ORIGINAL ARTICLE

The role of preoperative ultrasound in predicting conversion from laparoscopic cholecystectomy to open surgery in acute cholecystitis

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ABSTRACT

BACKGROUND: The aim of this study is to evaluate the role of pre-operative ultrasound findings for conversion from laparoscopic cholecystectomy to open surgery in patients with acute cholecystitis and to evaluate the effects of pre-operative ultrasound findings on operation time and length of stay.

METHODS: The study included 80 patients who underwent laparoscopic cholecystectomy for acute cholecystitis between January 1 and June 30, 2023. The relationship between gallbladder wall thickness and the presence of pericholecystic fluid on pre-operative ultrasonography and the duration of surgery, conversion to open surgery, and hospitalization was evaluated.

RESULTS: The patient group undergoing open surgery exhibited a statistically significant increase in both the median gallbladder wall thickness (P<0.001) and the frequency of pericholecystic fluid on pre-operative ultrasound (P=0.012). Receiver operating characteristic (ROC) analysis was used to assess the discriminative power of gallbladder wall thickness for predicting the requirement to convert from laparoscopic surgery to open surgery. The area under the curve value was found to be 0.907, indicating a strong discriminative power. Based on the ROC curve, a gallbladder wall thickness of ≥5.75 millimeters showed a sensitivity of 85.7% and specificity of 84.9% in predicting the requirement for open surgery.

CONCLUSION: Our study highlights the significance of two factors in predicting the conversion from laparoscopic cholecystectomy to open surgery in patients with acute cholecystitis. The presence of pericholecystic fluid and a gallbladder wall thickness of 5.75 mm or greater are indicators that the laparoscopic procedure may be more challenging in such cases. These results can aid surgeons in making informed decisions and planning the surgical approach accordingly for better patient outcomes.

Keywords: Acute cholecystitis; laparoscopy; pre-operative ultrasonography.

INTRODUCTION

The prevalence of gallstones varies in different societies, with an average rate of 10–15%. Around 20–40% of individuals with cholelithiasis experience gallstone-related symptoms. If left untreated, gallstones may lead to high morbidity and potentially fatal outcomes such as acute cholecystitis, obstructive jaundice, cholangitis, and acute pancreatitis.[1,2]

At present, ultrasound is the most commonly used imaging technique for diagnosing acute cholecystitis. Although hepatobiliary iminodiacetic acid scan offers higher sensitivity and specificity compared to other methods, ultrasound is more commonly used due to its wider availability, lower cost, and accuracy in detecting gallstones.[1]

Anticipating potential difficulties faced during gallbladder surgery is crucial for selecting appropriate cases and planning

Cite this article as: Altıner S, Ergüder E, Altınok SH, Aydın SM, Barlas AM, Tuncal S. The role of preoperative ultrasound in predicting conversion from laparoscopic cholecystectomy to open surgery in acute cholecystitis. Ulus Travma Acil Cerrahi Derg 2023;29:1109-1113.

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Ulus Travma Acil Cerrahi Derg 2023;29(10):1109-1113 DOI: 10.14744/tjtes.2023.45469 Submitted: 28.07.2023 Revised: 13.09.2023 Accepted: 17.09.2023

the surgical technique based on the surgeon's experience and skills. In addition, conducting a more effective pre-operative risk assessment allows for better anesthesia planning and managing the expectations of both the patient and the surgeon, ultimately, leading to obtaining more detailed and informed consent.[3]

The primary aim of this study is to evaluate the role of pre-operative ultrasound findings for conversion from laparoscopic cholecystectomy to open surgery in patients with acute cholecystitis. The second aim of the study is to evaluate the effects of pre-operative ultrasound findings on operation time and length of stay.

MATERIALS AND METHODS

The study included 80 patients who underwent laparoscopic cholecystectomy for acute cholecystitis between January 1 and June 30, 2023. Before the operation, patients underwent a comprehensive physical examination and their medical history was taken. To diagnose acute cholecystitis, various tests were conducted, including complete blood count, hepatic and renal function tests, serum amylase and lipase levels, and hepatobiliary ultrasound. A diagnosis of acute cholecystitis was established in patients with elevated leukocyte and/or CRP levels, signs of gallbladder inflammation on hepatobiliary ultrasound, accompanied by fever, tenderness in the right upper quadrant, and a positive Murphy's sign. Patients with a history of recurrent acute cholecystitis attacks, choledocholithiasis, or prior abdominal surgery were excluded from the study.

