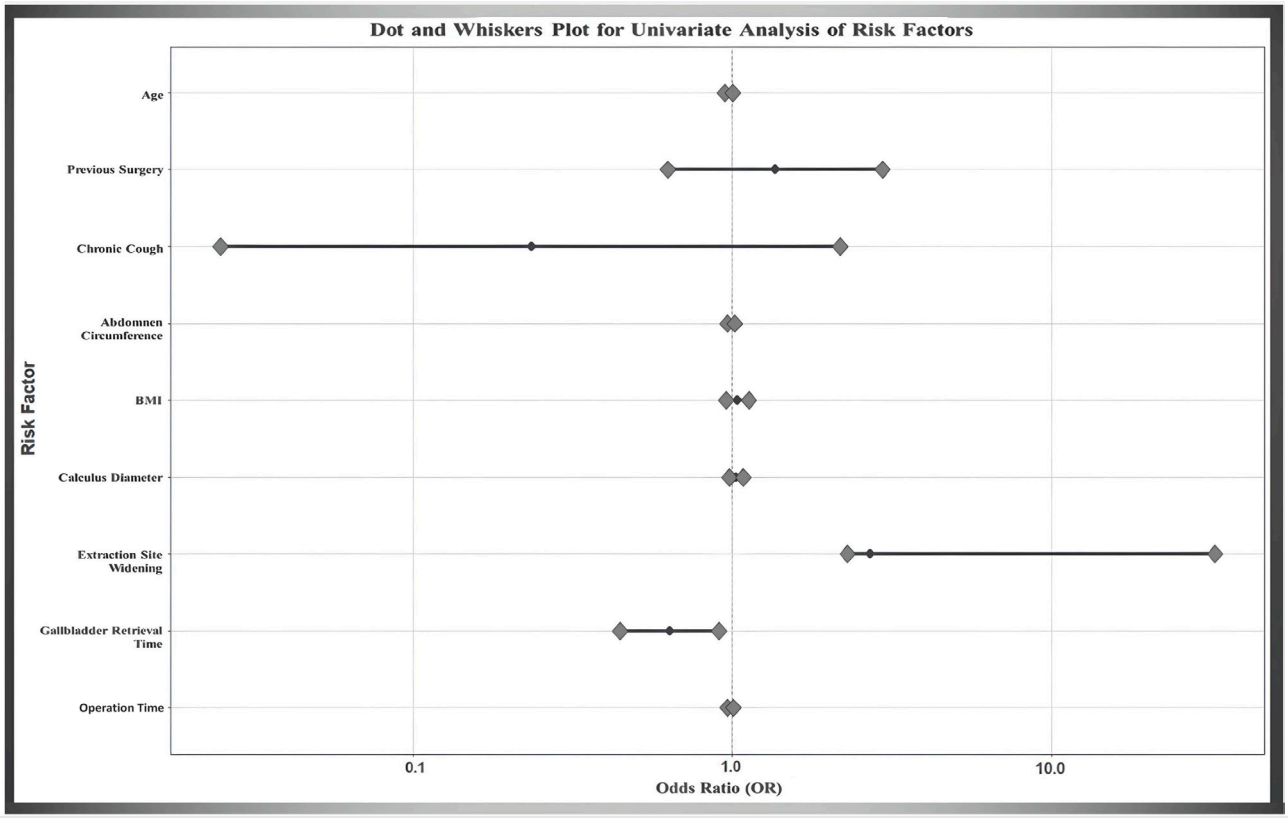

Figure 3. Each point represents the OR for a given variable, with horizontal lines indicating the 95% confidence intervals. Diamond markers highlight the confidence interval boundaries. Variables assessed include patient demographics, clinical characteristics, and intraoperative factors. Extraction site widening showed a strong association with TSH risk, while longer gallbladder retrieval time appeared protective
BMI: Body mass index, OR: Odds ratio, TSH: Trocar site hernias

Table 4. Univariate analysis of risk factors associated with incisional hernia

	Univariate				Multivariate			
Variable	B	95% CI	OR	p (Sig.)	B	95% CI	OR	p (Sig.)
Age (years)	-0.027	0.946-1.002	**0.974**	**0.071**	0.002	0.952-1.055	1.002	0.935
Previous surgery	0.309	0.629-2.951	1.362	0.434				
Chronic cough	-1.449	0.025-2.178	0.235	0.202				
Abdomen circumference	-0.009	0.966-1.016	0.991	0.471				
BMI (kg/m^2)	0.037	0.956-1.126	1.038	0.377				
Calculus diameter	0.029	0.981-1.080	1.029	0.241				
Extract site widening	0.993	2.29732.496	**2.698**	**0.130**	1.406	1.001-16.640	**4.080**	**0.050**
Gallbladder retrieval time	-0.452	0.445-0.909	**0.636**	**0.013**	-0.690	0.273-1.050	0.535	0.069
Operation minutes	-0.015	0.964-1.007	**0.985**	**0.177**	0.005	0.971-1.040	1.005	0.772

Univariate analysis. Statistical significance at p<0.005
CI: Confidence interval, OR: Odds ratio, BMI: Body mass index

Discussion

TSHs are recognized complications of laparoscopic procedures, with incidence rates reported to range from 0.2% to 25%, depending on factors such as trocar size, site, patient comorbidities, and follow-up duration (4,11). One of the largest cohorts reported a 2% TSH rate within 5 years after LC (12).

