**Comparison of Clinical Characteristics and Neutrophil Values in Omental Infarction and Acute Appendicitis in Children**

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### 1. Introduction

Omental infarction is a rare entity in children¹⁻⁴ and conservative treatment is usually safe and effective. However, the manifestation of right lower quadrant abdominal pain may lead to omental infarction being clinically misdiagnosed as appendicitis, with subsequent unnecessary surgery.⁵⁻⁸ Computed tomography (CT) emphasizes the infarcted omentum, which appears as a large cake-like high-attenuation

**Background:** Omental infarction is a rare occurrence in children. It is often diagnosed during surgery for suspected appendicitis. This study investigated the use of clinical and laboratory data for distinguishing between omental infarction and acute appendicitis.

**Methods:** Seven patients with surgically and pathologically proven omental infarction and 28 age- and sex-matched patients with acute appendicitis were included in this study. The clinical characteristics, imaging study results and laboratory data were analyzed.

**Results:** All 35 patients had right lower quadrant abdominal pain at presentation. The frequency of nausea and fever were significantly lower in the omental infarction group compared with the acute appendicitis group \((p<0.001\) and \(p=0.018\), respectively). In laboratory studies, the white blood cell count, C-reactive protein value and neutrophil percentage were all higher in the acute appendicitis group compared with the omental infarction group \((p=0.001, p<0.001,\) and \(p=0.008\), respectively). It was possible to separate patients with omental infarction from those with acute appendicitis based on a neutrophil percentage of less than 77% (sensitivity 100%, specificity 100%).

**Conclusions:** Results of the current study suggest that omental infarction should be considered as a possible diagnosis in patients presenting with right lower quadrant abdominal pain without nausea or fever, and with a neutrophil percentage below 77%.
fatty mass centered in the omentum,\textsuperscript{9,10} permitting an appropriate preoperative diagnosis. However, in a previous study,\textsuperscript{11} four of the six omental infarction patients could not be accurately diagnosed by preoperative CT scans, and three of the six patients were incorrectly diagnosed with acute appendicitis before surgery. Stefanutti et al\textsuperscript{12} and Wang et al\textsuperscript{13} suggested that the combination of elevated white blood cell (WBC) count and C-reactive protein (CRP) levels could provide additional information that would allow surgeons to confirm acute appendicitis before surgery.

We conducted a case-control study with surgically-proven omental infarction patients and age- and sex-matched controls with acute appendicitis to determine if clinical presentations, WBC/differential count and CRP could distinguish between omental infarction and acute appendicitis in children prior to surgery.

2. Materials and Methods

2.1. Patients

All the subjects were children with surgically and pathologically proven omental infarction or acute appendicitis in our hospital from 2005 to 2008. All patients were diagnosed with acute appendicitis before surgery and underwent laparoscopic omentectomy or appendectomy, respectively, performed by a single experienced pediatric surgeon (S.Y. Lee). We retrospectively analyzed the clinical characteristics, complete blood cell counts, CRP values and operative outcomes in both groups. The study was approved by the Ethics and Clinical Research Committee of the Chang Gung Memorial Hospital.

2.2. Collection of clinical and laboratory data

Major clinical features and laboratory data, including complete blood cell count, differential count and CRP values were recorded in both groups of patients and coded for analyses. Laboratory data were obtained before surgery. The absolute differential count was calculated from the total WBC count, together with the percentage of differential count from peripheral blood samples. Only one patient with omental infarction underwent sonography before surgery, and a 5-cm mass was tentatively diagnosed. None of the patient with omental infarction underwent CT scanning.

2.3. Statistical analysis

All values in the figures and tables are expressed as mean±standard error. Student’s t tests (unpaired, two-tailed) were used for comparisons between groups. A p value <0.05 was considered statistically significant. Differences in frequencies between groups were calculated using $\chi^2$ tests. The receiver operating characteristics (ROC) curve method was used to differentiate between acute appendicitis and omental infarction; different cut-off points had different sensitivities and specificities for the diagnosis of acute appendicitis. The cut-off points for accurate diagnosis of acute appendicitis by neutrophil percentage and CRP level were based on the highest value of sensitivity plus specificity identified by ROC curve. All statistical tests were performed using SPSS version 12.0 (SPSS Inc., Chicago, IL, USA).