The operative time was measured from the insertion of the Veress needle to the closure of the final trocar incision.

Ethical approval for the study was received from the Local Ethics Committee of Ankara Training and Research Hospital with no E-23-1345. The study adhered to the principles outlined in the Declaration of Helsinki.

Statistical Analysis

Statistical analysis of the study data was performed using the Statistical Package for the Social Sciences (SPSS) version 23.0 for Windows (SPSS Inc., Chicago, USA). Descriptive statistics were used to present categorical variables as numbers and percentages, while continuous variables were presented as mean ± standard deviation or interquartile range. The normality of continuous variables was assessed through visual methods such as histograms and probability graphs, as well as analytical methods such as the Kolmogorov–Smirnov and Shapiro–Wilk tests. Differences in continuous variables were analyzed using the Mann–Whitney U-test, while Chi-square tests were used for categorical variables. To determine the probability of conversion to open surgery based on gallbladder wall thickness values, receiver operating characteristic (ROC) analysis was conducted. The area under the curve and its statistical significance were evaluated to decide whether to calculate a cutoff point for the relevant parameters. The

Table 1. Sociodemographic and operative characteristics of patients

Characteristics	Values (%)
Age (years), mean±SD[a]	50.7±15.7
Gender, n (%)	
Female	50 (62.5)
Male	30 (37.5)
Gallbladder wall thickness (mm), median (IQR[b])	5.0 (4.0-5.5)
Presence of pericholecystic fluid, n (%)	
No	49 (61.3)
Yes	31 (38.8)
Conversion to open surgery, n (%)	
No	73 (91.3)
Yes	7 (8.8)
Operative time (minute), median (IQR[b])	90.0 (60.0-120.0)
Length of hospital stay (days), median (IQR[b])	4.0 (3.0-6.0)

[a]Standard deviation; [b]Interquartile range.

Table 2. Comparison of certain characteristics between cases requiring conversion to open surgery

Characteristics	Conversion to open surgery (n=7)	Laparoscopic (n=73)	P -value
Age, median (IQR[a])	62.0 (57.0- 82.0)	49.0 (37.5- 62.5)	0.039*
Gender, n (%)			
Female	4 (8.0%)	46 (92.0%)	>0.999**
Male	3 (10.0%)	27 (90.0%)	
Gallbladder wall thickness, median (IQR[a])	7.0 (6.0-8.0)	5.0 (4.0- 5.0)	<0.001*
Presence of pericholecystic fluid, n (%)			
No	1 (2.0%)	48 (98.0%)	0.012**
Yes	6 (19.4%)	25 (80.6%)	

[a]Interquartile range; *Mann-Whitney-U test; ** Fisher's exact test.

Table 3. Evaluation of factors affecting operative time and length of hospital stay

Characteristics	Operative Time		Length of Hospital Stay	
	r[b]	P*	r[b]	P*
Age (years)				
≤ 65 years	0.229	0.062	0.065	0.601
> 65 years	0.472	0.103	0.511	0.074
Gallbladder wall thickness (mm)	0.412	<0.001	0.240	0.032
	Median (IQR)[a]	P**	Median (IQR)[a]	P**
Presence of pericholecystic fluid				
No	80.0(60.0-105.0)		4.0(3.0-5.0)	
Yes	90.0(75.0-150.0)	0.011	6.0(4.0-8.0)	0.001

[a]Interquartile range; [b]Spearman's correlation coefficient; *Spearman correlation test; ** Mann-Whitney-U test.

Youden index was utilized to determine the appropriate cut-off point. For this study, the level of statistical significance was set at P<0.05.

