Appendicitis in Bahrain: A study of prevalence, bacterial colonisation and postoperative wound infection

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Abstract
Objective: To study prevalence of appendicitis, the bacterial colonization of inflamed appendices and the associated post operative wound infection.

Design: A prospective study in a twenty-four month period. Histopathological and bacteriological studies of excised appendices, and bacteriological cultures from post operative wounds were carried out.

Setting: Department of Pathology, Division of Microbiology and Department of Surgery, Salminiya Medical Centre, Bahrain.

Subjects: Five hundred and thirty-three patients operated upon for acute appendicitis, of whom 192 patients were studied for bacterial colonization.

Results: Most cases (96%) occurred in patients below 40 years of age. Histopathologically (12%) had perforated appendices. A hundred and two patients (53%) had sterile cultures; with perforated appendices having the highest rate (90%) followed by gangrenous (56%) and acutely inflamed appendices (37%). Escherichia coli was the predominant organism isolated (48%) while Rectoroids spp accounted for only (7.7%). The post operative infection rate was (6.4%). Escherichia coli and Bacteroides spp were the predominant isolates. Members of Enerobacteriaceae constitutes 75% of isolates.

Conclusion: Incidence of acute appendicitis is relatively high in Bahrain. Bacterial role in the aetiology is suspected especially by Escherichia coli; its precise role in acute appendicitis warrants further investigations.

Keywords: Appendicitis, bacterial colonization

The incidence of acute appendicitis varies in different parts of the world. High incidence is found in Europe while low incidence is found in Africa. In Bahrain the incidence of the disease is not known. The aetiology of the disease is not completely understood. Lack of dietary fibre has been implicated in the past, but recently this theory has been challenged and the role of infection emphasised.

Appendicitis occurs mostly in young adults with a peak incidence in the early 20s, and declines at both ends of the age spectrum. Appendectomy is a routine surgical procedure with very low mortality. However, wound infection is a common complication, in which the incidence has been variously estimated to occur in up to 30% or more of cases. The likelihood of wound and septic complication is greater when perforation has occurred before surgical intervention.

Since the infection aetiology of appendicitis has been proposed, several studies have highlighted the importance of anaerobes, particularly Bacteroides fragilis in the pathogenesis of acute appendicitis. The present study describes the bacterial colonisation of inflamed appendices and the associated post operative wound infection in Bahrain.

Patients and methods. Out of a total of 533 patients, undergoing surgery for acute appendicitis in a 24 month period, 192 were studied for the appendicular bacterial colonization while 221 patients were studied for the development of post-operative wound infection. Detailed information of the patients was recorded including age, sex, date of admission and discharge.

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**Antibiotic therapy.** A defined protocol for the administration of antibiotics was followed. Patients with signs of non-complicated appendicitis, i.e., patients showing minimal clinical manifestations with stable vital signs were not given antibiotics pre-operatively. Patients with clinical signs of complicated appendicitis, i.e., showing changes in the vital signs in addition to rigidity of the abdominal wall in the affected site and exaggerated clinical manifestations of acute appendicitis, were given cefuroxime 750 mg i.v. and metronidazole 500 mg i.v. immediately before the induction of anesthesia. If the operative findings showed the appendix to be inflamed, gangrenous, perforated, or if there was local or generalised peritonitis, the antibiotics were continued for three to five days, depending on the progress of the patient.

**Bacteriological and histopathological studies.**

After opening the peritoneal cavity, two swabs were taken from the appendix fossa. One swab was immediately placed in pre-heated Robertson cooked meat, and the second in Aimes transport media. The excised appendix was sent to the histopathology laboratory for diagnosis.

- The swab in Robertson cooked meat was subcultured on blood agar and 0.1% neomycin blood agar incubated anaerobically either using the gas pack system or in an anaerobic cabinet (Don Whitely) in an atmosphere of 90% nitrogen, 5% hydrogen and 5% v/v carbon dioxide. The plates were examined after 24 hours and daily for 5 days.
- The swab in Aimes transport media was plated on blood agar, and MacConkey agar; the plates were incubated aerobically for 24 hours at 37°C.

**Identification of bacteria.** Strains belonging to Enterobacteriaceae were identified using API 20E identification system. Anaerobes were identified by aerotolerance antibiotic susceptibility pattern and according to biochemical reactions.

**Post-operative wound infection.** Wound infection was diagnosed on clinical and/or positive bacteriology culture. Clinically, wound infection was defined whenever a purulent discharge or wound dehiscence was observed. Two swabs were taken from each wound for aerobic and anaerobic bacterial culture using a suitable transport media as mentioned before. Culture and identification of bacteria were as described above.

