Predictive Value of Diameter of Appendix on Ultrasound Examination and in Appendectomy Specimens in Acute Appendicitis

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Gurmeet Singh Sarla. Predictive Value of Diameter of Appendix on Ultrasound studies in cases of Acute Appendicitis over a period of two years in a peripheral hospital. The diameter of appendix specimens sent for histopathological examination after appendectomy were also analysed. A total of 91 appendectomies were done over a period of two years in a peripheral hospital in Nasik, India. Out of the 91 patients who underwent appendectomy, 13 patients (14.28%) showed the appendicular diameter between 5.1-6.0mm on Ultrasound examination, 21 patients (23.07%) had an appendicular diameter between 6.1-7.0mm, 35 patients (38.46%) had an appendicular diameter between 7.1-8.0mm and 22 patients (24.17%) revealed an appendicular diameter of more than 8mm. Specimens of appendices sent to Pathological Lab postoperatively were studied which showed diameter between 2.1-3.0mm in 15 patients (16.48%), 24 specimens (26.37%) showed diameter between 3.1-4.0mm, 28 specimens (30.76%) measured between 4.1-5.0mm and 20 appendicular specimens (21.97%) were of the diameter more than 5mm. The shrinkage effects of formalin fixation and histological processing might have resulted in the decrease in diameter of appendix on histopathological examination as compared to that on Ultrasound studies.

Abstract
Emergency Appendicectomy is the most commonly performed surgery world over. A retrospective study was carried out to analyse the diameter of appendix on Ultrasound studies in cases of Acute Appendicitis over a period of two years in a peripheral hospital. The diameter of appendix specimens sent for histopathological examination after appendectomy were also analysed. A total of 91 appendectomies were done over a period of two years in a peripheral hospital in Nasik, India. Out of the 91 patients who underwent appendectomy, 13 patients (14.28%) showed the appendicular diameter between 5.1-6.0mm on Ultrasound examination, 21 patients (23.07%) had an appendicular diameter between 6.1-7.0mm, 35 patients (38.46%) had an appendicular diameter between 7.1-8.0mm and 22 patients (24.17%) revealed an appendicular diameter of more than 8mm. Specimens of appendices sent to Pathological Lab postoperatively were studied which showed diameter between 2.1-3.0mm in 15 patients (16.48%), 24 specimens (26.37%) showed diameter between 3.1-4.0mm, 28 specimens (30.76%) measured between 4.1-5.0mm and 20 appendicular specimens (21.97%) were of the diameter more than 5mm. The shrinkage effects of formalin fixation and histological processing might have resulted in the decrease in diameter of appendix on histopathological examination as compared to that on Ultrasound studies.

Keywords: Acute Appendicitis, Diameter of Appendix, Appendectomy, Histopathology, Ultrasound

Introduction
The Vermiform Appendix is a tubular structure attached to the base of caecum at the confluence of taenia coli. It is approximately 8-10cm long in adults and represents the underdeveloped distal end of large caecum seen in other animals. The diameter of the normal appendix (mean anteroposterior diameter 4.4±0.9mm, mean transverse diameter 5.1±1.0mm) does not change with age and is normally distributed in children [1]. In 2015, Trout et al. studied diameters in the Ultrasound diagnosis of Acute Appendicitis in children using cut-off diameters to define 3 categories (diameter ≤6mm, >6mm to 8mm, >8mm), and inferred that Acute Appendicitis was present in these categories in 2.6%, 65% and 96%, respectively [2]. Real-time compression Ultrasound was first introduced by Puylaert [3]. Graded-compression US is performed in a step-wise approach and aims to optimize visualization of the appendix [4].

Materials and Methods
This is a retrospective study and Ultrasound reports of all cases operated for Acute Appendicitis were analysed. All surgically resected appendices submitted for histopathology were studied and data including diameter of appendicular specimens was analysed.

Negative appendectomy was defined as one which is performed for a clinical or sonological diagnosis of acute appendicitis but in which the appendix is found to be normal on histopathological examination with no evidence of inflammation.