RESULTS

In our retrospective study, we evaluated 80 patients who underwent laparoscopic cholecystectomy for acute cholecystitis on the specified dates. Of these patients, 30 (37.5%) were male, and 50 (62.5%) were female, with a mean age of 50.7±15.7 years. Before the surgery, hepatobiliary ultrasound showed that 49 (61.3%) patients did not have pericholecystic fluid, while 31 (38.8%) patients did have pericholecystic fluid. The median gallbladder wall thickness measured was 5.0 (4.0–5.5) mm. Successful laparoscopic cholecystectomy was achieved in 73 (91.3%) patients, while 7 (8.8%) patients required conversion to open surgery. The median operative time was 90.0 (60.0–120.0) min, and the median length of hospital stay was 4.0 (3.0–6.0) days (Table 1).

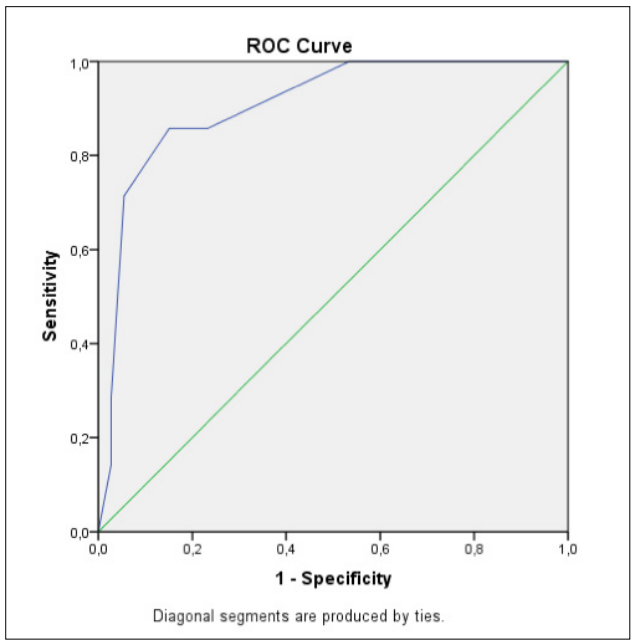

Figure 1. ROC analysis of gallbladder wall thickness for predicting conversion to open surgery.

Table 2 presents a comparison of certain characteristics between patients who required conversion to open surgery and who underwent laparoscopic surgery. The mean age of patients who had open surgery was 62.0 (57.0–82.0) years, whereas patients whose surgery was completed laparoscopically had a mean age of 49.0 (37.5–62.5) years, with a statistically significant difference (P=0.039). Moreover, the patient group undergoing open surgery exhibited a statistically significant increase in both the median gallbladder wall thickness (P<0.001) and the frequency of pericholecystic fluid on pre-operative ultrasound (P=0.012). However, there was no statistically significant difference in terms of gender between the patient groups who underwent open surgery and those who had laparoscopic surgery (P>0.999).

Table 3 illustrates the evaluation of factors influencing operative time and length of hospital stay. The analysis of the age groups (65 and younger, and over 65) revealed no statistically significant correlation between age and either the operative time or the length of hospital stay (P>0.05). However, a moderate positive correlation was found between the gallbladder wall thickness measured by pre-operative ultrasound and the operative time (correlation coefficient: r=0.412, P≤0.001), as well as a weak positive correlation with the length of hospital stay (correlation coefficient: r=0.240, P=0.032). In addition, patients with pericholecystic fluid on pre-operative ultrasound had a significantly longer operative time (P=0.011) and length of hospital stay (P=0.001) compared to those without pericholecystic fluid.

ROC analysis was used to assess the discriminative power of gallbladder wall thickness for predicting the requirement to convert from laparoscopic surgery to open surgery. The area under curve value was found to be 0.907, indicating a strong

discriminative power. Based on the ROC curve, a gallbladder wall thickness of ≥5.75 mm showed a sensitivity of 85.7% and specificity of 84.9% in predicting the requirement for open surgery [Figure 1].

Of note, there were no reported deaths among our patients during both the intraoperative and post-operative periods.

