Evaluation of power Doppler sonography in acute cholecystitis to predict intraoperative findings: a prospective clinical study

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ABSTRACT

BACKGROUND: This study aimed to evaluate the diagnostic value of gray-scale and power Doppler sonography for acute cholecystitis and show a correlation between sonographic and intraoperative findings, quantitively.

METHODS: Forty chronic and forty acute cholecystitis patients were examined. Early laparoscopic cholecystectomy was performed for acute cholecystitis. Demographic characteristics, sonographic findings, and adhesion scores were analyzed. Data were collected prospectively (clinicaltrials.gov: NCT02156947).

RESULTS: Wall thickness (≥3 mm) and vascularity increased in acute cholecystitis (p<0.01 and <0.01). Vascularity was found to be moderately correlated with adhesion (p<0.01, r=0.59) but it did not affect the difficulty of the operation by means of perforation, conversion rate, and operation time. In addition, wall thickness did not correlate with adhesion formation (p=0.36). Sensitivity and specificity of wall thickness and vascularity were found to be 96.9%, 72.7%, and 68%, 87.2%, respectively. When both diagnostic measurements were taken into account, sensitivity was calculated 69.7% and specificity reached up to 97.6%.

CONCLUSION: Vascularity correlated with adhesion but failed to predict operation difficulty. Specificity of gray-scale sonography could be improved with power Doppler examination; however, desired diagnostic accuracy could not be obtained with only quantitative measurements of sonography.

Key words: Acute; cholecystitis; chronic; power Doppler; vascularity.

INTRODUCTION

For a long time, gray-scale sonography has generally been considered first-line diagnostic tool for patients with suspected gallbladder (GB) diseases. Moreover, it has been proven to be a valuable imaging technique in differential diagnosis for acute or chronic cholecystitis. In the presence of gallstones, sonographic findings such as GB wall thickening and the Murphy’s sign has 95.2% sensitivity for the diagnosis of acute cholecystitis. In acute cholecystitis, GB wall thickness is caused by increased vascularity of the GB wall but in chronic cholecystitis it is caused by fibrosis. On the other hand, a number of conditions can cause GB wall thickness, such as pancreatitis, hepatitis, cirrhosis, and congestive heart failure. In order to increase the specificity of the diagnosis, determining the vascularity of the GB wall with Doppler sonography showed valuable diagnostic benefits in previous reports and diagnostic superiority was obtained especially with power Doppler sonography. Despite higher diagnostic capability of power Doppler sonography for the discrimination of acute cholecystitis from the chronic form, the real challenge is to determine the association between sonographic findings and predicting the difficulty of dissection and to help physician to make a clear decision for performing or not performing an emergent operation. So as to evaluate the diagnostic and prognostic value of gray-scale and power Doppler sonography for acute cholecystitis, it was our aim to show a correlation between...
quantitative sonographic findings and intraoperative adhesion scale and compare it with the chronic cholecystitis as a control group.

MATERIALS AND METHODS

A total of eighty cholecystitis patients (40 symptomatic chronic, 40 acute) treated in our tertiary care center between January 2012 and July 2013 constituted the study groups. An informed consent was taken from all patients before they were included into the study. The protocol of this prospective clinical study was approved by the local Institutional Review Board (4/16.01.2012). Data were collected prospectively (clinicaltrials.gov registration ID: NCT02156947). The occurrence of clinical signs in the first 72-96 hours after the onset of symptoms was termed as acute cholecystitis. The diagnosis of acute cholecystitis was made on clinical, sonographic and laboratory findings. Acute right upper quadrant abdominal pain with positive Murphy's sign, fever, leukocytosis were considered clinically; distended GB, presence of gallstones or sludge, GB wall thickness of 3-mm or more, and sonographic Murphy's sign were considered sonographically significant. If a patient was diagnosed with acute cholecystitis, he or she was informed about early laparoscopic cholecystectomy (LC) and if LC was accepted, the patient was included into the study and operated in the first 24 hours following the diagnosis. Detected cholecdocholithiasis and patients <18 years of age were excluded. No age limit was specified. Age and sex were recorded.

All patients were examined by a single radiologist with Mindray DC-7 ultrasonography device and a 3.5 MHz abdominal transducer, following a fasting period of a minimum of 6 hours. Gray-scale abdominal US examination was followed by power Doppler examinations in which quantitative measurements were made according to previous report of Uggowitzer et al. Vascularity was 0 if there was no vessel within the GB wall; vascularity was + when no more than two signals per centimeter were detected within the wall; vascularity was ++ when there were multiple scattered signals; and continuously depicted vessels for a length of at least 25 mm were assigned a vascularity ++++. In addition, sonographic GB wall thickness and free fluid on the GB fossa were recorded.