The umbilical site, particularly when a 10-mm trocar is used, is the most common location for TSH development (13). Anatomically, the umbilicus represents a naturally weakened area of the linea alba, with a congenital fascial defect that originally allowed the passage of the umbilical cord. The periumbilical arteries, which traverse the single-layer fascia, further compromise its structural integrity (14). Furthermore, the presence of diastasis recti may contribute to weaken the layers and has been reported as a strong risk factor for TSH (15). Consequently, creating an artificial fascial defect at this already vulnerable site predisposes patients to TSH formation. Intraoperative maneuvers, particularly those involving increased force or fascial enlargement during organ extraction, may further stress the umbilical fascia. Several studies have shown that using the umbilical trocar for specimen retrieval is associated with an increased risk of TSH (16-18). A recent retrospective study of more than 2,300 patients reported similar results, with umbilical specimen retrieval being associated with more TSH (3.2%) compared to epigastric retrieval (0.7%) (19). In our study, all observed TSHs occurred at the umbilical trocar site, in line with existing literature.

Another concern with using the umbilical site for extraction is potential operative delay. Switching camera positions, reorienting the visual field, and adapting to an altered surgical axis may contribute to increased operative time. The literature on this topic is mixed, with some studies reporting no difference in retrieval time (17,18,20,21), others favoring epigastric extraction (22), and some still supporting umbilical use (16). Our findings are consistent with those demonstrating shorter retrieval times associated with the epigastric approach.

Postoperative pain is a major determinant of patient satisfaction and is one of the leading causes of readmission following LC (23). While some studies suggest that umbilical extraction results in less postoperative pain (18,20,22), others, including a recent meta-analysis, find no significant difference between extraction routes (17). Anand et al. (20) demonstrated higher VAS scores at all postoperative time points in patients undergoing epigastric extraction. In our cohort, umbilical extraction was associated with significantly lower VAS scores at 6 hours postoperatively, and non-significantly lower scores at 24 hours. This is consistent with most previous reports. Higher pain scores associated with epigastric extraction may be attributed to greater muscle disruption or tension in the upper abdominal wall.

However, postoperative pain is multifactorial and influenced by various elements such as patient pain threshold, anxiety levels, intraoperative medication use, and surgical manipulation technique (24). As this study did not account for all potential contributors to postoperative pain, our findings should be interpreted with caution. A definitive conclusion regarding the impact of retrieval site on postoperative pain would require a randomized controlled trial designed to control for these confounding variables.

Risk factors for TSH include older age, obesity, diabetes, and chronic pulmonary disease (25-27). Regardless of patient-related risks, current surgical guidelines recommend fascial closure for all trocar sites ≥10 mm to reduce TSH incidence (28,29). In our study, the only variable significantly associated with TSH formation was fascial widening during extraction. This observation is consistent with previous findings that larger trocars are linked to increased hernia rates (7,30). In contrast, a recent meta-analysis comprising more than 7,000 patients reports that there was no association between incision enlargement and TSH risk. However, there is a paucity of randomized controlled trials evaluating the isolated effect of fascial dilation on hernia formation. Notably, TSH rates as low as 0.08% have been reported with the use of 5-mm trocars, suggesting that when feasible, use of a 5-mm umbilical port with a 5-mm laparoscope may reduce TSH risk.

Given that all incisional hernias in this study occurred at the umbilical trocar site, a subgroup analysis was conducted to specifically assess the impact of extraction site widening among patients who underwent umbilical gallbladder retrieval. In this subgroup, extraction site widening was significantly associated with an increased risk of incisional hernia.

This finding strengthens the hypothesis that even in the absence of large trocar sizes or other systemic risk factors, mechanical disruption of the umbilical fascia substantially increases hernia risk. While the umbilicus is already anatomically predisposed to weakness, our results suggest that technical factors-specifically fascial handling-play a decisive role in postoperative hernia formation. Given that all hernias in our study occurred at the umbilical site, minimizing fascial manipulation during retrieval should be a priority. This may include avoiding unnecessary enlargement of the port and considering alternative extraction routes in appropriate patients.

Study Limitations

While larger series and meta-analyses on TSH exist, our study adds value through strict standardization of surgical technique and routine USG screening, which minimized diagnostic bias. Although an a priori power analysis was conducted, the relatively small sample size limits statistical power. Larger, multicenter studies are needed to confirm our findings and support broader clinical application.

Conclusion

Epigastric extraction was not associated with an increased risk of TSH in our study. Additionally, it was linked to shorter operative times compared to umbilical extraction. However, this benefit comes at the cost of slightly higher postoperative pain. Given this trade-off, epigastric extraction may be preferred in cases where reduced operative time is a priority, and effective pain management strategies are readily available. Future studies should investigate the impact of using a 5-mm camera and trocar at the umbilical site on TSH formation, as this approach may offer a balance between safety and patient comfort.

Ethics

Ethics Committee Approval: The study was approved by the University of Health Sciences Türkiye, Ümraniye Training and Research Hospital, Clinical Research Ethics Committee (approval number: 106, date: 31.03.2022).

Informed Consent: Written informed consent was obtained from all patients for participation in and publication of the study.

Footnotes

Authorship Contributions: Surgical and Medical Practices - T.C., O.E., M.E.B., A.A.; Concept - T.C., F.B.; Design - T.C.; Data Collection or Processing - M.E.B., A.A.; Analysis or Interpretation - O.E., A.A., F.B.; Literature Search - M.E.B.; Writing - O.E.

Conflict of Interest: No conflict of interest was declared by the authors.

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