DISCUSSION

Laparoscopic cholecystectomy has become the gold standard surgical technique for the treatment of symptomatic cholelithiasis due to its numerous advantages over open cholecystectomy, including quicker return to work, shorter length of hospital stay, less post-operative pain, and lower morbidity and mortality rates.[3] Despite the increased risk of complications in cases of acute cholecystitis such as biliary tract and vascular injuries due to inflammation, the laparoscopic approach is becoming safer and more common with increasing surgical experience over the years.[4]

Several studies have identified certain factors that can predict the technical difficulties in laparoscopic cholecystectomy, including male gender, advanced age, and the time elapsed from symptom onset to surgery.[5-8] In addition, some studies suggest that an increased gallbladder wall thickness due to inflammation may also contribute to the complexity of the procedure.[9-14] However, the specific cutoff value for gallbladder wall thickness remains unclear, with various studies in the literature reporting cutoff values ranging from 3 mm to 5 mm[5,6,10,11] In our study, we found that a gallbladder wall thickness of ≥5.75 mm was a significant indicator for conversion to open surgery.

The frequency of conversion from laparoscopic cholecystectomy to open surgery in patients who underwent surgery for acute cholecystitis was 8.8%, which aligns with the results reported in the literature.[7,15,16]

The length of hospital stay varies depending on the patient's general condition and the complexity of the operation. Our study revealed that patients who had laparoscopic surgery had a shorter length of hospital stay postoperatively compared to those who required conversion to open surgery. Furthermore, an increase in gallbladder wall thickness and the presence of pericholecystic fluid on pre-operative ultrasound were associated with a significant rise in the length of hospital stay, which is consistent with the results from other studies.[17,18]

Pericholecystic fluid refers to edematous changes surrounding the gallbladder caused by inflammation in acute cholecystitis. In our study, the presence of pericholecystic fluid was associated with a longer operative time and an increased rate of conversion from laparoscopic cholecystectomy to open surgery. Similar studies have demonstrated that pericholecystic fluid complicates dissection of Calot's triangle, leads to more adhesions, and makes it challenging to dissect the gallbladder from the liver bed,[19,20] ultimately resulting in difficult surgery. In addition, in the Parkland system, which has five stages arranged according to intraoperative gallbladder findings in cholecystectomies, pericholecystic fluid is evaluated as minimum Grade 3 and has been shown to increase the difficulty of surgical technique.[21] Our results align with those reported by relevant studies in the literature.

In our study, we evaluated factors affecting conversion from laparoscopic cholecystectomy to open surgery in acute cholecystitis. We found that patients who required open surgery had significantly higher median age values. While some studies in the literature have suggested that age may not be a significant factor in such conversion,[22,23] our results are supported by other publications.[24,25]

As with any study, there were certain limitations that should be considered. Our study was designed retrospectively and conducted in a single center, which might limit the generalizability of the results. The sample size was relatively small, and the follow-up period was short. Moreover, due to the retrospective nature of the study, we were unable to assess the impact of intraoperative findings on the decision to convert to open surgery, as some relevant findings might not have been documented by the surgeon. Despite these limitations, our study provides valuable insights. We believe that future studies with larger sample sizes and more in-depth exploration of risk factors will further contribute to the existing literature on this topic.

CONCLUSION

Our study highlights the significance of two factors in predicting conversion from laparoscopic cholecystectomy to open surgery in patients with acute cholecystitis. The presence of pericholecystic fluid and a gallbladder wall thickness of 5.75 mm or greater is indicators that the laparoscopic procedure may be more challenging in such cases. These results can aid surgeons in making informed decisions and planning the surgical approach accordingly for better patient outcomes.

Ethics Committee Approval: This study was approved by the Ankara Training and Research Hospital Ethics Committee (Date: 26.07.2023, Decision No: E-23-1345).

Peer-review: Externally peer-reviewed.

Authorship Contributions: Concept: S.A.; Design: S.A.; Supervision: S.T.; Data collection and/or processing: S.H.A., E.E.; Analysis and/or interpretation: A.M.B.; Literature search: S.M.A.; Writing: S.A.; Critical review: A.M.B., S.T.

Conflict of Interest: None declared.

Financial Disclosure: The author declared that this study has received no financial support.