3. Results

3.1. Clinical features of omental infarction and acute appendicitis

Approximately 100 appendectomies per year are performed on children at our hospital. However, only seven patients with surgically and pathologically proven omental infarction were identified between 2005 and 2008. The present study enrolled these seven patients with omental infarction [6 boys (86%) and 1 girl (14%)], as well as 28 patients with acute appendicitis [24 boys (86%) and 4 girls (14%)]. All patients with omental infarction were diagnosed as having acute appendicitis before surgery. Detailed patient histories were recorded including age, sex, initial symptoms and signs before surgery, and duration of hospitalization (Table 1). Omental infarction occurred at around 10 years old, and there was a male predominance. The most common signs and symptoms in both groups were right lower quadrant pain and tenderness. However, patients in the omental infarction group had less nausea or vomiting and fewer than those in the acute appendicitis group ($p<0.001$ and $p=0.018$, respectively). Only one patient with omental infarction underwent sonography, which showed a 6-cm heterogeneous echogenic mass in the right lower abdominal quadrant. It is possible that a lack of awareness contributed to the failure to make a preoperative diagnosis of omental infarction in this case. No patients with omental infarction underwent CT scans before surgery. In the omental infarction group, a portion of the right omentum was found to be ischemic and hemorrhagic, with severe edema and normal appendiceal morphology. Notably, the duration of hospitalization after surgery was shorter in the omental infarction group than in the acute appendicitis group (1.86±0.46 vs. 5.1±0.39, $p<0.001$). There were no complications or antibiotics prescribed in the omental infarction...
group during the short-term hospitalization after laparoscopic omentectomy.

3.2. Significantly lower total white cell count and CRP levels in omental infarction compared with acute appendicitis

To further characterize the inflammatory markers, we compared the WBC counts and CRP levels between the two groups. WBC count, neutrophil count and CRP level were all significantly higher in the acute appendicitis group than those of the omental infarction group (Table 2). There were no significant differences in hemograms or platelet counts between the groups. The WBC count also showed left shifting in the acute appendicitis group, with a significantly higher neutrophil percentage (Figure 1). To more accurately distinguish between these two groups, we chose cut-off points for neutrophil percentage and CRP level based on the highest values of sensitivity plus specificity identified by ROC curves. A neutrophil percentage above 77% had a sensitivity of 96.4% and specificity of 100% for the diagnosis of acute appendicitis, while a CRP level above 56mg/L had a sensitivity of 53.5% and specificity of 85.7%. We combined the neutrophil percentage and CRP level with cut-off points of 77% and 56mg/L, respectively. According to these criteria, patients with omental infarction might have leukocytosis and elevated CRP levels, but none of the patients in this group had a neutrophil percentage of above 77% (Table 3). Nevertheless, the acute appendicitis group showed a trend towards higher neutrophil percentages, irrespective of the CRP level.

Table 1 Demographic data for patients with omental infarction and acute appendicitis patients

<table>
<thead>
<tr>
<th>Variable</th>
<th>Omental infarction (n=7)</th>
<th>Acute appendicitis (n=28)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>10.86 ±0.60</td>
<td>11.11 ±0.31</td>
<td>0.722</td>
</tr>
<tr>
<td>Male sex</td>
<td>6 (86%)</td>
<td>24 (86%)</td>
<td>1</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>39.14 ±0.98</td>
<td>38.23 ±2.07</td>
<td>0.692</td>
</tr>
<tr>
<td>Nausea or vomiting</td>
<td>1 (14%)</td>
<td>25 (90%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Fever</td>
<td>1 (14%)</td>
<td>18 (64%)</td>
<td>0.018</td>
</tr>
<tr>
<td>McBurney sign</td>
<td>7 (100%)</td>
<td>28 (100%)</td>
<td>1</td>
</tr>
<tr>
<td>Hospitalization (d)</td>
<td>1.86 ±0.46</td>
<td>5.10 ±0.39</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Table 2 Comparison of complete blood count and C-reactive protein levels between omental infarction and acute appendicitis patients

