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Predictive factors for conversion to open surgery during laparoscopic cholecystectomy

Laparoskopik kolesistektomiden açık cerrahiye geçişi öngören faktörler

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Abstract

Aim. Laparoscopic cholecystectomy is the gold standard method in the treatment of elective symptomatic gallstones. In acute cholecystitis, the rate of conversion to an open procedure is 15-25% higher when compared to elective cases. In this study we aimed to evaluate the effectiveness of patients' preoperative features, as these may affect the decision to convert to open surgery. **Methods.** This single-center study was conducted between June 2007-2009 with 122 patients who were treated for acute cholecystitis. The primary objective was to define the criterias for C-reactive protein, erythrocyte sedimentation rate, white blood count, gender and age for conversion to open procedure. **Results.** A total of 102 patients were included in the study. Laparoscopic cholecystectomy was successfully performed in 75 patients; and open conversion was required in 27 patients. The analysis showed that male gender, erythrocyte sedimentation rate and C-reactive protein levels, and severe ultrasonographic findings of acute cholecystitis in the conversion group were significantly different than in the laparoscopy group and these parameters were independent predictive factors of conversion. **Conclusion.** Male gender, high erythrocyte sedimentation rate and C-reactive protein levels and severe ultrasonographic findings are predictive actors which may help facilitate a conversion to open surgery.

Keywords: Acute cholecystitis, laparoscopic cholecystectomy, C-reactive protein, erythrocyte sedimentation rate

Özet

Amaç. Laparaskopik kolesistektomi, semptomatik safra taşlarının elektif tedavisinde altın standarttır. Akut kolesistitte elektif vakalara göre açık cerrahiye geçiş oranı %15-25 daha fazladır. Bu çalışmada açık cerrahiye geçiş kararını etkileyebileceği düşünülen preopratif hasta özelliklerinin değerlendirilmesi amaçlanmıştır. **Yöntemler.** Bu tek merkezli çalışmada Haziran-2007-2009 arası akut kolesistit nedeni ile tedavi gören 122 hasta ile çalışmaya başlandı. Çalışmadaki primer hedef C-reaktif protein (CRP), eritrosit sedimentasyon hızı (ESH), beyaz küre sayımı, cinsiyet ve yaş için açık işleme geçişte kriterler belirlemekti. **Bulgular.** Çalışmaya toplam 102 hasta dahil edildi. 75 hastada başarılı bir şekilde laparaskopik kolesistektomi gerçekleştirildi ve 27 hastada açık cerrahiye geçildi. Analiz sonuçları erkek cinsiyet, ESH, CRP düzeyleri ve ağır ultrasonografik bulguların geçiş grubunda laparoskopi grubuna göre anlamlı derecede farklı olduğunu gösterdi ve bu parametrelerin geçiş için bağımsız prediktif faktörler oldukları görüldü. **Sonuç.** Erkek cinsiyet, yüksek ESH ve CRP düzeyleri ile ağır USG bulguları açık cerrahiye geçiş kararı vermede yardımcı olabilecek prediktif faktörlerdir.

Anahtar sözcükler: Akut kolesistit, laparoskopik kolesistektomi, C-reaktif protein, eritrosit sedimentasyon hızı

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Introduction

Various studies have proven that laparoscopic cholecystectomy (LC) is effective and safe in the treatment of elective symptomatic gallstones, and this procedure is now regarded as the gold standard. In the early years after laparoscopic cholecystectomy came into use, acute cholecystitis (AC) was among the listed contraindications [1, 2]. With technological improvements and increased experience, more recent studies have shown that laparoscopy is, indeed, safe for patients with AC [3, 4]. In AC, where inflammatory reaction is frequent, dissection is difficult and time-consuming and it may not be possible to fully distinguish the tissues; therefore the rate of conversion to an open procedure is 15-25% higher when compared to elective cases [5]. Besides, the discrepancy of the surgeon to convert to an open cholecystectomy may lead to serious complications [4]. The high rate of conversion has prompted studies aimed at defining the proper predictive factors to complete early laparoscopy in acute cholecystitis. These predictive factors are required to thoroughly inform the patient on the method of operation in the preoperative stage and to define the risk of converting to open surgery. The literature lists various risk factors (age, comorbid conditions, obesity and experience) which are not based on conclusive evidence [6].