REFERENCES

1. Pisano M, Allievi N, Gurusamy K, Borzellino G, Cimbanassi S, Boerna D, et al. 2020 World Society of Emergency Surgery updated guidelines for the diagnosis and treatment of acute calculus cholecystitis. World J

Emerg Surg 2020;15:61. [CrossRef]
2. Kanakala V, Borowski DW, Pellen MG, Dronamraju SS, Woodcock SA, Seymour K, et al. Risk factors in laparoscopic cholecystectomy: a multivariate analysis. Int J Surg 2011;9:318–23. [CrossRef]
3. Cho KS, Baek SY, Kang BC, Choi HY, Han HS. Evaluation of preoperative sonography in acute cholecystitis to predict technical difficulties during laparoscopic cholecystectomy. J Clin Ultrasound 2004;32:115–22.
4. Borzellino G, Sauerland S, Minicozzi AM, Verlato G, Di Pietrantonj C, de Manzoni G, et al. Laparoscopic cholecystectomy for severe acute cholecystitis. A meta-analysis of results. Surg Endosc 2008;22:8–15. [CrossRef]
5. Rosen M, Brody F, Ponsky J. Predictive factors for conversion of laparoscopic cholecystectomy. Am J Surg 2002;184:254–8. [CrossRef]
6. Low SW, Iyer SG, Chang SK, Mak KS, Lee VT, Madhavan K. Laparoscopic cholecystectomy for acute cholecystitis: safe implementation of successful strategies to reduce conversion rates. Surg Endosc 2009;23:2424–9. [CrossRef]
7. Murphy MM, Ng SC, Simons JP, Csikesz NG, Shah SA, Tseng JF. Predictors of major complications after laparoscopic cholecystectomy: surgeon, hospital, or patient?. J Am Coll Surg 2010;211:73–80. [CrossRef]
8. Garber SM, Korman J, Cosgrove JM, Cohen JR. Early laparoscopic cholecystectomy for acute cholecystitis. Surg Endosc 1997;11:347–50. [CrossRef]
9. Ishizaki Y, Miwa K, Yoshimoto J, Sugo H, Kawasaki S. Conversion of elective laparoscopic to open cholecystectomy between 1993 and 2004. Br J Surg 2006;93:987–91. [CrossRef]
10. Jansen S, Jorgensen J, Caplehorn J, Hunt D. Preoperative ultrasound to predict conversion in laparoscopic cholecystectomy. Surg Laparosc Endosc 1997;7:121–3.
11. Kama NA, Doganay M, Dolapci M, Reis E, Atli M, Kologlu M. Risk factors resulting in conversion of laparoscopic cholecystectomy to open surgery. Surg Endosc 2001;15:965–8. [CrossRef]
12. Ghanem Y, Fahmy K, Refaat D, Mouhammed M. Preoperative prediction of difficult laparoscopic cholecystectomy: In Zagazig University Hospitals. Zagazig University Med J 2017;4:1–13. [CrossRef]
13. Panni RZ, Strasberg SM. Preoperative predictors of conversion as indicators of local inflammation in acute cholecystitis: strategies for future studies to develop quantitative predictors. J Hepatobiliary Pancreat Sci 2018;25:101–8. [CrossRef]
14. Kumawat S, Agarwal l, Yadav A. An observational study on prediction of difficulties during laproscopic cholecystectomy in cases of cholelithiasis by preoperative ultrasonography. BJSRG 2022;2:27–33. [CrossRef]
15. Chandio A, Timmons S, Majeed A, Twomey A, Aftab F. Factors influencing the successful completion of laparoscopic cholecystectomy. JSLS 2009;13:581–6. [CrossRef]
16. Raman SR, Moradi D, Samaan BM, Chaudhry US, Nagpal K, Cosgrove JM, et al. The degree of gallbladder wall thickness and its impact on outcomes after laparoscopic cholecystectomy. Surg Endosc 2012;26:3174–9.
17. Coccolini F, Catena F, Pisano M, Gheza F, Fagiuoli S, Di Saverio S, et al. Open versus laparoscopic cholecystectomy in acute cholecystitis. Systematic review and meta-analysis. Int J Surg 2015;18:196–204. [CrossRef]
18. Boo YJ, Kim WB, Kim J, Song TJ, Choi SY, Kim YC, et al. Systemic immune response after open versus laparoscopic cholecystectomy in acute cholecystitis: a prospective randomized study. Scand J Clin Lab Invest 2007;67:207–14. [CrossRef]
19. Chand P, Kaur M, Bhandari S. Preoperative predictors of level of difficulty of laparoscopic cholecystectomy. Niger J Surg 2019;25:153–7.
20. Kuldip S, Ashish O. Difficult laparoscopic cholecystectomy: A large series from north India. Indian J Surg 2006;68:205–8.
21. Uçaner B, Durmus D, Buldanli MZ, Hancerliogullari O. Correlation between preoperative ultrasonography and parkland grading scale in patients undergoing laparoscopic cholecystectomy. Indian J Surg 2023;1:1–7. [CrossRef]
22. Gupta N, Ranjan G, Arora MP, Goswami B, Chaudhary P, Kapur A, et al. Validation of a scoring system to predict difficult laparoscopic cholecystectomy. Int J Surg 2013;11:1002–6. [CrossRef]
23. Fried GM, Barkun JS, Sigman HH, Joseph L, Clas D, Garzon J, et al. Factors determining conversion to laparotomy in patients undergoing laparoscopic cholecystectomy. Am J Surg 1994;167:35–9; discussion 39–41.
24. Kanaan SA, Murayama KM, Merriam LT, Dawes LG, Prystowsky JB, Rege RV, et al. Risk factors for conversion of laparoscopic to open cholecystectomy. J Surg Res 2002;106:20–4. [CrossRef]
25. Gabriel R, Kumar S, Shrestha A. Evaluation of predictive factors for conversion of laparoscopic cholecystectomy. Kathmandu Univ Med J (KUMJ) 2009;7:26–30. [CrossRef]