<table>
<thead>
<tr>
<th>Variables</th>
<th>Omental infarction (n=7)</th>
<th>Acute appendicitis (n=28)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>White blood cell (×10^9/L)</td>
<td>11.928 ±1.042</td>
<td>16.207 ±0.857</td>
<td>0.024</td>
</tr>
<tr>
<td>Hemoglobin (g/L)</td>
<td>137 ±7</td>
<td>136 ±11</td>
<td>0.775</td>
</tr>
<tr>
<td>Platelets (×10^9/L)</td>
<td>301.8 ±22.0</td>
<td>277.2 ±12.3</td>
<td>0.369</td>
</tr>
<tr>
<td>Neutrophils (×10^9/L)</td>
<td>8.080 ±0.832</td>
<td>14.057 ±0.781</td>
<td>0.001</td>
</tr>
<tr>
<td>C-reactive protein (nmol/L)</td>
<td>319 ±110</td>
<td>865 ±158</td>
<td>0.008</td>
</tr>
</tbody>
</table>

Figure 1 Neutrophil percentage was lower in patients with omental infarction than in those with acute appendicitis.

4. Discussion

Our results demonstrated that although omental infarction presenting as right lower quadrant
abdominal pain could mimic acute appendicitis, it was associated with less nausea and fever, a lower WBC count and CRP level, and in particular a lower neutrophil percentage than acute appendicitis. Evaluation of a child with acute onset of abdominal pain is a common challenge in any children’s hospital. The differential diagnosis of right lower quadrant pain in children includes appendicitis, diverticulitis, ischemic colitis, omental infarction and numerous other acute abdominal conditions of the right abdomen. However, acute appendicitis remains by far the most common diagnosis. The pathogenesis of omental infarction has been attributed to an embryologic variant of the blood supply to the right portion of the omentum, which predisposes it to venous thrombosis following omental torsion, although it does not develop extensive inflammation. Omental infarction resulting from omental torsion leads to thrombosis around the distal right epiploic artery. It can cause right-sided abdominal pain, but rarely induces a generalized inflammatory response in an aseptic environment. However, it is often overlooked as a cause of acute abdominal pain. A male predominance has been reported in patients with omental infarction. Varjavandi et al² reported that patients with omental infarction tended to be obese, but no significant difference in body weight was found between the groups in the current study. Primary or secondary abnormalities of the omental pedicle leading to vessel thrombosis might be more important than obesity. Omental infarction rarely causes intestinal irritation or systemic inflammatory response, which could account for the rare occurrence of nausea, vomiting and fever. The rationale for using the results of laboratory tests to differentiate between omental infarction and acute appendicitis is based on the possibility that signs of systemic inflammation could be detected using easy and widely available methods. The presence of a raised WBC count, left shifting and elevated CRP value show a high degree of sensitivity for diagnosing acute appendicitis.¹²,¹³ We chose the cut-off points of neutrophil percentage to be above 77% and CRP level to be above 56 mg/L (533 nmol/L) to separate these two groups of patients, based on the highest value of sensitivity plus specificity identified by ROC curve. All of the seven omental infarction patients in this study had neutrophil percentages below this cut-off point. Increased WBC count was less reliable for separating these two groups, despite the fact that acute appendicitis patients tended to have higher WBC counts. Indeed, one patient with omental infarction had a WBC count of 17.2 × 10⁹/L. Our results suggest that neutrophil percentage may be a more helpful measure for differentiating between omental infarction and acute appendicitis. However, there may be exceptions, as Sakellaris et al¹⁶ presented two boys with omental infarctions who had neutrophil percentages of above 77% and normal WBC counts.

Theoretically, sonography can reveal noncompressible hyperechoic lesions at the site of tenderness in omental infarction patients.¹ However, a lack of awareness of omental infarction means that sonography still shows low sensitivity for its diagnosis.⁵,¹⁷ Preoperative CT scans can reduce the negative appendectomy rate in adult females, but not in adult males or children.⁶ Abadir et al⁶ demonstrated that CT scans were more sensitive than sonography for diagnosing omental infarction. Based on an accurate diagnosis of omental infarction, increasing evidence suggests that a conservative approach can provide safe and successful treatment.⁶,⁷,¹⁴ Alternatively, laparoscopic omentectomy is also effective for diagnosing and treating omental infarction.⁶,¹⁵,²⁰,²¹ All of the patients in the current study who underwent laparoscopic omentectomy experienced immediate and uneventful resolution of pain, with no morbidity after short-term hospital stay.

In summary, omental infarction often mimics acute appendicitis in children. Results of the present study stress that a diagnosis of omental infarction should be considered in patients presenting with right lower quadrant abdominal pain without nausea or fever, and with a neutrophil percentage that is below 77%.

References