**Results**

The occurrence of the disease in different age groups is given in Table 1.

The peak incidence occurred in patients in the 21-30 years age group (32.8%). The majority of cases (95.6%) occurred in patients below the age of 40 years. As for sex, there was a male to female ratio of 2.6 to 1.

**Table 1 - Incidence of acute appendicitis in different age groups**

<table>
<thead>
<tr>
<th>Age (Years)</th>
<th>Number of cases</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 10</td>
<td>91</td>
<td>17.0</td>
</tr>
<tr>
<td>11 - 20</td>
<td>158</td>
<td>29.6</td>
</tr>
<tr>
<td>21 - 30</td>
<td>175</td>
<td>32.8</td>
</tr>
<tr>
<td>31 - 40</td>
<td>88</td>
<td>16.5</td>
</tr>
<tr>
<td>41 - 50</td>
<td>19</td>
<td>3.5</td>
</tr>
<tr>
<td>51 - 60</td>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td>61 - 70</td>
<td>1</td>
<td>0.2</td>
</tr>
</tbody>
</table>

**Results of the bacterial culture of appendix fossa.** From 192 patients studied, 102 (53%) had sterile cultures, whereas 92 (47%) had a positive bacterial culture. Table 2 gives the number of types of cultures obtained in the different clinical groups; whereas the numbers and bacterial species isolated in each clinical group are given in Table 3.

**Table 2 - Types and number of bacterial cultures in four clinical groups**

<table>
<thead>
<tr>
<th>Group</th>
<th>Sterile</th>
<th>Pure Anaerobes</th>
<th>Pure Aerobes</th>
<th>Anaerobes &amp; Aerobes</th>
<th>% of +ve Cultures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>14</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>30%</td>
</tr>
<tr>
<td>Group 2</td>
<td>67</td>
<td>0</td>
<td>38</td>
<td>2</td>
<td>37%</td>
</tr>
<tr>
<td>Group 3</td>
<td>19</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>56%</td>
</tr>
<tr>
<td>Group 4</td>
<td>2</td>
<td>0</td>
<td>17</td>
<td>3</td>
<td>91%</td>
</tr>
</tbody>
</table>

Group 1: Normal
Group 2: Acutely inflamed
Group 3: Inflamed gangrenous
Group 4: Perforated

**Results of post-operative wound infection.** Wound infection developed in 15 patients out of 221 studied (6.8%), of whom 8 were diagnosed...
Table 3: Types and number of bacteria isolated from appendix fossa in the different groups

<table>
<thead>
<tr>
<th>Bacterial species</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sterile</td>
<td>14</td>
<td>67</td>
<td>19</td>
<td>2</td>
<td>102</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>2</td>
<td>18</td>
<td>12</td>
<td>12</td>
<td>44</td>
</tr>
<tr>
<td>Klebsiella spp.</td>
<td>1</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Staph. aureus</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Staph. epidermidis</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Pseudomonas</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Aeruginosa</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Proteus mirabilis</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Bacteroides spp.</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>S Typhimurium</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Str. faecalis</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Str. pneumonia</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Beta hemolytic strept.</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Citrobacter spp.</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Enterobacter spp.</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Corynebacterium spp.</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Candida albicans</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>107</td>
<td>43</td>
<td>22</td>
<td></td>
<td>192</td>
</tr>
</tbody>
</table>

Group 1: Normal
Group 2: Acutely inflamed
Group 3: Inflamed gangrenous
Group 4: Perforated

Table 4: Bacterial species isolated from the appendix fossa of 90 patients with acute appendicitis

<table>
<thead>
<tr>
<th>Bacterial species</th>
<th>No of isolates</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Escherichia coli</td>
<td>44</td>
<td>48.8</td>
</tr>
<tr>
<td>Klebsiella spp.</td>
<td>11</td>
<td>12.29</td>
</tr>
<tr>
<td>Staphylococcus aureas</td>
<td>10</td>
<td>11.1</td>
</tr>
<tr>
<td>Bacteroides fragilis</td>
<td>4</td>
<td>4.4</td>
</tr>
<tr>
<td>Bacteroides melaninogenicus</td>
<td>3</td>
<td>3.3</td>
</tr>
<tr>
<td>Proteus mirabilis</td>
<td>3</td>
<td>3.3</td>
</tr>
<tr>
<td>Steptococcus faecalis</td>
<td>3</td>
<td>3.3</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>2</td>
<td>2.2</td>
</tr>
<tr>
<td>Staphylococcus epidermidis</td>
<td>2</td>
<td>2.2</td>
</tr>
<tr>
<td>Beta-hemolytic strept.</td>
<td>2</td>
<td>2.2</td>
</tr>
<tr>
<td>Enterobacter spp.</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>Salmonella typhimurium</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>Citrobacter frundai</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>Corynebacterium spp.</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>Streptococcus pneumonia</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>Candida albicans</td>
<td>1</td>
<td>1.1</td>
</tr>
</tbody>
</table>