In this study, our hypothesis was that the C-reactive protein (CRP), the erythrocyte sedimentation rate (ESR), increased white blood count (WBC), the male gender and findings of severe cholecystitis in the ultrasonography (USG) are predictive factors for conversion from a laparoscopic to an open procedure for AC. Therefore, we intend to evaluate the prognostic value of patients' preoperative diagnostic tests, as these may influence the decision to convert to open surgery. We will also assess the current surgical treatment model used in treating AC patients who are now diagnosed using conventional diagnostic methods.

Materials and methods

This single-center study was conducted between June 2007 and June 2009 with patients who were treated in our clinic. The data were collected prospectively and analysed retrospectively. The rationale for conversion to open cholecystectomy were obtained from the operative report. All participants were given full informaton about the study, and their written and oral consent to participate in the study was obtained.

The study included patients who were diagnosed with AC upon physical examination (sensitivity in the upper right quadrant), USG (gallstones, edema and increase in the thickness of the gallbladder wall, pericholecystic fluids, positive sonographic Murphy sign) and laboratory (WBC >10.000/mm^3, body temperature >37.5°C, and high CRP and ESR) findings.

Laparoscopic surgery was undertaken within 48 hours and an AC diagnosis was confirmed histopathologically. The exclusion criteria were upper abdominal operation, comorbid conditions (cardiac insufficiency, uncontrolled hypertension, diabetes mellitus, kidney and liver disorders), pregnancy, hepatitis, common bile duct stones, unwillingness to undergo the operation, lack of diagnosis of acute cholecystitis histopathologically in the postoperative stage and patient's refusal to cooperate.

After diagnostic tests, the first objective was to define the criteria for conversion to open procedure. The second objective was the evaluation and prevention of complications after the surgical procedures.

In the first 48 hours following the patient's referral to our unit, an early cholecystectomy was almost always decided upon. All operations were initially planned as laparoscopic and were completed by expert surgeons (minimum 30 laparoscopic cholecystectomies per year).

Oral water and food intake were discontinued in patients diagnosed with acute cholecystitis. In the preoperative stage, intravenous fluids and prophylactic antibiotic therapy (cefuroxime axetil 750 mg IV) were administered.

Acute cholecystitis was evaluated in three categories based on USG findings: mild, moderate and severe. Tenderness when pressure is applied on the gallbladder with an ultrasonography probe was classified as mild; thickness in the gallbladder wall (thicker than 4 mm in patients who don't have right cardiac insufficiency; chronic liver disease and/or ascites) was classified as moderate; and enlarged gallbladder (long axe diameter longer than 8 cm, short axe diameter longer than 4 cm) and pericholecystic fluid were classified as severe [7].

Operation technique

Laparoscopic cholecystectomy was applied using the "American" technique with 4 trocars in which the patient lies in a supine position, the table is inclined to the Fowler position and left lateral, and the surgeon is on the left side of the patient. A nasogastric tube was routinely placed to provide gastric decompression and was later removed after the operation. Dissection was begun from the Callot triangle. The cystic artery and duct were located, clipped and cut, and the gallbladder was dissected from the liver with scissors and cauterized. An endobag was used to remove the gallbladder. After the bleeding was brought under control, a drain was placed at the Winslow's space from the lateral trocar and the fascial defects were closed.

The criteria for conversion to open surgery were defined as inabiltiy to reach the Callot triangle after 20 minutes of dissection, inability to view the anatomical structures, bleeding which cannot be stopped, and technical problems.

Statistical analysis

The Statistical Package for the Social Sciences (SPSS) for Windows, version 15.0 (SPSS Inc., Chicago, IL, USA), software tool was used for conversion of acquired information into data and analysis. Receiver-operating characteristics (ROC) analysis for breakpoints and chi-square test for variances were applied. The results are in a 95% confidence interval, and p value less than 0.05 was considered statistically significant. The predictors responsible for converting to open procedure were analyzed using the double logistics regression Backward (wald) method. In the Backward analysis ESR and CRP levels were found to be significant predictive factors for converting to open procedure. We then conducted a ROC analysis. The ROC curve is the plot of proportions of true positive versus true negative results for each value of the study variable.