All operations were performed by the senior staff of our clinic. The technique used for LC was the conventional four-trocar approach. Inability to provide critical view of safety was considered an indication for conversion to open cholecystectomy. GB adhesion score developed by Akoğlu et al. and intraoperative findings of patients were assessed and recorded by one surgeon (S. C.). Adhesion scoring scale is recorded by one surgeon (S. C.). Adhesion scoring scale is used. For easy interpretation of the association, sub-classification for vascularity and intraoperative adhesion scale were performed. The technique used for LC was the conventional four-trocar approach. Inability to provide critical view of safety was considered an indication for conversion to open cholecystectomy. GB perforation during dissection, conversion to open cholecystectomy, operation time, drain usage and intraoperative complications were recorded. Operation time was calculated from the initiation of skin incision to the last skin suture.

Postoperative pain measured by visual analog scale (VAS) was recorded.

Data were presented as mean±standard deviation (SD) or median (min-max) according to the distribution pattern. Student’s t test and Mann-Whitney U test were used for the comparison of continuous variables. Chi-Square test and Fisher’s Exact test were used for the comparison of categorical variables. Kendall’s Tau-b Correlation test was used for correlation analysis of categorical variables. A p value less than 0.05 was considered statistically significant. Statistical analyses were performed with SPSS Version 16.00 (Chicago, IL, USA).

RESULTS

All patients were operated successfully without any intraoperative complications. Seven (17.5) of the forty patients in the acute cholecystitis group were crossed over to chronic cholecystitis group after the pathological assessment of the specimens. All statistical analyses were conducted according to pathologically proven chronic (n=47) and acute cholecystitis (n=33).

Age and sex were similar between the groups. Demographic and descriptive characteristics of the groups are presented in Table 1.

For easy interpretation of the association, sub-classification for vascularity and intraoperative adhesion scale were performed. After the pilot statistical analysis with different combinations, mild / severe (0, +/++, +++; and Grade I, II/Grade III, IV) sub-classification for vascularity and intraoperative adhesion scale was used.

Wall thickness (≥3 mm) and vascularity were found to be increased in acute cholecystitis (p<0.01 and <0.01).

Vascularity was found to be moderately correlated with adhesion in acute cholecystitis (p<0.01, r=0.59) but wall thickness did not reveal any correlation (p=0.36).

In acute cholecystitis patients, according to vascularity and adhesion grade, GB perforation, conversion and operation time were not different (p=0.07, 0.99; 0.99, 0.99; and 0.35, 0.18, respectively). Drain usage was found to be statistically
significant regarding the vascularity and adhesion in acute cholecystitis (p=0.02 and 0.05) while postoperative pain score was different with adhesion (p<0.01).

Sensitivity and specificity of increased wall thickness and vascularity for the proof of pathological diagnosis of acute cholecystitis were found to be 96.9%, 72.7% and 68%, 87.2%, respectively. When both diagnostic measurements were taken into account, sensitivity was calculated 69.7%, and specificity reached 97.6%. Receiver operating characteristic (ROC) analysis of the patients with pathologically confirmed acute cholecystitis is shown in Figure 1.

**DISCUSSION**

Radiological discrimination between chronic and acute cholecystitis is important in terms of decision making. If the decision is made as acute cholecystitis, a cholecystectomy should be performed within the first 72 hours for more satisfactory results for the patients and the surgeons.\(^7\)\(^8\) In the past, laparoscopic cholecystectomy was considered a relative contraindication in the treatment of acute cholecystitis.\(^9\) With the accumulating experience in laparoscopic surgery, laparoscopic cholecystectomy (LC) has become the gold standard treatment for benign biliary diseases even in acute cases. It has been shown that early laparoscopic cholecystectomy during acute cholecystitis is safe and shortens total hospital stay.\(^10\) Although laparoscopic approach to acute cholecystitis has a number of advantages, timing of the operation and intraoperative findings of GB wall inflammation are critical for performing a safe cholecystectomy. In the beginning of gallbladder wall inflammation, adhesions are easily dissected from the liver bed within the oedematous periton around the gallbladder. Progression in the inflammation makes the dissection difficult and increases the perforation rate of the gallbladder.\(^11\) Furthermore, distortion of the anatomy by severe inflammation and related fibrous adhesions increase the risk of bleeding and bile duct injury.\(^10\) These findings may lead the surgeon to convert LC to an open cholecystectomy. In our patients, intraoperative bleeding or bile duct injury were not encountered. Various conversion rates have been reported in the literature, ranging from 4.9% to 29%.\(^12\)\(^-\)\(^14\) With limited number of patients, our conversion rates were 2.1% and 3%, in