ORİJİNAL ÇALIŞMA - *ÖZ*

Akut kolesititte preoperatif ultrasonografinin laparoskopik kolesistektomiden açık cerrahiye geçişi tahmin etmedeki rolü

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AMAÇ: Bu çalışmanın amacı, akut kolesititli hastalarda laparoskopik kolesistektomi sırasında açık cerrahiye geçiş için preoperatif ultrason bulgularının rolünü değerlendirmek; ayrıca operasyon ve yatış süreleri üzerine etkilerini değerlendirmektir.

GEREÇ VE YÖNTEM: Çalışmaya 1 Ocak – 30 Haziran 2023 tarihleri arasında akut kolesistit sebebiyle laparoskopik kolesistektomi tekniğiyle ameliyata başlanan 80 hasta dahil edildi. Preoperatif ultrasonografide kese duvar kalınlığı ve perikolesistik mayi varlığı ile ameliyat süresi, açık cerrahiye geçme ve hastanede yatış süreleri arasındaki ilişkisi değerlendirildi.

BULGULAR: Safra kesesi duvar kalınlığı, açık cerrahiye geçilen hastalarda 7.0 (6.0- 8.0) mm iken, diğer grupta 5.0 (4.0- 5.0) mm ölçüldü ve fark istatistiksel olarak anlamlıydı($p<0.001$). Ayrıca preoperatif ultrasonografide perikolesistik mayi bulunması açık cerrahiye geçilen ve laparoskopik tamamlanan hasta grupları arasında değerlendirildiğinde istatistiksel olarak anlamlı fark bulundu ($p=0,012$). Safra kesesi duvar kalınlığının ameliyatın açık cerrahiye geçilmesinde ayırt edici gücü ROC analizi ile değerlendirildi. Area Under Curve (AUC) değeri 0.907 olarak saptandı. ROC eğrisine göre safra kesesi duvar kalınlığı ≥5.75 milimetre için duyarlılık ve özgüllük yüzdesi sırasıyla, %85.7; %84.9 bulundu.

SONUÇ: Akut kolesistit atağı geçiren hastalarda, perikolesistik mayi bulunması ve safra kesesi duvar kalınlığının 5.75 mm ve daha büyük olmasının laparoskopik kolesistektominin teknik olarak daha zor geçeceğini gösteren faktörler olarak değerlendirilebilir.

Anahtar sözcükler: .Akut kolesistit; laparoskopi; preoperatif ultrasonografi.

Ulus Travma Acil Cerrahi Derg 2023;29(10):1109-1113 DOI: 10.14744/tjtes.2023.45469