To calculate sensitivity and specificity, we used cutoff values to determine true or false results. In order to predict when to convert from the laparoscopic to open procedure using ESR, 65 mm/hour was selected as the cutoff value in the ROC analysis. The selected cutoff value provided an ideal balance between sensitivity and specificity for the prediction to the open procedure. The cutoff value for CRP level was 109 mg/L.

Results

Demographic characteristics and preoperative features

Within the mentioned period, 122 AC patients were treated. Twenty patients were excluded from the study due to previous upper abdominal surgery (n=10), anticoagulant treatment (n=3), severe cardiac insufficiency (n=3), or common bile duct stones (n=4). A total of 102 patients were included in the study (56 women, 46 men) and taken into surgery with a planned LC. The pathologic examinations of all resected specimens were confirmed with a diagnosis of AC. A laparoscopy was successfully performed in 75 of 102 patients (73.5%) (laparoscopy group, LG). Twenty-seven patients (26.5%), who required the conversion procedure, comprised the conversion group (CG). Of these 27 patients, 17 were men (63%) and 10 were women (37%) and this distribution was statistically different from the LC group (39% vs. 61%, respectively; p=0.03). The mean

age of all patients was 61.5 ± 18.8 (27-96) years. The difference in age between the groups was not significant (p>0.05). The patient characteristics are presented in Table 1.

Table 1. Patient characteristics and preoperative features.

	All patients (n=102)	LG (n=75)	CG (n=27)	p value
Men	46 (45%)	29 (39%)	17 (63%)	
Women	56 (55%)	46 (61%)	10 (37%)	
Sex ratio (m/w)	0.8	0.6	1.7	0.03
Age; mean years±SD (range)	61.5±18.8 (27-96)	60.4±19.1 (27-95)	64.7±17.9 (27-96)	0.617
WBC; mean/mm3±SD (range)	12.784±4.739 (5.300-27.000)	12.312±4.876 (5.300-27.000)	14.096±4.141 (7.400-27.000)	0.255
CRP; mean mg/L±SD (range)	111.3±83.2 (11-313)	87±66.8 (11-303)	175.4±90.7 (13-313)	<0.05
ESR; mean mm/hour±SD (range)	62±15.7 (23-91)	58.7±15.5 (23-90)	71±13 (50-91)	<0.05
USG features, n (%)				
Mild	66 (65%)	53 (70%)	13 (48%)	
Moderate	32 (31%)	22 (30%)	10 (37%)	<0.05
Severe	4 (5%)	-	4 (15%)	

LG: Laparoscopy group, **CG:** Conversion group, **WBC:** White blood count, **CRP:** C-reactive protein, **ESR:** Erythrocyte sedimentation rate, **USG:** Ultrasonography, **SD:** Standard deviation

The erythrocyte sedimentation rate, CRP and WBC levels of the LC group were 58.7 ± 15.5 mm/hour (23-90), 87 ± 66.8 mg/L (11-303), 12.312 ± 4.876/mm3 (5.300-27.000), respectively. In the CG, they were 71 ± 13 mm/hour (50-91), 175.4 ± 90.7 mg/L (13-313) and 14.096 ± 4.141 /mm3 (7.400-22.100), respectively. The analysis showed that the ESR and CRP levels of patients in the CG were significantly higher than in the LG (p<0.05).

The erythrocyte sedimentation rate and CRP levels are defined as independent predictive factors to estimate conversion to open surgery (OR 1.04, 95%, CI 1.00-1.08; OR 1.01, 95%, CI 1.00-1.01, respectively) (Table 2). In the ROC curve analysis, the effect of the CRP level at initial reference > 109 mg/L (specificity 73%, sensitivity 74%) and ESR > 65 mm/hour (specificity 66%, sensitivity 70%) were found efficient on conversion to open procedure (Figure 1 and 2).

Table 2. Logistic regression analysis.