### Table 1. Demographic and descriptive characteristics of the groups

<table>
<thead>
<tr>
<th>Pathologic diagnosis</th>
<th>Chronic cholecystitis</th>
<th>Acute cholecystitis</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>Mean±SD</td>
</tr>
<tr>
<td>Number of patients</td>
<td>47</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>48.8±14.2</td>
<td>52.1±11.2</td>
<td>0.26</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>36</td>
<td>76.6</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>11</td>
<td>23.4</td>
<td></td>
</tr>
<tr>
<td>GB wall thickness</td>
<td>2.2±0.7</td>
<td>4.6±1</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>GB wall vascularity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>8</td>
<td>17</td>
<td>1</td>
</tr>
<tr>
<td>+</td>
<td>33</td>
<td>70.2</td>
<td></td>
</tr>
<tr>
<td>++</td>
<td>6</td>
<td>12.8</td>
<td></td>
</tr>
<tr>
<td>+++</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Free fluid on GB fossa</td>
<td>1</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td>GB adhesion scoring scale</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade I</td>
<td>20</td>
<td>42.6</td>
<td>4</td>
</tr>
<tr>
<td>Grade II</td>
<td>21</td>
<td>51.1</td>
<td>11</td>
</tr>
<tr>
<td>Grade III</td>
<td>2</td>
<td>4.2</td>
<td>15</td>
</tr>
<tr>
<td>Grade IV</td>
<td>1</td>
<td>2.1</td>
<td>3</td>
</tr>
<tr>
<td>Operation time</td>
<td>78.7±20</td>
<td>79.8±26.3</td>
<td>0.78</td>
</tr>
<tr>
<td>Conversion to open</td>
<td>1</td>
<td>2.1</td>
<td>1</td>
</tr>
<tr>
<td>Perforation</td>
<td>5</td>
<td>12.8</td>
<td>7</td>
</tr>
<tr>
<td>Drain usage</td>
<td>9</td>
<td>19.1</td>
<td>15</td>
</tr>
<tr>
<td>Postop pain (VAS), median (min-max)</td>
<td>3</td>
<td>0-9</td>
<td>5</td>
</tr>
</tbody>
</table>

GB: Gallbladder; VAS: Visual analog scale.
However, our drain usage rate of 45.5% in acute insertion adds no benefits even in complicated acute cholecystitis. In recent years, drain usage in surgery has been a commonly associated with all of these factors since most of our patients were female, the median age was 51 years (19-79), and all operations were performed by our experienced senior staff.

In our study, obtained lower rate of conversion could be associated with all of these factors since most of our patients were female, the median age was 51 years (19-79), and all operations were performed by our experienced senior staff.

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tion was found between severe vascularity and severe intra-operative adhesion grade but increased wall thickness was not correlated with the presence of adhesion. The positive correlation between severe vascularity and severe adhesion formation did not affect the difficulty of the operation in our patients by means of GB perforation, conversion rate and operation time. Drain usage increased in the presence of severe vascularity and severe adhesion. Postoperative pain did not increase in severe vascularity but it increased in the patients developing severe adhesions.

It must be noted that our study had some strong and weak points. For the elimination of inter-operator changes, one radiologist examined all patients, one surgeon assessed GB adhesion score in all operations, and all measurements were based on quantitative scoring systems. Additionally, in order to overcome heterogeneities in previous studies, regarding the sample size and the time frame between diagnosis to operation, patients with confirmed diagnosis of acute cholecystitis were operated in the first 24 hours. On the other hand, the difficulties of laparoscopic cholecystectomy were indirectly assessed in terms of GB perforation, conversion rate and operation time; however, all relevant factors affecting the difficulty of the operation, such as body mass index (BMI), symptom duration, number of right-upper quadrant pain attack, were not evaluated. Moreover, our sample size was relatively small, especially for the evaluation of rare complications of surgery.

Conclusion

Our results indicated that GB wall vascularity correlated with adhesion formation but failed to predict difficulties in the dissection of the operation. The diagnostic specificity of gray-scale sonography for acute cholecystitis could be improved with additional power Doppler examination. However, desired diagnostic accuracy of preoperative sonography could not be obtained with only quantitative measurements.

Conflict of interest: None declared.

REFERENCES

Ọlgu sunumu

Akut kolesistitte intraoperatif bulguları öngörmede power Doppler ultrasonun değerlendirilmesi: İleriye yönelik klinik çalışma

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AMAÇ: Akut kolesistit tanısında gri-skala ve power Doppler ultrasonografının değerini belirlemek için quantitatif sonografik ve intraoperatif bulgular arasındaki ilişkiyi göstermek amaçlandı.


BULGULAR: Duvar kalınlığı (≥3 mm) ve vaskülarite akut kolesistitte artırdı (p<0.01 ve <0.01). Vaskülerite ile adezyon arasında orta düzey ilişki saptanmasına rağmen (p<0.01, r=0.59) perforasyon, konversiyon ve operasyon süresi açısından ilişki saptanmadı. Duvar kalınlığı adezyon gelişimi ile ilişkili değildi (p=0.36). Duvar kalınlığı ve vaskülerite için duyarlılık ve özgüllük sırasıyla: %96.9, %72.7 ve %68, %87.2 idi. Her iki tanısal değerlendirmede birleşirlüğünde duyarlılık %69.7 iken, özgüllük %97.6'ya çıkmaktaydı.

TARTIŞMA: Vaskülerite, adezyon gelişimi ile ilişkili, ancak operasyon zorluğunu belirlemede yetersiz idi. Gri-skala ultrasonografının özgüllüğünün power Doppler incelemesi ile artırılabileceği görüldü, ancak istenilen tanısal doğruluğa sadece quantitatif ultrasonografik bulgular ile ulaşlamayacağı anlaşıldı.

Anahtar sözcükler: Akut; kolesistit; kronik; power Doppler; vaskülerite.