Results
A total number of 91 patients underwent Appendicectomy over a period of two years in the department of surgery of a peripheral hospital in Nasik, India. Out of the 91 patients, on preoperative Ultrasound examination, 13 patients (14.28%) showed the appendicular diameter between 5.1-6.0mm.

21 patients (23.07%) had an appendicular diameter between 6.1-7.0mm.
35 patients (38.46%) had an appendicular diameter between 7.1-8.0mm
22 patients (24.17%) revealed an appendicular diameter of more than 8mm.
Specimens of appendices sent to Pathological Lab postoperatively were studied which showed diameter between 2.1-3.0mm in 15 patients (16.48%),
24 specimens (26.37%) showed diameter between 3.1-4.0mm.
28 specimens (30.76%) measured between 4.1-5.0mm.
20 appendicular specimens (21.97%) were of the diameter more than 5mm. (Table 1-2)

Table 1: Diameter of Appendix on Ultrasound examination.

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Number of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1-6.0 mm</td>
<td>13</td>
</tr>
<tr>
<td>6.1-7.0 mm</td>
<td>21</td>
</tr>
<tr>
<td>7.1-8.0 mm</td>
<td>35</td>
</tr>
<tr>
<td>&gt;8 mm</td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td>91</td>
</tr>
</tbody>
</table>

Table 2: Size of Appendix specimen

<table>
<thead>
<tr>
<th>Size</th>
<th>Number of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1-3.0 mm</td>
<td>15</td>
</tr>
<tr>
<td>3.1-4.0 mm</td>
<td>24</td>
</tr>
<tr>
<td>4.1-5.0 mm</td>
<td>28</td>
</tr>
<tr>
<td>&gt;5 mm</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>91</td>
</tr>
</tbody>
</table>

Discussion

The cause of acute appendicitis is unknown but is probably multifactorial. Luminal obstruction, dietary and familial factors have all been suggested [5]. When luminal obstruction occurs, intraluminal pressure surpasses that in the appendiceal veins, causing venous outflow obstruction. Finally ischemia develops in the appendiceal wall which weakens the epithelial integrity and increases the organ's risk of bacterial invasion. Lymphoid hyperplasia and fecoliths are the most common cause of luminal obstruction.

Appendicitis is the most common abdominal emergency and accounts for more than 40000 hospital admissions in England every year [6]. This makes the appendix one of the most commonly received specimen in the histology department. The life time risk of appendicitis is 7%, commonly occurring in adolescents and young adults [7]. Appendicitis is most common in the age group of 10-20 years but no age is exempt [8]. Diagnostic sequence of abdominal pain followed by vomiting with migration of pain to right iliac fossa was first described by Murphy but may be present in only 50% of patients [9]. Percussion tenderness, guarding and rebound tenderness are most reliable clinical findings indicating a diagnosis of acute appendicitis [7]. The diagnosis is predominantly a clinical one [10]. As ultrasonography studies are operator dependent and need careful examination, use of computed tomography in preference to ultrasonography is recommended as it has a greater diagnostic accuracy [11,12].

The rate of acute appendicitis varies among countries. Declining rates have been reported in the United states and Europe [13]. In developing countries, the incidence is increasing in most urban centres, probably due to adoption of western diet [14].

The diagnosis of acute appendicitis relies on an evaluation of the patient's history, laboratory and radiologic findings, as well as the surgeon's subjective judgment based on experience. However, the reported rates of histology-proven negative cases following appendectomy have ranged between 9.2% and 35.0%. The rates of negative cases are particularly high for women during childbearing years [15]. However, if patients requiring surgery are denied the procedure in order to avoid the risk of performing a negative laparotomy, there may be an increased risk of undesirable clinical events, such as perforation. As Acute Appendicitis with perforation is associated with significant morbidity and an increase in mortality, there is broad agreement that high rates of negative appendectomies (around 15%) have to be accepted in order to reduce the rate of perforation. Multi-detector computed tomography (MDCT) is considered the gold standard technique to evaluate patients with suspected Acute Appendicitis, because of its high sensitivity and specificity. Magnetic resonance imaging (MRI) has also shown high accuracy in the detection of AA, especially when radiation protection in children and in pregnant patients is of major importance. It is crucial to avoid two potential situations in patients with suspected Acute Appendicitis viz delay in diagnosis leading to perforation of the appendix and negative appendectomy.