clinically, while positive bacteriological cultures were obtained in 7 patients. The type of bacteria isolated are given in Table 5. Aerobes as well as anaerobes were isolated. The most common anaerobe was Bacteroides fragilis and the most common aerobe was Escherichia coli. Members of the Enterobacteriaceae constituted 75% of the isolates.

Table 5: Bacterial species isolated from bacteriological cultures in patients with post-operative wound infections

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive bacteriological cultures No. = 7</td>
<td>Normal Appendix</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acute Inflamed Appendix</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Inflamed Appendix</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Ganganous Appendix</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Perforated Appendix</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

Histopathological results. Patients were divided into four clinical groups according to the histopathological findings on the excised appendices. This is given in Table 6.

Table 6: Histopathology findings of appendices from 192 patients

<table>
<thead>
<tr>
<th>Clinical groups</th>
<th>Group 1 normal</th>
<th>Group 2 acutely inflamed</th>
<th>Group 3 gangrenous</th>
<th>Group 4 perforated</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>20</td>
<td>107</td>
<td>43</td>
<td>22</td>
</tr>
<tr>
<td>%</td>
<td>10</td>
<td>56</td>
<td>22</td>
<td>12</td>
</tr>
</tbody>
</table>

The effect of wound infection on hospital stay. The average hospital stay for patients who did not develop wound infection was 6 days, whereas patients who developed wound infection was 20 days, Table 7.

Table 7: Relationship between wound infection, hospital stay and duration of antibiotics

<table>
<thead>
<tr>
<th>No. of patients</th>
<th>Average hospital stay</th>
<th>Duration of antibiotics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients with wound infection</td>
<td>15</td>
<td>20 days</td>
</tr>
<tr>
<td>Patients without wound infection</td>
<td>206</td>
<td>6 days</td>
</tr>
</tbody>
</table>

Discussion Appendicitis is the most common surgical operation performed in Bahrain. Considering the catchment area of Salmaniya Medical Centre (SMC), this probably represents 70% of all cases of appendicitis occurring in
Bahrain. Compared to other regions of the world, the incidence of acute appendicitis is lower than in European countries, but is higher than in African countries. In Malaysia, 147 patients underwent appendectomy in a district hospital during a 6 month period while in another university hospital 529 cases of acute appendicitis were treated in a 1 year period. In Nigeria, 326 appendectomies were carried out over a 10 year period in a university hospital.

The relationship between the incidence of acute appendicitis and dietary intake of fibre is now well established. In Western countries where the consumption of refined carbohydrate is high, appendicitis is correspondingly high, whereby it is estimated that approximately 12% of the European population will have an attack of appendicitis a year. The dietary intake of fibre of the Bahraini population is generally poor, which explains the common occurrence of the disease.

The peak incidence of acute appendicitis was found to be in age group 21 - 30 years, while 96% of patients were 40 years or below. Also male to female ratio was 2.6:1. This is very much in keeping with established epidemiological data of age and sex in acute appendicitis. The clinical diagnostic accuracy of acute appendicitis was compared to the histopathological findings in the excised appendices. Only 10% of patients operated upon had normal appendices. In a study of diagnostic accuracy in 500 childhood appendectomies, normal appendices comprised 16.2%. Reported diagnostic errors in previous studies are 11.7%, 18.6% and 25%. The finding of 10% normal appendices makes the clinical diagnosis of acute appendicitis to be excellent.

The majority of studies of the bacterial flora in acute appendicitis have highlighted the role of anaerobes, particularly B. fragilis. However, in this study, anaerobic organisms were isolated in small numbers. Although this contradicts the findings in the above studies it is in agreement with the findings of Gilmore and Martin who found Escherichia coli to be the predominant isolate in acute appendicitis and B. fragilis was isolated from only 9 out of 146 patients undergoing emergency surgery for appendicitis.