	OR	**p**	**CI**
CRP	10.211	0.001	0.980-0.995
Gender	1.662	0.197	0.934-1.014
WBC	0.112	0.738	1.000-1.000
ESR	4.878	0.027	1.160-12.041
Fever	1.531	0.216	0.318-1.296
Age	0.184	0.668	0.966-1.022

Among those who underwent LC, mild inflammation was detected in 53 patients, and 22 patients showed moderate inflammation during the USG evaluation. Mild, moderate and severe inflammation was detected in 13, 10 and 4 patients in the CG respectively and a statistically significant difference was detected between the groups (p=0.001) (Table 1).

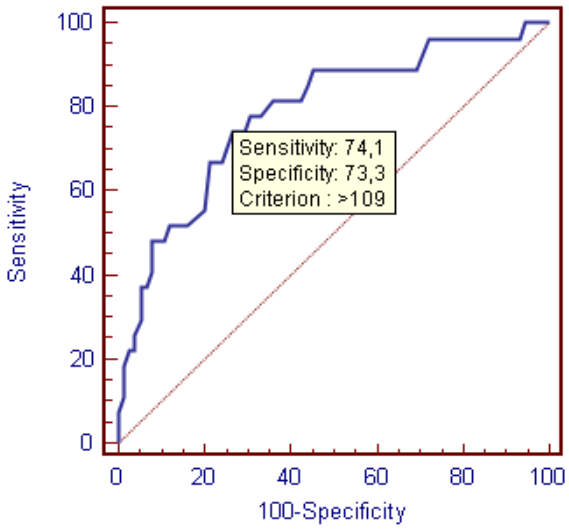

Figure 1. ROC plot shows the power of C-reactive protein measurements.

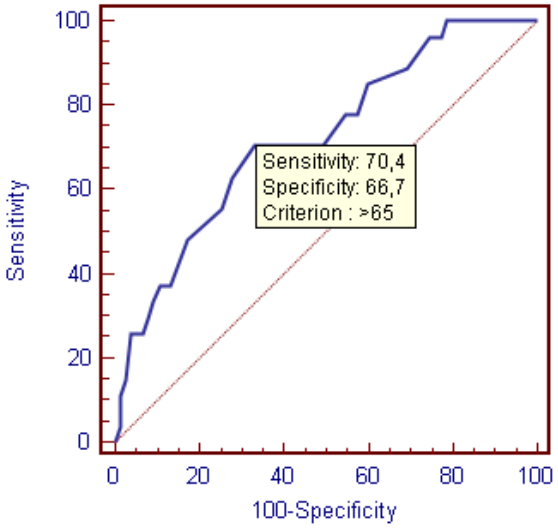

Figure 2. ROC plot shows the power of erythrocyte sedimentation rate analysis.

Morbidity and mortality

The most common factors leading to conversion were inflammation, adhesions (67%) and bleeding (15%) (Table 3). Complications were detected in 11 (14%) patients in the LG (4 major, 7 minor). One patient's operation was converted to open procedure due to intraabdominal bleeding (unexpected opening of the metal clip). Another patient needed a relaparoscopy on postoperative day 1 due to trochar-releated abdominal wall bleeding, and this procedure was also performed on postoperative day 6 on another patient with intraabdominal abscess (was drained). Endoscopic retrograde cholangiopancreatography and sphincterotomy were carried out on postoperative day 5 in another patient with a bile leak. Seven other minor complications (wound infection (n=1), paralytic ileus (n=2), urinary tract infection (n=3), and pulmonary infection (n=1)) were treated with conservative methods. One patient in the LG died on postoperative day 1 from cardiopulmonary arrest. The mean hospital stay was 3.7 ± 2.3 (1-14) days including the treatment for complications.

In the CG, 7 (26%) complications (3 major, 4 minor) were observed. In 3 cases with major complications, a relaparotomy was performed due to venous bleeding from the

liver bed, a bile leak (cystic duct opening due to necrosis) and intraabdominal abscess. Other minor complications (paralytic ileus (n=1), wound infection (n=2), and pulmonary infection (n=1)) were treated with conservative methods. One patient in this group died from multiple organ failure on postoperative day 5. The mean hospital stay was 6.4 ± 2.7 (3-14) days, including the treatment for complications.