Preoperative imaging studies in the form of MRI, CT scan or Sonography improve upon these due to the potential for early diagnosis and the high sensitivities (CT scan, MRI) and specificities (Ultrasound, CT scan, MRI) of these techniques.

Ultrasoundography: Real-time compression Ultrasoundography was first introduced by Puylaert in 1986 [3]. Graded-compression US is performed in a step-wise approach and aims to optimize visualization of the appendix [4]. In 2015, Trout et al. studied diameters in the Ultrasound diagnosis of Acute Appendicitis in children using cut-off diameters to define 3 categories (diameter ≤6mm, >6mm to 8mm, >8mm), and inferred that Acute Appendicitis was present in these categories in 2.6%, 65% and 96% respectively [2]. (Table 3)

In a recent review of the literature, there was an extremely variable diagnostic accuracy of US with sensitivities ranging from 44% to 100% and specificities ranging from 47% to 100% [19]. Ultrasound diagnosis relies on the “direct” visibility of the appendix and on “indirect” signs for local inflammation [20].
Table 3: Direct and indirect (secondary) signs of acute appendicitis

<table>
<thead>
<tr>
<th>Direct signs</th>
<th>Indirect signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non compressibility of the appendix</td>
<td>Free fluid surrounding the appendix</td>
</tr>
<tr>
<td>Perforation: appendix might be compressible</td>
<td></td>
</tr>
<tr>
<td>Diameter of appendix &gt; 6mm.</td>
<td>Local abscess formation</td>
</tr>
<tr>
<td>Single wall thickness &gt; 3mm.</td>
<td>Increased echogenicity of local mesenteric fat</td>
</tr>
<tr>
<td>Target sign: Hypoechoic fluid filled lumen.</td>
<td>Enlarged local mesenteric lymph nodes</td>
</tr>
<tr>
<td>Hyperechoic mucosa/ submucosa.</td>
<td>Hypoechoic muscularis layer</td>
</tr>
<tr>
<td>Appendicolith : hyperechoic with posterior shadowing</td>
<td>Thickening of peritoneum</td>
</tr>
<tr>
<td>Colour Doppler and contrast enhanced Ultrasound: Hypervascularity in early stages of Acute Appendicities.</td>
<td>Signs of secondary small bowel obstruction</td>
</tr>
<tr>
<td>Hypo to avascularity in abscess and necrosis</td>
<td></td>
</tr>
</tbody>
</table>

Real-time Ultrasound signs of Acute Appendicitis [4,16,17,18]:

Formalin acts by diffusing through the tissue and binding to amino groups, precipitating the formation of an extensive network of cross-linked proteins and nucleic acids, which can cause histological changes, such as cell shrinkage and distortion [21]. These cellular changes can have a global effect on the whole tissue specimen. This formalin-induced shrinkage effect occurs in a range of specimens, including those from the lung, gastrointestinal system, oral cavity, vulva and breast [21]. In the previously published studies, the percentage of shrinkage from the fixed to the microscopic measurements ranged from approximately 10% to 27%, and the overall percentage of shrinkage from fresh to microscopic measurements ranged from 4.5% to 41% [22].

Conclusion

In Acute Appendicitis, the appendicular diameter on Ultrasound examination was generally more than 6mm with or without indirect evidence in the form of presence of fluid in the Right paracolic gutter. Non visualisation of Appendix on Ultrasound examination should be assessed and reassessed clinically and operated upon if repeated clinical examinations are suggestive of features of Acute Appendicitis. In an ideal medical world, we would like to optimally diagnose and treat all patients with suspected Acute Appendicitis without negative appendectomies. Our outcomes revealed that diameter of Appendix on Ultrasound studies are larger than pathologic measurements done by the Pathologist for histopathological studies of the specimen. The shrinkage effects of formalin fixation and histological processing might have resulted in the decrease in diameter of appendix on histopathological examination as compared to that on Ultrasound studies.

References