Moreover Elhaq et al suggested a minor role for B. fragilis in acute appendicitis. They showed that the immune response to the bacteroides group of organisms was present in patients with normal as well as inflamed appendices, and that an IgM antibody response to B. fragilis was present only in patients with septic complications. Bacteroides spp. seems to play a significant role in wound infections, and in septic complications. In our study, bacteroides spp. comprised 30% of the isolates from wound infections.

As is the case with most studies, Escherichia coli was the most predominant organism encountered. Despite the fact that it is a normal inhabitant of the gastrointestinal tract, it is being increasingly recognised as an etiological agent in an increasing spectrum of diseases, such as the hemolytic uraemic syndrome and hemorrhagic colitis and more recently bacterial ileitis. It's precise role in acute appendicitis warrants further investigation.

Comparing bacteria found in acute and complicated (gangrenous or perforated) appendicitis. Baro et al found 2.3 strains per specimen in the former and 9.9 strains per specimen in the latter. They, thus suggested that some bacteria transverse the intact appendiceal wall prior to perforation and that progressive infection and subsequent tissue damage and recесс allow larger numbers and varieties of bacteria to move through appendiceal wall tissue and into the peritoneal cavity. In the present study appendicitis with perforation had the highest bacterial culture (91%).

Post-operative wound infection is a common complication of appendectomy. Estimates vary from 10% to 30%. In cases where perforation of the appendix occurs, post-operative wound infection is usually high.

In studying post-appendectomy wound infection, the overall rate of wound infection was low (6.8%) and this could be explained by the fact that there was a low number of patients with perforated appendices. Ricci et al, had post-operative wound infection 8.7% when the appendix was not perforated, while 29.5% with a perforated appendix.

High-risk patients with perforated appendicitis were found to have a lower infection rate with routine antibiotic use. Nevertheless, antibiotics would undoubtedly prevent septic complications and is fully justified. None of the patients in this study developed sepsis.

The development of wound infection in patients prolonged both the hospital stay and the duration of antibiotic therapy.
Conclusion Incidence of acute appendicitis is relatively high in Bahrain. Most patients are less than 40 years of age. Bacterial role in the aetiology is suspected, especially by E. coli which has recently been implied as the etiological agent in bacterial ileocitis. Its precise role in acute appendicitis warrants further investigation.

References

التهاب الزائدة في البحرين
دراسة عن معدل الانتشار،الوجود الجرثومي
وخصوص الجرح بعد العملية الجراحية

عزيز يوسف،عبد الرحمن فخر،محسن العريض، وإيهان فريد.

الهدف: دراسة معدل الانتشار التهاب الزائدة في البحرين،الوجود الجرثومي وخصوص الجرح بعد العملية الجراحية.

التصميم: دراسة تقدمية استغرقت 24 شهرًا تم فيها تشريح مرضى نسيجى وعمل مزرعة جرثومية للجرح.

المكان: المختبر وقسم الجراحة بمركز السلمانية العالي بالبحرين.

الأشخاص: شملت الدراسة 522 مريضًا من أجريت لهم عملية استئصال الزائدة ودرس 192 مريضًا منهم دراسة جرثومية.

النتائج: معظم الحالات (96%) حدثت عند مرضى أقل من أربعين عامًا وأثبتت الدراسة النسبية المرضية أن 12% من الزائدة كانت متوقعة،وكانت نتيجة المزرعة الجرثومية عند 101 مريض من 192 (53%) وعزلت الجراثيم من 90 مريضًا (47%) وكانت أعلى نسبة مزرعة موجبة هي حالات التهاب الزائدة اللثاني (90%) ثم التهاب الزائدة الموائي (67%) ثم التهاب الزائدة الحاد (37%) وجرثومة (الأشوكيكية القولونية) كانت هي السائدة (48%) أما العصوانات فكانت بنسبة (7%) من الجراثيم الإجمالية المزعولة.

وقد كانت نسبة الإصابة الإجمالية بخصوص الجرح ما بعد الجراحة (8,6%) وجرثومة (الأشوكيكية) كانت السائدة ما بين الجراثيم الهوائية أما جرثومة (العصوانات) فكانت هي النوع السائد ما بين الجراثم اللاهوائية ولوحظ أن (75%) من الجراثيم المزعولة كانت من عائلة الأمراضيات.

الاستنتاج: عند التهاب الزائدة مرتفع نسبى في البحرين وقد يكون للدكتورا دور في المسببات، وخاصة جرثومة الأشوكيكية القولونية التي يوصي بدراسة دورها في أحداث الالتهاب الحاد للزائدة.