Table 3. Indications for conversion.

	n (%)
Inflammations / adhesions	18 (67%)
Bleeding	4 (15%)
Hypercapnia	2 (7%)
Cardiac problems	2 (7%)
Technical difficulty*	1 (4%)
Total	**27**

*Failure of the laparoscopic light source

Discussion

Within the entire study group, 73.5% of the operations were completed laparoscopically and 26.5% were done with the open method. Acute cholecystitis was confirmed histopathologically in all patients postoperatively. This study confirmed that being a male, showing high ESR and CRP levels, and severe findings of AC by the USG were statistically significant risk factors for conversion to an open procedure. Although age and WBC count were high in the CG, they were not statistically significant.

The limiting factors of this study were the small number of patients and a lack of randomization between the two groups.

The conversion rate in our study was 26.5%. The reported rate of conversion as indicated in the literature is between 7-38% [8-10]. For various reasons, a more experienced surgeon was consulted when making the decision to convert to an open surgery. Although our conversion rate was higher than some studies, it was still within the limits reported in the literature. In the CG, the number of male patients was higher than the women (17 vs. 10) and the mean age was 64.7 years. Some studies have focused on the fact that the rate of conversion is higher in older and male patients [10-12]. Our data showed no significant differences when comparing the mean ages of patients between the LG and the CG, however, it was determined that the rate of conversion in men was significantly higher than that of the women. The reason of this difference is unclear. It was estimated to be due to the anatomical location of the gall bladder in men [13]. In addition, the intraabdominal adhesions and inflamation were responsible for conversion in men [13].

Some authors have remarked that severe inflammation and associated adhesions were among the most important factors in making a change from conversion to open procedure and because of the severe inflammation, late cholecystectomy (open or laparoscopic) may increase the rate of complications. [10-12, 14, 15]. Many diagnostic tests are used to define the severity of inflammation including CRP. A study by Schafer M. et al. [10] stated that inflammation was more severe in patients with higher levels of CRP, and the rates of associated complications and postoperative mortality were also higher. The analysis showed that the mean CRP values for LC and conversion to open and open cholecystectomy was 37 mg/L, 127.1 mg/L and 132.2 mg/L, respectively; and the CRP values of LC patients were significantly lower than the other groups [7]. High values of CRP were a powerful diagnostic tool to detect the severity of inflammation, especially in tissue necrosis and bacterial infection [16, 17]. In our analysis, the mean serum CRP level in the LG was 87 mg/L, however in the CG it was 175 mg/L. Since high CRP levels indicate inflammation, we think this test may help the surgeon to correctly predict the need for conversion.

White blood count levels increase in the first few hours of gall bladder inflammation. However, various articles have stated that WBC levels provide limited data in the differentiation of mild and severe cases [10, 18]. According to our data the mean level of WBC in the CG was high (14.096/mm3), but no significant difference was found when compared with the LG. The erythrocyte sedimentation rate is an effective diagnostic test in detecting the severity of infection and inflammation and it can be used also for AC. In a study, which was published by Mealy K et al. [19] the ESR values in open and laparoscopic operations was compared and were stated that the levels in the open group were higher than in the other group. We found the ESR levels, which are effective in defining the severity of inflammation, significantly higher in the CG.

The studies, which investigated whether the preoperative USG findings of gall bladder were effective for conversion, stated that pericholecystic fluids and severe inflammation features on the USG were determining factors in conversion to an open procedure [20-22]. Considering the USG findings of our study, no severe AC findings were observed in the LG, but 4 cases with severe inflammation features were observed in the CG. The analysis showed that in cases of severe USG findings, the incidence of conversion to an open procedure increased significantly. When compared to the postoperative histopathologic examination, we believe that the USG is an effective method in defining the severity of inflammation despite providing false negative results in patients with necrosis of the gall bladder.

Regarding postoperative complications, no significant differences between the groups were found, but it should be noted that in cases of AC, insisting on the laparoscopic method rather than conversion to an open procedure may lead to complications in some cases.

As a conclusion, some parameters should be considered to reduce the possible complications in the perioperative stage of AC cases. We are of the opinion that male gender, high CRP and ESR values and severe USG findings are useful predictive factors which may warn the surgeon of major complications and thus help facilitate a conversion to open surgery.

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